HANDBOOK OF STRUCTURAL STEELWORK

EUROCODE EDITION

BCSA

TATA STEEL

SCI
Steel Knowledge

BCSA Publication No. 55/13

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THE BRITISH CONSTRUCTIONAL STEELWORK ASSOICIATION LIMITED

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The British Constructional Steelwork Association Ltd.
4 Whitehall Court, London, SW1A 2ES.
Telephone: +44 (0) 20 7839 8566   Fax: +44 (0) 20 7976 1634
Email: postroom@steelconstruction.org

Website: www.steelconstruction.org
www.steelconstruction.info

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The Steel Construction Institute, Silwood Park, Ascot, Berkshire, SL5 7QN.
Telephone: +44 (0) 1344 636525   Fax: +44 (0) 1344 636570
Email: reception@steel-sci.com

Website: www.steel-sci.org

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Tata Steel, PO Box 1, Scunthorpe, North Lincolnshire, DN16 1BP
Telephone: +44 (0) 1724 404040
Email: construction@tatasteel.com

Website: www.tatasteeleurope.com

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Jointly published by

The British Constructional
Steelwork Association Ltd
4 Whitehall Court
London SW1A 2ES

Tel: +44 (0) 20 7839 8566
Fax : +44 (0) 20 7976 1634

The Steel Construction Institute
Silwood Park
Ascot
SL5 7QN

Tel: +44 (0) 1344 636525
Fax: +44 (0) 1344 636570

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FOREWORD

The objective of this publication is to present a practical guide to the design of structural steel elements for buildings. The document comprises three principal Sections: general guidance, general design data and design tables.

Generally the guidance is in accordance with BS EN 1993-1-1: 2005 *Eurocode 3: Design of steel structures – Part 1.1: General rules and rules for buildings,* its UK National Annex and other relevant Eurocodes. Worked examples are presented where appropriate. No attempt has been made to consider complete structures, and it is to be noted therefore that certain important design matters are not dealt with - those for instance of overall stability, of interaction between components and of the overall analysis of a building.

The Section on General Design Data includes bending moment diagrams, shear force diagrams and expressions for deflection calculations. A variety of beams and cantilevers with different loading and support conditions are covered. Expressions for properties of geometrical figures are also given, together with useful mathematical solutions.

The design tables also include section property, member resistance and ultimate load tables calculated according to BS EN 1993-1-1: 2005 and its associated National Annex. The tables are preceded by a comprehensive set of explanatory notes. Section ranges include universal beams and columns, joists, parallel flange channels, asymmetric beams, equal angles, unequal angles, equal angles back-to-back, unequal angles back-to-back, Tees cut from universal beams and columns, hot-finished circular, square and rectangular hollow sections and cold-formed circular, square and rectangular hollow sections. The range includes the Tata Steel Advance® sections. In addition to the BS section designation, the tables also provide the Advance®, Celsius® and Hybox® branding. The relationship between the branded sections/steel grade and the BS sections/steel grades is given in Section 11 of the explanatory notes.

The member resistance tables also include the resistances for commonly used non-preloaded and preloaded bolts together with the longitudinal and transverse resistances of fillet welds.

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Dr D. B. Moore	The British Constructional Steelwork Association
Mr. D. G. Brown	The Steel Construction Institute
Dr R. J. Pope	The British Constructional Steelwork Association

Valuable comments were also received from:

Mr. A. S. Malik	The Steel Construction Institute
Mr. D. C. Iles	The Steel Construction Institute

The section property and member resistance tables for this edition were produced by Miss E. Nunez Moreno formerly of the Steel Construction Institute.

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CHAPTER 1 - GENERAL DESIGN CONSIDERATIONS

1.1 Design aims

The aim of any design process is the fulfilment of a purpose, and structural steelwork design is no exception. In building design, the purpose is most commonly the provision of space that is protected from the elements. Steelwork is also used to provide internal structures, particularly in industrial situations.

The designer must ensure that the structure is capable of resisting the anticipated loading with an adequate margin of safety and that it does not deform excessively during service. Due regard must be paid to economy which will involve consideration of ease of manufacture, including cutting, drilling and welding in the fabrication shop and transport to site. The provision and integration of services should be considered at an early stage and not merely added on when the structural design is complete. The need to consider buildability also arises under the Construction (Design and Management) Regulations 2007 [1], as the designer has an obligation to consider how the structure will be erected, maintained and demolished. Sustainability issues such as recycling and reuse of materials should also be considered. Any likely extensions to the structure should be considered at this stage in the process.

1.2 Introduction to BS EN 1990

BS EN 1990 Eurocode - *Basis of structural design* [2] establishes the common principles and requirements that apply to all aspects of structural design to the Eurocodes. These include requirements for safety, serviceability and durability of structures. In BS EN 1990, loads and imposed deformations and accelerations are classed together as ‘Actions’. BS EN 1990 also sets out the method/s for determining the effects of combined actions. A full description of the combinations given in BS EN 1990 is beyond the scope of this publication and the reader is referred to the Designers’ Guide to EN 1990 [3].

In BS EN 1990, actions are classified by their variation with time, as permanent, variable or accidental actions. These three types of action (loading) are briefly described below:

(i) Permanent actions (dead loads)
Permanent actions are those that do not vary with time, such as the self-weight of a structure and fixed equipment. These have generally been referred to as dead loads in previous British Standards.

(ii) Variable actions (live loads)
Variable actions are those that can vary with time. Gravity loading due to occupants, equipment, furniture, material which might be stored within the building, demountable partitions, snow load and wind pressures are all variable actions on building structures. These have generally been referred to as live loads in previous British Standards.

(iii) Accidental actions
Accidental actions result from exceptional conditions such as fire, explosion and impacts.

1.3 Limit state design

In the limit state design approach given in the Eurocodes the actions (loads) are multiplied by partial factors for actions and member resistances are determined using the material strength divided by a partial factor for the material and type of member resistance.

The values of the partial factors for actions are given in BS EN 1990 and its associated National Annex [4] and vary according to the design situation to reflect the required reliability for each specified situation. Reduction factors are applied to the partial factors when actions are combined as it is less likely that, for example, maximum wind will occur with maximum imposed load.

The procedures used to determine the recommended values of partial and combination factors are explained in an Annex to BS EN 1990 in terms of the overall target reliability for construction.

The values of the material partial factors are given in the appropriate material Eurocodes and their associated National Annex (i.e. BS EN 1992, BS EN 1993, BS EN 1994, BS EN 1995, BS EN 1997 and BS EN 1999). These values reflect the reliability in determining the resistance of elements of the relevant material or product.

BS EN 1990 identifies two fundamentally different types of limit state. These are:

- Ultimate limit states
- Serviceability limit states

1.3.1 Ultimate limit states

The ultimate limit states are associated with collapse and other forms of structural failure. The regulatory provisions are concerned with the safety of people through the safety of the structure. In some cases, designers need to consider other requirements such as the protection of the structure's contents (e.g. a warehouse for classified pharmaceuticals or a museum housing irreplaceable art). BS EN 1990 lists the following ultimate limit states:

- EQU: Loss of static equilibrium of the structure or any part of the structure
- STR: Internal failure or excessive deformation of the structure or structural members
- GEO: Failure or excessive deformation of the ground
- FAT: Fatigue failure of the structure or structural members

The application of these ultimate limit states to the design of structural steelwork is explained in Section 1.5.

1.3.2 Serviceability limit states

Serviceability limit states (SLS) correspond to the limit beyond which the specified service criteria are no longer met. In particular, they concern the functioning of the structure or structural members, comfort of people and the appearance of the structure. Serviceability loads are taken as unfactored loads with appropriate combination factors.

BS EN 1990 identifies three combinations of actions for serviceability. These relate to irreversible serviceability limit states, reversible serviceability limit states and a third one relating to long term effects and the appearance of the structure. The latter is not generally of concern in the design of steel structures.

Irreversible serviceability limit states are those limits that are permanently exceeded when the load is removed. (e.g. local damage or permanent deflections).

Reversible serviceability limit states are those limit states that are not exceeded when the load is removed (e.g. elastic deflections or vibrations).

For most steel buildings the reversible serviceability limit states apply, although the irreversible situation may apply to cracking in concrete and steel composite structures.

1.3.3 Structural integrity

The requirement for structural integrity or robustness is additional to the ultimate and serviceability limit state requirements. Structural integrity/robustness is the ability of a structure to withstand an event without being damaged to an extent disproportionate to the original cause. The events referred to include explosions, impact and the consequences of human error. To ensure that the damage is not disproportionate, BS EN 1990 requires the designer to choose one or more of the following measures:

- Avoiding, eliminating or reducing the hazard to which the structure can be subjected
- Selecting a structural form which has a low sensitivity to the hazards considered
- Selecting a structural form and design that will survive adequately the removal of an individual element or limited part of the structure or the occurrence of acceptable localised damage
- Avoiding as far as possible a structural system that can collapse without warning
- Tying the structural members together

In terms of buildings, adequate structural integrity is usually achieved by ensuring that key elements are not susceptible to damage (due to a notional accidental action), by providing redundancy in the structure, such that only localised damage occurs, or by providing details that are sufficiently robust to tie the structural members together.

1.3.4 Durability

With respect to durability, BS EN 1990 states '*The structure shall be designed such that deterioration over its design working life does not impair the performance of the structure below that intended, having due regard to its environment and the anticipated level of maintenance*.' It recommends that to achieve a durable structure the following factors should be taken into account:

- The intended or foreseeable use of the structure,
- The required design criteria,
- The expected environmental conditions,
- The composition, properties and performance of the materials and products,
- The properties of the soil,
- The choice of the structural system,
- The shape of members and the structural detailing,
- The quality of workmanship, and the level of control,
- The particular protective measures,
- The intended maintenance during the design working life.

1.4 Actions – Eurocodes

The values to be adopted for the different types of actions are given in EN 1991 – Eurocode 1: *Actions on Structures*. This Eurocode has the following four main Parts:

BS EN 1991-1 – General actions

BS EN 1991-2 – Traffic loads on bridges [5]

BS EN 1991-3 – Actions induced by cranes and machinery [6]

BS EN 1991-4 – Actions in silos and tanks [7]

Part 1 is sub-divided into seven Parts, which provide designers with most of the information required to determine each individual action on a structure. The seven Parts are:

BS EN 1991-1-1 – Densities, self-weight, imposed loads for buildings [8]

BS EN 1991-1-2 – Actions on structures exposed to fire [9]

BS EN 1991-1-3 – Snow loads [10]

BS EN 1991-1-4 – Wind actions [11]

BS EN 1991-1-5 – Thermal actions [12]

BS EN 1991-1-6 – Actions during execution [13]

BS EN 1991-1-7 – Accidental actions [14]

The main Parts used for the design of buildings are briefly described below, with reference to previous British Standards.

BS EN 1991-1-1 replaces BS 6399-1 [15].

BS EN 1991-1-3 replaces BS 6399-3 [16]. It is used to determine snow loads, although some of the terminology may be unfamiliar. The UK National Annex [17] specifies the use of a different snow map from that in BS 6399-3. This map in the National Annex is zoned with altitude adjustments, whereas the previous map had isopleths; the National Annex map benefits from better analysis of the latest data from the meteorological office.

BS EN 1991-1-4 replaces BS 6399-2[18] but has a major difference in that the basic wind velocity is based on a 10 minute mean wind speed, as opposed to the hourly mean wind speed in BS 6399-2 and the reference height has changed. The UK National Annex [19] provides a new wind map on this basis.

A fuller description of each of these parts can be found in references [20], [21] and [22].

1.5 Design basis for structural steelwork

Ultimate Limit States

In the context of structural steelwork in buildings, the EQU limit state (overturning as a rigid body) and the STR limit state (internal failure) are of main concern. These relate to the following design issues:

i) Loss of equilibrium of the structure
ii) Strength failure
iii) Instability due to buckling
iv) Sway instability
v) Brittle fracture

For structures subject to fatigue loading, the FAT limit state must also be considered.

i) Loss of equilibrium

The ultimate limit state of static equilibrium comprises the limit states of overturning, uplift (e.g. raised by buoyancy) and sliding. Overturning of the structure (or part of it) involves rotation of the structure as a rigid body. This is often relevant for tall structures such as towers subjected to wind and it is normal practice to consider the structure as a rigid body rotating about a point. Uplift is the lifting of the structure off its seating while sliding is the movement of the structure on its foundations. In all cases, it is normal practice to consider the structure as a rigid body and the design issues are focussed on the means of securing the structure to its foundations and on the security of the foundations themselves.

ii) Strength failure

Yielding of the steel can lead to rupture (i.e. a strength failure) or buckling (i.e. instability) or a combined failure, any of which would limit the load carrying capacity of the structure. Ties and similar components in tension such as bolts are unaffected by buckling and will be limited by their strength to resist rupture. Columns and other members in compression will be limited by their resistance to buckling (see below) unless they are short enough to accept the full “squash load”. Strength considerations are most likely to be relevant in connection zones where forces are concentrated in local areas of high compression/tension.

iii) Instability due to buckling
Buckling is a complex phenomenon and occurs where unrestrained out-of-plane movement occurs before the full compressive strength can be developed. For individual components, this can occur in columns subjected principally to compression, in beams subjected principally to bending and in members (beam-columns) subjected to a combination of compression and bending. There can be several modes of buckling. The most common modes are flexural buckling (Euler buckling) of columns and lateral-torsional buckling of beams. Local elements of a built-up member (such as the web of a plate girder) may also fail by local shear buckling before the whole member becomes unstable. In addition, a built-up frame such as a portal frame may be limited in strength by its ability to resist global buckling.

In all cases of buckling (local, member or global), the limit of resistance is determined by the weakest buckling mode and this is determined by the restraints provided by the designer to resist out-of-plane movement. Examples are web stiffeners in plate girders, use of side rails to restrain columns and use of purlin systems and knee braces to resist buckling in portal frames.

iv) Sway instability
Instability can arise due to lateral deflection (or sway) of the whole structure. If sway deflections due to horizontal forces become too large then excessive secondary effects can become significant. With respect to the secondary effects arising from sway, the design requirements are discussed further in Section 1.6.2.

v) Brittle fracture
This is a phenomenon in which steel loses its normal ductility and fails in a brittle manner. It is avoided by ensuring that the steel used (for all components, including welds) has adequate notch toughness. Brittle fracture is more likely with low temperatures, large steel thickness, high tensile stresses, high strain rates and details that include stress raisers such a holes and welds. The higher the risk of brittle fracture, the tougher the specified steel must be. The requirements for material toughness are expressed in BS EN 1993-1-10[23] in terms of a maximum permitted thickness that depends on the grade and sub-grade of the steel, the maximum stress at the relevant location and a reference temperature. The reference temperature is not simply the lowest steel temperature but the lowest temperature plus adjustments for detail category (local stress raisers), strain rate etc.

The National Annex for BS EN 1993-1-10 [24] simplifies the whole procedure and refers to PD 6695-1-10 [25], which provides simple look-up tables for maximum thicknesses for internal and external steelwork in buildings.

vi) Fatigue
Fatigue (FAT) is rarely a problem in building structures as it happens when a very large number (of the order of 2×10^6 cycles) of stress reversals of a significant magnitude occur. The only time that this is likely to cause concern is in buildings containing heavy vibrating plant or machinery, such as printing presses or cranes.

Serviceability Limit States
The serviceability limit states that affect the use and appearance of buildings include deflections and vibrations. Each of these is considered below.

i) Deflections
Although a structure may have adequate strength, deflections at the specified characteristic design loading may still be unacceptable. Such distortion may result in doors or windows being inoperable and plaster and other brittle finishes cracking. Clauses NA 2.23 and NA 2.24 of the National Annex to BS EN 1993-1-1[26] give suggested limits for a variety of conditions, some of which are listed below in Tables 1.1 and 1.2. Note that the clauses refer to the limits as "suggested limits for calculated deflections". This is because a general standard cannot give definitive values to cater for all cases and it is essential for the designer to exercise judgement in determining the requirements for each specific case considered.

Table 1.1: Suggested limits for calculated vertical deflections at SLS

Vertical deflections	**Limit**
Cantilevers	Length/180
Beams carrying plaster or other brittle finish	Span/360
Other beams (except purlins and sheeting rails)	Span/200
Purlins and sheeting rails	To suit the characteristics of particular cladding

Table 1.2: Suggested limits for calculated horizontal deflections at SLS

Horizontal deflections	**Limit**
Tops of columns in single-storey buildings except portal frames	Height/300
Columns in portal frame buildings, not supporting crane runways	To suit the characteristics of the particular cladding
In each storey of a building with more than one storey	Height of that storey/300

ii) Vibrations and wind induced oscillations
Traditionally, this has been deemed to be a problem only for masts and towers when wind oscillations have needed attention, or in structures supporting vibrating machinery. Vibrations are not usually a problem with normal buildings unless spans are large, say in excess of 9m, or for the floors of dance halls or gymnasia that are subject to rhythmic loading. The solution to any problem is not simply to over-design the members but rather to investigate the natural frequency of the structural system, which should differ significantly from the frequency of the disturbing forces so that resonance does not occur. An SCI publication gives guidance on this topic [27].

Durablilty
The durability of a steel structure is its expected life to its first maintenance. The factors that influence durability are the structure's intended use (in particular the corrosivity category of its environment) and how its maintenance requirements relate to its overall intended design life. The use of BS EN ISO 12944 [28] for paints and varnishes and BS EN ISO 14713 [29] for zinc and aluminium coatings are recommended as references for the provision of suitable anti-corrosion protection schemes.

Consideration should be given to the environment and degree of exposure for each component, as well as to the level and ease of maintenance after completion. In particular, care should be taken to avoid detailing that produces pockets in which water and dirt can accumulate. Helpful information can be found in guides to corrosion [30], which note that, steel will corrode only if exposed to air and water together. In certain circumstances such as the interiors of multi-storey buildings, untreated steelwork may well be acceptable.

1.6 Steel structures – Eurocode 3

1.6.1 Structural analysis

To check the strength of the members and the stability of a steel framed structure it is first necessary to determine the internal forces in the structure, in which the behaviour of the joints is fundamental. BS EN 1993-1-1 gives three joint methods:

- Simple, in which the joint is assumed not to transmit bending moments;
- Continuous, in which the joint transmits bending moments but the flexibility of the joint is assumed to have no effect on the analysis
- Semi-continuous, in which the joint transmits bending moments but the flexibility of the joint needs to be taken into account in the analysis

Elastic, plastic and elastic-plastic methods of global analysis can be used with any of these three methods.

BS EN 1993-1-8 [31] gives separate definitions for the terms ‘connection’ and ‘joint’. A connection is the location where two or more elements meet and a ‘joint’ is defined as the zone where two or more elements are interconnected. For design purposes, a connection is the assemblage of basic components (i.e. the end-plate, bolts welds etc.) whereas a joint consists of the web panel and either one or two connections. These definitions are shown in Figure 1.1.

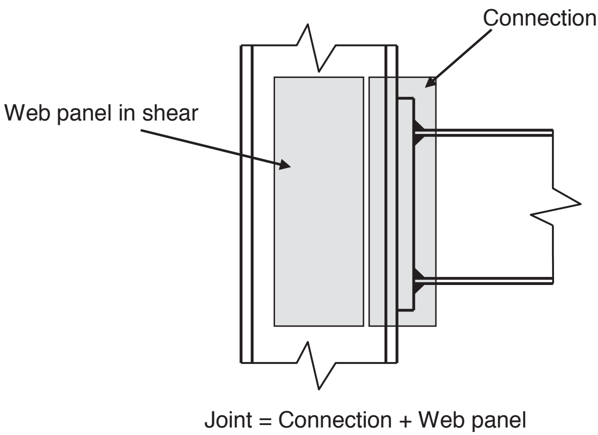


Figure. 1.1 Definition of the terms Joint and Connection

Table 1.3 shows how the joint classification, the joint model and the method of global analysis are related.

Table 1.3 – Classification of joints

Method of global analysis	Classification of joint, according to joint model		
	Simple	*Continuous*	*Semi-continuous*
Elastic	Nominally-pinned	Rigid	Semi-rigid
Rigid-plastic	Nominally-pinned	Full-strength	Full or partial-strength and semi-rigid or partial-strength and rigid
Elastic-Plastic	Nominally-pinned	Rigid and full-strength	Semi-rigid and partial strength

Joints may be classified by their stiffness and by their strength. Based on stiffness joints can be classified as nominally pinned, semi-rigid or rigid. Based on their strength, joints can be classified as pinned, partial-strength or full-strength. Alternatively, joints can be classified on the basis of previous satisfactory experience. The joints given in the BCSA/SCI publications for simple joints [32] and moment-resisting joints [33] may be assumed to be nominally pinned and rigid respectively.

The vast majority of designs assume the joints are either nominally pinned or rigid to render design calculations manageable.

It is convenient to relate the type of joint to the terms used for design approaches commonly used in the UK – thus in 'simple design', the joints are idealised as perfect pins, in 'continuous design' the joints are assumed to be rigid with no relative rotation of connected members whatever the applied moment, and in semi-continuous design, in which the true behaviour of the joint is taken into account. A brief description of each of these approaches is given below.

Simple design

Simple design is the most traditional approach and is still commonly used. It is assumed that no moment is transferred from one connected member to another except for the nominal moments which arise as a result of eccentricity at joints. The resistance of the structure to lateral loads and sway is usually ensured by the provision of steel bracing or in some multi-storey buildings by concrete cores.

It is important that the designer recognises the assumptions regarding connection response and ensures that the detailing of the connections is such that no moments develop which adversely affect the performance of the structure. Many years of experience have demonstrated the types of details that satisfy this criterion and the designer should refer to the standard connections given in the BCSA/SCI publication on joints in simple construction [32].

Continuous design

In continuous design, it is assumed that joints are rigid and transfer moment between members. The stability of the frame against sway is by frame action (i.e. by bending of beams and columns). Continuous design is more complex than simple design, therefore software is commonly used to analyse the frame. Realistic combinations of pattern loading must be considered when designing continuous frames. The joints between members must have different characteristics (i.e. stiffness, strength and rotation capacity) depending on whether the design method for the frame is elastic or plastic.

In elastic design, the joint must possess rotational stiffness to ensure that the distribution of forces and moments around the frame correspond to those calculated. The joint must be able to carry the full moments, forces and shears arising from the frame analysis.

In plastic design, when determining the ultimate load capacity, the strength (not stiffness) of the joint is of prime importance. The strength of the joint will determine if hinges occur in the joints or the members, and will have a significant effect on the collapse mechanism. If hinges are designed to occur in the joints, they must be detailed with sufficient ductility to accommodate the resulting rotations.

The stiffness of the joints will be important when calculating beam deflections, sway deflections and sway stability.

Semi-continuous design

True semi-continuous design is more complex than either simple or continuous design as the real joint response is more realistically represented.

Similar to continuous design, connections between members must have different characteristics depending on whether the design method for the frame is elastic, plastic or elastic-plastic.

In elastic design, the joint must possess rotational stiffness but unlike continuous elastic design, the stiffness of the joint can be semi-rigid.

In plastic design, the joint must possess strength. In semi-continuous design, the joint can have a lower moment capacity than the connected members. These joints are called partial-strength. In this case, the joint will plastify before the connected member and must therefore possess sufficient ductility (i.e. rotational capacity) to allow plastic hinges to form in other parts of the structure.

Where elastic-plastic design is used the joints must possess stiffness, strength and rotational capacity. These joints are called semi-rigid, partial strength connections.

The wind moment method is a kind of semi-continuous method for unbraced frames. In this procedure, the beam-to-column joints are assumed to be pinned when considering gravity loads. However, under wind loads they are assumed to be rigid, which means that lateral loads are carried by frame action. A fuller description of the method can be found in reference [34].

1.6.2 Sway stiffness

BS EN 1993-1-1[35] requires the effects of deformed geometry (second order effects) to be taken into account in frame analysis if they significantly increase the effects (moments and forces) in the members. The sensitivity to second order effects is measured by the α_{cr} parameter, which represents the factor by which the vertical design loading would have to be increased to cause overall elastic buckling of the frame (see Clause 5.2.1(3) of BS EN 1993-1-1). If the parameter exceeds the following simplified limits, given in Clause 5.2.1 of BS EN 1993-1-1, second order effects may be neglected:

$$\alpha_{cr} = \frac{F_{cr}}{F_{Ed}} \geq 10 \text{ for elastic analysis}$$

$$\alpha_{cr} = \frac{F_{cr}}{F_{Ed}} \geq 15 \text{ for plastic analysis}$$

As a guide, for the second order effects to be ignored, a frame should contain a bracing system with a lateral stiffness of at least five times that of the unbraced frame.

For portal frames with shallow roof slopes and beam-and-column type plane frames in buildings, Clause 5.2.1(4) of BS EN 1993-1-1 gives a simplified method for checking sensitivity to second order effects. In these structures α_{cr} may be calculated using the following approximate equation provided that the axial compression in the beams or rafters is not significant (Compression can be significant in most portal frames):

$$\alpha_{cr} = \left(\frac{H_{Ed}}{V_{Ed}}\right)\left(\frac{h}{\delta_{H,Ed}}\right)$$

where:

H_{Ed} is the horizontal reaction at the bottom of the storey due to the horizontal loads (e.g wind) and the equivalent horizontal loads

V_{Ed} is the total design vertical load on the structure at the level of the bottom of the storey under consideration

$\delta_{H,Ed}$ is the horizontal deflection at the top of the storey under consideration relative to the bottom of the storey with all horizontal loads (including the equivalent horizontal loads)

h is the storey height

In cases where α_{cr} is less than 10, the designer is presented with a number of options. These include enhancement of the stability system such that α_{cr} is raised above 10 and hence second order effects may be ignored, making allowance for second order effects by performing a second order structural analysis accounting for deformation of the structure under load, or making allowance for second order effects by approximate means. It should be noted that if α_{cr} is less than 3, then BS EN 1993-1-1 requires a full second order analysis to be performed (See Clause 5.2.2(5) of BS EN 1993-1-1). The different approaches given in BS EN 1993-1-1 are summarised in Table 1.4.

Table 1.4 – Summary of how BS EN 1993-1-1 treats second order effects

Limits on α_{cr}	**Recommendation**	**Outcome**
$\alpha_{cr} > 10$	First order analysis	First order only
$10 > \alpha_{cr} > 3$	First order analysis plus amplified sway method or effective length method	Second order effects by approximate means
$\alpha_{cr} < 3$	Second order analysis	More accurate second order analysis

BS EN 1993-1-1 gives a number of approaches for allowing for second order effects. The first is to include all material and geometrical imperfections in a second order analysis. This approach will require the use of specialist computer programs and is unlikely to be used for regular buildings.

Another more general approach is to separate the global frame imperfections from the local members' imperfections. In this approach, the global imperfections may be replaced by a system of equivalent horizontal forces (EHF). Since frame imperfections are always present, the EHF should be applied to all structures and should be included in all combinations of actions. Further information on EHF is given in Clause 5.3.2(7) of BS EN 1993-1-1.

The most common approximate treatment of second order effects in multi-storey buildings, which may be applied provided that $\alpha_{cr} > 3$, is the 'amplified sway method'. In this method, account for second order effects is made by amplifying all lateral loading on the structure (typically wind loads and EHF) by a factor, denoted herein as k_{amp}, related to the sway stiffness of the structure through the following expression (Equation 5.4 of BS EN 1993-1-1).

$$k_{amp} = \frac{1}{1 - 1/\alpha_{cr}}$$

Design of the individual members now proceeds as described in the later chapters.

1.7 Steel design strength

In the standards for steel products, the specified minimum value of the yield strength and the ultimate strength of steel decrease with increasing thickness. For structural steels, the values are given in the appropriate part of the product standard (e.g. BS EN 10025 [36] for open sections). Table 1.5 gives the values of yield strength and ultimate strength for some of the more common grades of steel, as specified in BS EN 10025-2.

Table 1.5 – Yield strengths and Ultimate strengths from BS EN 10025-2 [36] for some common steel grades

Steel grade	Thickness (mm)	Yield strength, f_y (N/mm^2)	Thickness (mm)	Ultimate strength, f_u (N/mm^2)
S275	≤ 3	275	≤ 3	450 to 580
	≤ 16	275		
	≤ 40	265		
	≤ 63	255	≤ 100	410 to 560
	≤ 80	245		
	≤ 100	235		
	≤ 150	225	≤ 150	400 to 540
S355	≤ 3	355	≤ 3	510 to 680
	≤ 16	355		
	≤ 40	345		
	≤ 63	335	≤ 100	470 to 630
	≤ 80	325		
	≤ 100	315		
	≤ 150	295	≤ 150	450 to 600

BS EN 1993-1-1 states that the nominal values of the yield strength, f_y, and the ultimate strength, f_u for structural steel should be obtained either from Table 3.1 of BS EN 1993-1-1 or from the product standard: the choice is left to the National Annex. The UK National Annex [37] specifies the use of the values given in the appropriate product standard. There are marginal differences between Table 3.1 and the product standards. The value of f_u used in design should be that at the lower end of the range given by the Standard.

1.8 Structural integrity

BS EN 1991-1-7[14] gives recommendations for buildings which include a categorisation of building types into consequence classes that is very similar to the classification system used in Approved Document A [38]. Based on the consequence class of the building, BS EN 1991-1-7 recommends a strategy for achieving an acceptable level of robustness that is very similar to the recommendations for tying and/or the notional removal of supporting members given in Approved Document A.

For framed structures, horizontal ties should be provided around the perimeter of each floor and roof level and internally at right angles to tie the columns and wall elements to the structure of the building. This is most effectively done using members approximately at right angles to each other or by steel reinforcement in concrete floor slabs and profiled steel sheeting in composite steel/concrete flooring systems. These ties should be able to resist a design tensile force of:

For internal ties $T_i = 0.8(g_k + \psi q_k)sL$ or 75kN whichever is the greater
For perimeter ties $T_p = 0.4(g_k + \psi q_k)sL$ or 75kN whichever is the greater

where:

s is the spacing of the ties

L is the span of the tie

ψ is the relevant factor in the expression for combination of action effects for the accidental design situation (see BS EN 1990)

g_k is the characteristic permanent (dead) load

q_k is the characteristic variable (imposed) load

CHAPTER 2 - RESISTANCE OF CROSS-SECTIONS

2.1 Local buckling

The cross-section of most structural members may be considered to be an assemblage of individual parts. As these parts are plate elements and are relatively thin, they may buckle locally when subjected to compression. In turn, this may limit the compression resistance and the bending resistance. This phenomenon is independent of the length of the member and hence is termed local buckling. It is dependent upon a number of parameters. The following are of particular importance:

i) Width to thickness ratio of the individual compression elements. This is often termed the aspect ratio. Wide, thin compression elements are more prone to buckling.

ii) Support condition. This is dependent upon the edge restraint to the individual compression element. If the compression element is supported by other elements along both edges parallel to the direction of the member, then it is called an internal compression part as both edges are prevented from deflecting out of plane. If this condition only occurs along one edge, it is said to be an outstand part as the free edge is able to deflect out of plane. Each half of the flange of an I section is an outstand part; the web is an internal compression part.

iii) Yield strength of the material. The higher the yield strength of the material, the greater is the likelihood of local buckling before yielding is reached.

iv) Stress distribution across the width of the plate element. The most severe form of stress distribution is uniform compression, which will occur throughout a cross-section under axial compression or in the compression flange of an I section in bending. The web of an I section under flexure will be under a varying stress, which is a less severe condition. This is because the maximum compressive stress will only occur at one location and the stress level will reduce across the width of the element, possibly even changing to a tensile value.

All of these factors are included in the classification and design provisions of BS EN 1993-1-1 [35].

2.2 Classification

2.2.1 Classes of cross-sections

BS EN 1993-1-1 (see Clause 5.5 and Table 5.2) sets out a practical and conservative approach suitable for most design situations to ensure that local buckling does not occur. The standard introduces four classes of cross-section which are defined below:

i) Class 1

Class 1 cross-sections are those which have compression elements that are sufficiently stocky that the material yield strength may be attained throughout the cross-section. The bending resistance is therefore equal to the design value of the plastic moment, $W_{pl} f_y / \gamma_{M0}$, and this resistance can be maintained whilst rotation required for plastic design occurs at that cross-section.

ii) Class 2

Class 2 cross-sections are those which can attain the design value of the plastic moment but which do not necessarily have the rotation capacity required for plastic design.

iii) Class 3

Class 3 cross-sections are those in which the material yield strength is attainable in the extreme compression fibres of the cross-section assuming an elastic distribution of stress without necessarily being able to attain that stress throughout the cross-section. Such a cross-section can resist the design value of the elastic moment, $W_{el,min} f_y / \gamma_{M0}$.

iv) Class 4

Class 4 cross-sections are those which contain elements that are so slender that local buckling is likely to occur before the attainment of the material yield strength on the extreme fibres. Reference to BS EN 1993-1-5[39] is needed to evaluate the resistance of these cross-sections.

The differences in behaviour of the four classes may be seen in Figure 2.1, which illustrates the moment-rotation behaviour of the cross-section.

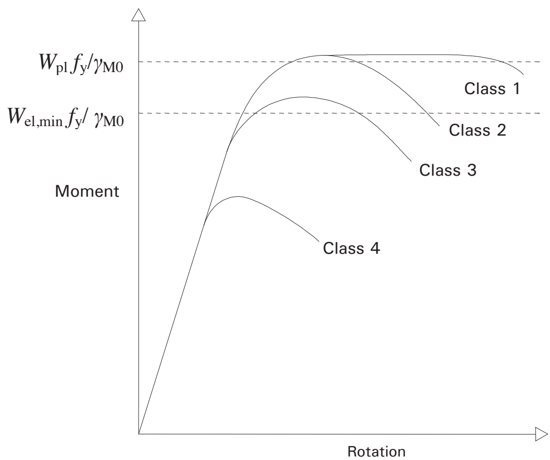


Figure 2.1 Moment rotation behaviour of cross-sections of different classes

If the section is under uniform axial force instead of bending the classification procedure is simpler. Classes 1, 2 and 3 are all able to develop the material strength in direct compression. If the section does not meet the limit for a Class 3 cross-section, it is a Class 4 section and a more complex procedure is needed to evaluate its resistance. The procedure for a Class 4 section is given in BS EN 1993-1-5[39].

When using hot rolled sections in steel grades S275 and S355, in the majority of cases the probability of the resistance being reduced by local buckling is quite small. If a more refined procedure is required, then the reader is referred to BS EN 1993-1-5, which deals specifically with cross-sections that are more susceptible to local buckling because of their high aspect ratios.

The situation when both axial force and bending are present is a little more complex, but is covered by the clauses of BS EN 1993-1-1. In this situation, the actual classification is dependent upon the design values of axial force and moment. To apply the classification limits from Table 5.2 of BS EN 1993-1-1 for a section under combined axial load and bending requires the calculation of the parameter α for Class 1 and 2 cross-sections and ψ for a Class 3 cross-section. For the case of an I or H section subject to combined axial compression and major axis bending and where the neutral axis is within the web of the member, α can be calculated from the following expression:

$$\alpha = \frac{1}{c}\left(\frac{h}{2} + \frac{1}{2}\frac{N_{\mathrm{Ed}}}{t_{\mathrm{w}} f_{\mathrm{y}}} - (t_{\mathrm{f}} + r)\right) \leq 1$$

where:

c is shown in Table 2.1
h is the depth of the section
t_{w} is the thickness of the web
t_{f} is the thickness of the flange
r is the root radius
f_{y} is the yield strength
N_{Ed} is the design axial force (+ve for compression and -ve for tension)

An example of classifying a section subject to combined axial load and moment is given in Section 2.3.

2.2.2 Classification process

For the classification process, BS EN 1993-1-1 provides Table 5.2. This table is split in to three sheets. Table 5.2 (sheet 1 of 3) gives the limits for internal parts in compression, bending, and compression and bending. Table 5.2 (sheet 2 of 3) gives the limits for outstand flanges in compression, and bending and compression, Table 5.2 (sheet 3 of 3) gives the limits for angles and tubular sections in compression and bending and/or compression respectively. These tables are reproduced here as Table 2.1. Their use is illustrated in the examples forming part of this Chapter.

The cross-section classification process follows seven basic steps as listed below:

i) Evaluate the slenderness ratio (c/t, h/t, $(b + h)/2t$, d/t) of all of the parts of the cross-section in which there is compressive stress. See the figures in Table 2.1 for notation and relevant dimensions.

It should be noted that the compression width c defined in Table 5.2 of BS EN 1993-1-is based on the flat portion of the cross-section. The root radius or the weld in the case of welded sections is omitted from the measurement. One consequence of this is that BS EN 1993-1-1 uses the same classification for both rolled and welded sections.

ii) To allow for the influence of variation in the material yield strength, evaluate the parameter ε as $[235/f_y]^{0.5}$ as indicated at the foot of Table 2.1. Note that this definition of ε uses a yield strength of 235N/mm^2 as a reference value. This is because grade S235 is widely regarded as the normal grade of steel throughout continental Europe. For steel of grade S275 up to 16 mm thick, ε = 0.92.

iii) Identify whether the element is an outstand compression element (supported along one edge only) or an internal compression element (supported along both edges) and choose the appropriate sheet of Table 2.1 for the element under consideration.

iv) Identify whether the element is subject to bending, compression or bending and compression.

v) In the appropriate sheet of Table 2.1, identify the appropriate column of the table for the element under consideration and, where appropriate, evaluate the parameters α or ψ. For the outstand flanges of Class 3 welded sections, see Table 2.1 (sheet 2 of 3), evaluate k_σ , which is given in Table 4.2 of BS EN 1993-1-5 [39] (or conservatively assume uniform stress in the flange).

vi) In Table 2.1, identify the appropriate row of the table for the element under consideration and determine the class of that element according to the limiting values.

vii) Classify the complete cross-section according to the least favourable (highest) classification of the individual elements in the cross-section.

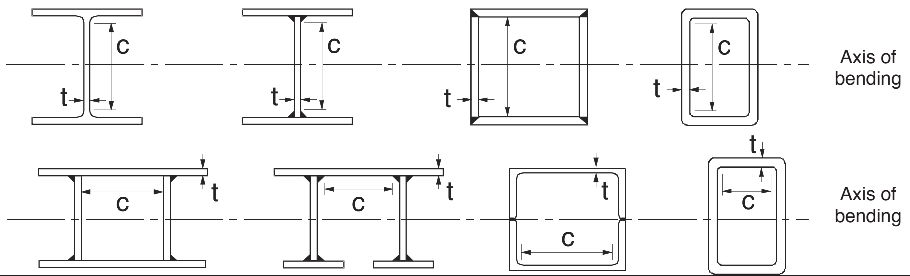
From this classification and the definitions given above in Section 2.2.1 the local resistance of the cross-section may be evaluated.

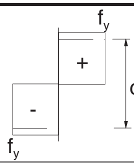
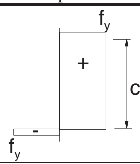
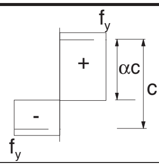
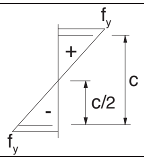
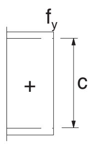
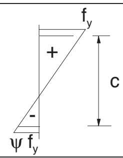
The choice of the appropriate sheet of Table 2.1 depends on the boundary support conditions of the element and the column within each sheet depends on the element's stress conditions (i.e. whether it is subject to uniform compression, bending or combined compression and bending).

For the compression flange of an I, H, channel or box section, the element is either an outstand element (supported along one edge only) or an internal element (supported along both edges). The stress is assumed to be uniform.
For webs of I, H and box sections where the stress varies from tension to compression, and the level of zero stress is at the mid-depth of the element, there is a set of three limits.
For webs of I, H and box sections where the stress various across the depth of the part, other than the simple case above, the parameters α or ψ must be determined.
The elements of angles are treated as outstand elements and a single limit given.

Table 2.1 (Sheet 1 of 3) Maximum width-to-thickness ratios for compression parts

Internal compression parts



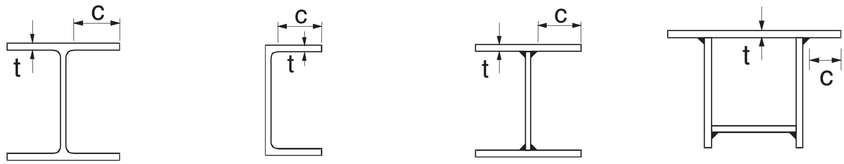
Class	Part subject to bending	Part subject to compression	Part subject to bending and compression
Stress distribution in parts (compression positive)			
1	$c/t \le 72\varepsilon$	$c/t \le 33\varepsilon$	when $\alpha > 0{,}5$: $c/t \le \frac{396\varepsilon}{13\alpha - 1}$ when $\alpha \le 0{,}5$: $c/t \le \frac{36\varepsilon}{\alpha}$
2	$c/t \le 83\varepsilon$	$c/t \le 38\varepsilon$	when $\alpha > 0{,}5$: $c/t \le \frac{456\varepsilon}{13\alpha - 1}$ when $\alpha \le 0{,}5$: $c/t \le \frac{41{,}5\varepsilon}{\alpha}$
Stress distribution in parts (compression positive)			
3	$c/t \le 124\varepsilon$	$c/t \le 42\varepsilon$	when $\psi > -1$: $c/t \le \frac{42\varepsilon}{0{,}67 + 0{,}33\psi}$ when $\psi \le -1$[*)]: $c/t \le 62\varepsilon(1-\psi)\sqrt{(-\psi)}$

$\varepsilon = \sqrt{235/f_y}$	f_y	235	275	355	420	460
	ε	1,00	0,92	0,81	0,75	0,71

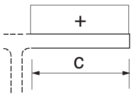
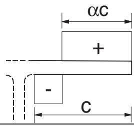
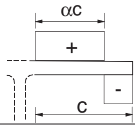
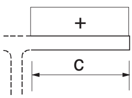
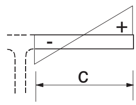
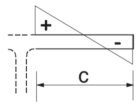
*) $\psi \le -1$ applies where either the compression stress $\sigma < f_y$ or the tensile strain $\varepsilon_y > f_y/E$

Table 2.1 (sheet 2 of 3) Maximum width-to-thickness ratios for compression parts

Outstand flanges



Rolled sections | Welded sections

Class	Part subject to compression	Part subject to bending and compression: Tip in compression	Part subject to bending and compression: Tip in tension
Stress distribution in parts (compression positive)			
1	$c/t \le 9\varepsilon$	$c/t \le \dfrac{9\varepsilon}{\alpha}$	$c/t \le \dfrac{9\varepsilon}{\alpha\sqrt{\alpha}}$
2	$c/t \le 10\varepsilon$	$c/t \le \dfrac{10\varepsilon}{\alpha}$	$c/t \le \dfrac{10\varepsilon}{\alpha\sqrt{\alpha}}$
Stress distribution in parts (compression positive)			
3	$c/t \le 14\varepsilon$	$c/t \le 21\varepsilon\sqrt{k_\sigma}$ For k_σ see EN 1993-1-5	

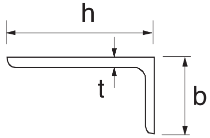
$\varepsilon = \sqrt{235/f_y}$						
	f_y	235	275	355	420	460
	ε	1,00	0,92	0,81	0,75	0,71

Table 2.1 (sheet 3 of 3) Maximum width-to-thickness ratios for compression parts

<table>
<tr><td colspan="7">

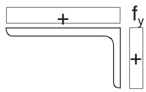
Angles

Refer also to "Outstand flanges" (see sheet 2 of 3)



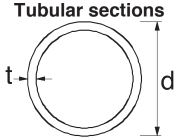
Does not apply to angles in continuous contact with other components

</td></tr>
<tr><td>Class</td><td colspan="6">Section in compression</td></tr>
<tr><td>Stress distribution across section (compression positive)</td><td colspan="6">



</td></tr>
<tr><td>3</td><td colspan="6">$h / t \leq 15\varepsilon : \dfrac{b+h}{2t} \leq 11,5\varepsilon$</td></tr>
<tr><td colspan="7">

Tubular sections



</td></tr>
<tr><td>Class</td><td colspan="6">Section in bending and/or compression</td></tr>
<tr><td>1</td><td colspan="6">$d / t \leq 50\varepsilon^2$</td></tr>
<tr><td>2</td><td colspan="6">$d / t \leq 70\varepsilon^2$</td></tr>
<tr><td>3</td><td colspan="6">$d / t \leq 90\varepsilon^2$
NOTE For $d / t > 90\varepsilon^2$ see EN 1993-1-6.</td></tr>
<tr><td rowspan="3">$\varepsilon = \sqrt{235 / f_y}$</td><td>$f_y$</td><td>235</td><td>275</td><td>355</td><td>420</td><td>460</td></tr>
<tr><td>ε</td><td>1,00</td><td>0,92</td><td>0,81</td><td>0,75</td><td>0,71</td></tr>
<tr><td>ε^2</td><td>1,00</td><td>0,85</td><td>0,66</td><td>0,56</td><td>0,51</td></tr>
</table>

2.3 Example 2.1 – Section classification

A 457 x 191 x 67 UB in steel grade S355 is to be used under the three conditions described below. Classify the section for each case and evaluate the local cross-sectional resistance.

i) Under bending
ii) Under axial compression
iii) Under bending about the major axis and an axial compression of 250 kN

The section properties are:

$h = 453.4$ mm		
$b = 189.9$ mm	$t_f = 12.7$ mm	
$d = 407.6$ mm	$t_w = 8.5$ mm	
$r = 10.2$ mm		
$A = 85.5$ cm^2	$W_{pl} = 1470$ cm^3	$W_{el} = 1300$ cm^3

Ratios for local buckling:
For the flange:
$c = (b - t_w - 2r)/2 = (189.9 - 8.5 - 2 \times 10.2)/2 = 80.5$ mm
$t = t_f = 12.7$ mm

$c/t = 6.34$

For the web:
$c = d = 407.6$ mm
$t = t_w = 8.5$ mm

$c/t = 48.0$

Influence of material strength
For thickness = 12.7 mm
$f_y = 355$ N/mm^2
Hence, $\varepsilon = [235/355]^{0.5} = 0.81$

(i) Bending

Flanges (Table 2.1, sheet 2 of 3)
Limiting value of c/t for Class 1 in compression is $9\varepsilon = 7.29$. The actual value is 6.34 therefore the flanges are Class 1.

Web (Table 2.2, sheet 1 of 3)
The limiting value of c/t for Class 1 in bending is $72\varepsilon = 58.32$. The actual value is 48 therefore the web is Class 1.

The entire cross-section is classified as Class 1 and therefore the design strength of the material can be attained throughout the section. The moment resistance of the cross-section given by Clause 6.2.5 is:

$$M_{c,Rd} = M_{pl,Rd} = W_{pl} f_y / \gamma_{M0}$$

$$M_{c,Rd} = 1470 \times 355 \times 10^{-3} / 1.00 = 522 \text{ kNm.}$$

(ii) Compression

Flanges (Table 2.1, sheet 2 of 3)
The limiting value of *c*/*t* is as in condition i) above and the flanges are therefore Class 1.

Web (Table 2.1, sheet 1 of 3)
The limiting value of *c*/*t* for Class 3 in compression is $42\varepsilon = 34.02$. The actual value is 48.0 therefore the web is Class 4.

The entire cross-section therefore may be treated as Class 4 under pure axial compression. The compression resistance (for a zero length strut) is therefore given by Clause 6.2.4(2) as:

$$N_{c,\,Rd} = A_{eff} f_y / \gamma_{M0}$$

$$A_{eff} = A_f + \rho A_w$$

where:
A_f is the area of the flanges (Class 1)
A_w is the area of the web
ρ is a reduction factor for plate buckling given in Clause 4.4 of BS EN 1993-1-5 as:

$$\rho = \frac{\bar{\lambda}_p - 0.055(3-\psi)}{\bar{\lambda}^2{}_p} \leq 1.0$$

When ρ=1, $\bar{\lambda}_p = 0.673$

From Clause 4.4(4)

$$\bar{\lambda}_p = \bar{\lambda}_{p.req} = \bar{\lambda}_p \sqrt{\frac{\sigma_{com,Ed}}{f_y / \gamma_{M0}}}$$

where:

$\sigma_{com,Ed}$ is the maximum design compressive stress in the element determined using the effective area of the section caused by all simultaneous actions

An iterative procedure is needed to determine the value of $\bar{\lambda}_p$
Assuming $\sigma_{com,Ed}$ is calculated based on the gross cross-section and that $\bar{\lambda}_p = 0.673$. For an axial force of 700kN, $\lambda_{p,req}$ is:

$$\lambda_{p,req} = 0.673\sqrt{\frac{700{,}000/8550}{355/1.0}} = 0.323$$

Therefore as $\overline{\lambda}_{\mathrm{p}} < 0.673$

$$\rho = 1.0$$

Therefore, the axial resistance of the section is based on the gross cross-section

$$N_{\mathrm{c,Rd}} = 8550 \text{ x } 355 \text{ x } 10^{-3}/1.00 = 3035 \text{ kN}.$$

(iii) Bending about the major axis and an axial compression of 250 kN

Classification under combined bending and compression

Web (Table 2.1, Sheet 1 of 3)
For a Class 2 element under varying stress, the limiting value of *c*/*t* is given by:

When $\alpha > 0.5$: $\dfrac{c}{t} \le \dfrac{456\varepsilon}{13\alpha - 1}$

When $\alpha \le 0.5$: $\dfrac{c}{t} \le \dfrac{41.5\varepsilon}{\alpha}$

Where from Section 2.2.1 α may be calculated for an I or H section in which the neutral axis lies within the web as:

$$\alpha = \frac{1}{c}\left(\frac{h}{2} + \frac{1}{2}\frac{N_{\mathrm{Ed}}}{t_{\mathrm{w}} f_{\mathrm{y}}} - \left(t_{\mathrm{f}} + r\right)\right) \le 1$$

$$\alpha = \frac{1}{407.6}\left(\frac{453.4}{2} + \frac{1}{2} \times \frac{250000}{8.5 \times 355} - \left(12.7 + 10.2\right)\right)$$

$$\alpha = 0.602$$

The limit for a Class 2 web is:

$$\frac{456\varepsilon}{13\alpha - 1} = \frac{456 \times 0.81}{13 \times 0.602 - 1} = 54.11$$

The actual value is 48, therefore the web is Class 2.

The overall section under combined bending and an axial compression of 250 kN is therefore a Class 2.

2.4 Classification of UB and UC sections

For grade S275 and S355, all UB, UC and joist sections, with the exception of those given in Table 2.2 below, are Class 2 or better when in bending about the major axis.

The vast majority of hot rolled sections classify as Class 1 and are therefore suitable for plastic design. Care should be exercised where a UB or UC section classifies as Class 4, as reference to BS EN 1993-1-5 is needed to evaluate the resistance of these cross-sections.

The reader should examine the tables at the back of this book, which give the classification for both flanges and webs of most structural sections in grades S275 and S355 for a variety of conditions. These tables also enable the local cross-section resistances to be determined directly, without the need to perform the calculations outlined in section 2.3.

Table 2.2 List of rolled sections that are Class 3 under bending alone

Section shape	**Grade S275**	**Grade S355**
Universal Beams	None	None
Universal Columns	152 x 152 x 23	356 x 368 x 129 305 x 305 x 97 152 x 152 x 23
Joists	None	None

2.5 Shear resistance

The shear resistance $V_{c,Rd}$ of an I or H section is given by Clause 6.2.6 of BS EN 1993-1-1. The plastic shear resistance $V_{c,Rd}$ in the absence of torsion is given by the following expression:

$$V_{pl,Rd} = \frac{A_v\left(f_y/\sqrt{3}\right)}{\gamma_{M0}}$$

where:

f_y is the yield strength

γ_{M0} is the partial factor for the resistance of cross-sections

A_v is the shear area and may be taken as follows:

a) for rolled I and H sections, loaded parallel to the web, $A_V = A - 2bt_f + (t_w + 2r)t_f$ but not less than $\eta h_w t_w$

b) for rolled channel sections loaded parallel to the web, $A_V = A - 2bt_f + (t_w + r)t_f$

c) for welded I and H sections loaded parallel to web, $A_V = \eta \sum (h_w t_w)$

d) for T-sections loaded parallel to the web:

for rolled T-sections, $A_V = A - bt_f + (t_w - 2r)\frac{t_f}{2}$

for welded T-sections, $A_V = t_w\left(h - \frac{t_f}{2}\right)$

e) for rectangular hollow sections and tubes of uniform thickness:

for load parallel to the depth, $A_V = Ah/(b+h)$
for load parallel to the width, $A_V = Ab/(b+h)$

f) for circular sections and tubes of uniform thickness $A_V = 2A/\pi$

where:
A is the cross-sectional area
b is the overall breadth
h is the overall depth
h_w is the depth of the web
r is the root radius
t_f is the flange thickness
t_w is the web thickness (if the web thickness is not constant, t_w, should be taken as the minimum thickness)
η is given in BS EN 1993-1-5 but may conservatively be taken as 1.00

2.6 Bending resistance

The design resistance for bending about a principal axis of a cross-section, $M_{c,Rd}$, is given by Clause 6.2.5 of BS EN 1993-1-1. In the presence of low shear, the design bending resistance is the resistance of the cross-section taking account of its classification.

Low shear is defined in Clause 6.2.8(2) of BS EN 1993-1-1 as those situations where the shear force is less than half the plastic shear resistance of the cross-section. An exception to this is where shear buckling reduces the section resistance. This is beyond the scope of this publication and readers are referred to BS EN 1993-1-5.

For low shear, the bending resistance of the cross-section is given by:

$$M_{c,Rd} = M_{pl,Rd} = \frac{W_{pl} f_y}{\gamma_{M0}}$$ for class 1 and 2 cross-sections

$$M_{c,Rd} = M_{el,Rd} = \frac{W_{el,min} f_y}{\gamma_{M0}}$$ for class 3 cross-sections

$$M_{c,Rd} = \frac{W_{eff,min} f_y}{\gamma_{M0}}$$ for class 4 cross-sections

where:

W_{pl} is the plastic section modulus

$W_{el,min}$ is the minimum elastic section modulus

$W_{eff,min}$ is the minimum effective section modulus

Fastener holes in the tension flange may be ignored, provided that for the tension flange:

$$\frac{A_{f,net}\,0.9 f_u}{\gamma_{M2}} \geq \frac{A_f f_y}{\gamma_{M0}}$$

Fastener holes in the tension zone of the web need not be allowed for, provided that the equation for fastener holes in the tension flange is satisfied for the complete tension zone comprising the tension flange plus the tension zone of the web.

Fastener holes in the compression zone of the cross-section, except for oversize and slotted holes, need not be allowed for provided that they are filled by fasteners.

If the shear force exceeds half the plastic shear resistance of the cross-section then the bending resistance needs to be reduced as set out in Clause 6.2.8 of BS EN 1993-1-1. It should be remembered that the maximum moment occurs at a position of low shear; the exception being cantilevers, where maximum moment and maximum shear occur together at the support.

In beams with full restraint, the design bending moments in the beam are simply verified against the above bending resistance. In beams without full restraint, the design bending moments must also be checked against the buckling resistance, as discussed in Chapter 3.

2.7 Example 2.2 – Beam with full lateral restraint

Design a simply supported beam carrying a concrete floor slab over a span of 5.0 m in S275 steel. The permanent (dead) load, which includes an allowance for self weight, is 14 kN/m, and the variable (imposed) load is 19 kN/m.

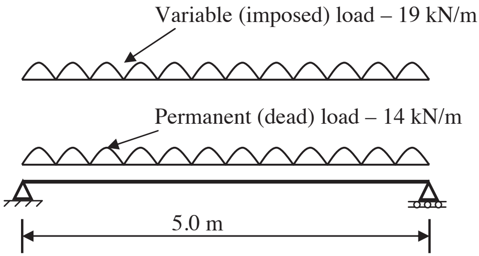


Figure 2.2 Simply supported beam

Ultimate limit state

Partial factors for actions

The partial factors for actions to be used for ultimate limit state design are taken from the National Annex to BS EN 1990 [4], Clause NA 2.2.3.2. Table NA.A1.2(b) gives the following values:

Partial factor for permanent actions $\gamma_G = 1.35$

Partial factor for variable actions $\gamma_Q = 1.50$

Reduction factor $\xi = 0.925$

Combination of actions at ULS

The design value of combined actions is given by equation (6.10b) in BS EN 1990.

$$\text{Design value of combined actions } F_{Ed} = \xi\gamma_G g_k + \gamma_Q q_k$$

Note: In this example the combination factor ψ_0 is not required as the only variable action is the imposed load.

$$F_{Ed} = (0.925 \times 1.35 \times 14) + (1.5 \times 19) = 45.98\text{kN/m}$$

Maximum shear force V_{Ed} is $F_{Ed}L/2 = 45.98 \times 5/2 = 114.95\text{kN}$

Maximum moment = $F_{Ed}L^2/8 = 45.98 \times 5^2/8 = 143.69$ kNm

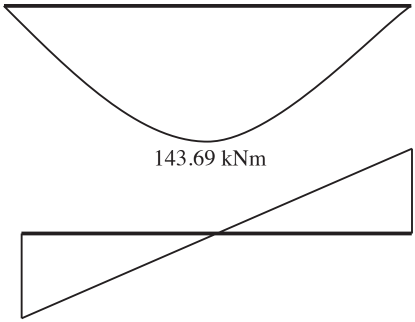


Figure 2.3 Bending moment and shear force diagrams

Choice of section
As the beam is fully restrained (due to the presence of the floor slab) the required bending resistance is:

$M_{c,Rd} = M_{pl,Rd} = \frac{W_{pl} f_y}{\gamma_{M0}}$ assuming that the section is at least Class 2

Assuming that the maximum thickness is 16mm, $f_y = 275$ N/mm^2.

$\gamma_{M0} = 1.00$

Therefore,
$W_{pl,required} = 143.69 \times 10^6 \times 1.0 / 275 \times 10^{-3} = 522.5 \text{cm}^3$

The lightest rolled section to satisfy this criterion is a 356 x 127 x 33 UB with a plastic modulus, $W_{pl,y} = 543$ cm^3

From section tables:

c_f/t_f	= 5.82;	c_w/t_w	= 51.9;	t_w	= 6.0 mm;	r	=10.2 mm
A	= 42.1 cm^2;	i_y	= 14.0 cm;	i_z	= 2.58 cm.	h	=349.0 mm
t_f	= 8.5 mm;	h/b	= 2.78	h_w	= 332 mm	b	=125.4 mm

For $t_f = 8.5$ mm, $f_y = 275$ N/mm^2;

$\varepsilon = \sqrt{235/f_y} = \sqrt{235/275} = 0.92$

Determine section classification
From Table 2.1, the Class 1 limit for an outstand flange in compression is:

$c/t = 9.0\varepsilon = 9.0 \times 0.92 = 8.28$

5.82 < 8.28, therefore the flange is Class 1.

The Class 1 limit for an internal compression element subject to bending is:

$c/t = 72\varepsilon = 72 \times 0.92 = 66.24$

51.9 < 66.24, therefore the web is Class 1

Therefore the whole section is Class 1.

Shear resistance

Shear resistance $V_{\text{pl,Rd}} = \dfrac{A_{\text{v}}\left(f_{\text{y}} / \sqrt{3}\right)}{\gamma_{\text{M0}}}$

From Clause 6.2.6(3) of BS EN 1993-1-1 the shear area, A_{v}, of an I section is given as:

The shear area is:

$$A_{\text{v}} = A - 2bt_{\text{f}} + \left(t_{\text{w}} + 2r\right)t_{\text{f}} \quad \text{but not less than } \eta h_{\text{w}} t_{\text{w}}$$

$$= 4210 - 2 \times 125.4 \times 8.5 + \left(6.0 + 2 \times 10.2\right) \times 8.5 = 2302.6\ \text{mm}^2$$

$\eta = 1.00$.

The depth of the web is:

$$h_{\text{w}} = h - 2t_{\text{f}} = 349 - 2 \times 8.5 = 332\ \text{mm}$$

$$\eta h_{\text{w}} t_{\text{w}} = 1.0 \times 332 \times 6.0 = 1992\ \text{mm}^2$$

Therefore $A_{\text{v}} = 2302.6\ \text{mm}^2$

Shear resistance $V_{\text{pl,Rd}} = \dfrac{2302.6 \times \left(275 / \sqrt{3}\right)}{1.0} \times 10^{-3} = 366\ \text{kN}$

Bending resistance

Where the shear force is less than half the plastic shear resistance, Clause 6.2.8(2) allows the effect of shear on the moment resistance to be neglected (except where shear buckling reduces the section resistance – see BS EN 1993-1-5).

For a Class 1 section, the bending resistance $M_{\text{c,Rd}}$ is given by:

$$M_{\text{c,Rd}} = M_{\text{pl,Rd}} = \frac{W_{\text{pl}} f_{\text{y}}}{\gamma_{\text{M0}}} = 543 \times 10^3 \times 275 \times 10^{-6} / 1.0 = 149.33\ \text{kNm}$$

CHAPTER 3 – BUCKLING RESISTANCE OF BEAMS

3.1 Design considerations

General
A beam is a member which carries loading primarily in bending and which spans between supports or between connections to other members. This Chapter describes the determination of the buckling resistance of beams in steel framed buildings, designed according to BS EN 1993-1-1. Guidance relates only to I, H and channel sections.

Lateral-torsional buckling
If an I section is subject to vertical loading that can move with the beam, the imperfections of the beam mean it will tend to displace as indicated in Figure 3.1, which shows one half of a simply supported beam. Due to the bending action, the upper flange is in compression and acts like a strut. Being free to move, the compression flange will tend to buckle sideways dragging the tension flange with it. The tension flange resists this sideways movement and therefore, as the beam buckles, the section twists with the web no longer vertical. This action is known as lateral-torsional buckling.

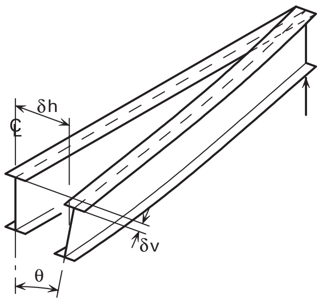


Figure 3.1 Lateral-torsional buckling – buckled shape of one half of a simply supported beam

Fully restrained beams
Lateral-torsional buckling will be inhibited by the provision of restraints to the compression flange. If the flange is restrained at intervals, lateral-torsional buckling may occur between the restraints and this must be checked. If this restraint is continuous, the beam is fully restrained and lateral-torsional buckling will not occur.

Full (continuous) lateral resistant is provided by:

i) In-situ and precast flooring or composite decking, provided that the flooring is supported directly on the top flange or is cast around it.
ii) Timber flooring, if the joists are fixed by cleats, bolts or other method providing a positive connection.
iii) Steel plate flooring that is bolted or welded at closely spaced intervals.

BS EN 1993-1-1 gives very little information on what constitutes sufficient lateral restraint other than to say beams with sufficient lateral restraint to the compression flange are not susceptible to lateral-torsional buckling. Practical guidance on the lateral stability of steel beams and columns can be found in SCI publication P360 [40]. The standard also points out that certain types of cross-section, such as square or circular hollow sections, fabricated circular tubes or square box sections, are not susceptible to lateral-torsional buckling.

In the absence of any other information in BS EN 1993-1-1, the restraining force may be taken as 2.5% of the maximum force in the compression flange and should be assumed to be uniformly distributed along the compression flange. This force must also be carried by the connection between the flooring and the beam.

Note that the restraint must be to the compression flange. Special care is required when considering regions where the bottom flange is in compression.

3.2 Buckling resistance of laterally unrestrained beams

When lateral-torsional buckling is possible, either over the full span of the beam or between intermediate restraints, the resistance of the beam to bending will be reduced by its tendency to buckle. According to Clause 6.3.2.1(1) of BS EN 1993-1-1, the beam should be verified against lateral-torsional buckling resistance as follows:

$$\frac{M_{\mathrm{Ed}}}{M_{\mathrm{b,Rd}}} \leq 1.0$$

where:

M_{Ed} is the design value of the moment

$M_{\mathrm{b,Rd}}$ is the design buckling resistance moment

The design buckling resistance moment, $M_{\mathrm{b,Rd}}$, is given by Clause 6.3.2.1(3) as:

$$M_{\mathrm{b,Rd}} = \chi_{\mathrm{LT}} W_{\mathrm{y}} \frac{f_{\mathrm{y}}}{\gamma_{\mathrm{M1}}}$$

where:

W_{y} is the appropriate section modulus as follows:

$= W_{\mathrm{pl,y}}$ for Class 1 or 2 cross-sections

$= W_{\mathrm{el,y}}$ for Class 3 cross-sections

$= W_{\mathrm{eff,y}}$ for Class 4 cross-sections

χ_{LT} is the reduction factor for lateral-torsional buckling

3.2.1 Reduction factor for lateral-torsional buckling

For rolled or equivalent welded sections in bending, Clause 6.3.2.3(1) of BS EN 1993-1-1 gives the values of the reduction factor χ_{LT} as:

$$\chi_{LT} = \frac{1}{\Phi_{LT} + \sqrt{\Phi_{LT}^{2} - \beta\bar{\lambda}_{LT}^{2}}} \quad \text{but} \quad \begin{array}{l} \chi_{LT} \leq 1.0 \\ \chi_{LT} \leq \dfrac{1}{\bar{\lambda}_{LT}^{2}} \end{array}$$

$$\Phi_{LT} = 0.5\left[1 + \alpha_{LT}\left(\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}\right) + \beta\bar{\lambda}_{LT}^{2}\right]$$

where:

$\bar{\lambda}_{LT}$ is the non-dimensional slenderness, defined in Section 3.2.2

α_{LT} is an imperfection factor for lateral-torsional buckling and is given in Table 6.3 of BS EN 1993-1-1which is reproduced below as Table 3.1.

Table 3.1 Recommended values for imperfection factors for lateral-torsional buckling curves

Buckling Curve	a	b	c	d
Imperfection factor α_{LT}	0.21	0.34	0.49	0.76

The values for $\bar{\lambda}_{LT,0}$ and β are given in Clause NA.2.17 of the National Annex to BS EN 1993-1-1, as follows.

a. For rolled sections, and hot finished and cold-formed hollow sections
   $\bar{\lambda}_{LT,0} = 0.4$
   $\beta = 0.75$

b. For equivalent welded sections
   $\bar{\lambda}_{LT,0} = 0.2$
   $\beta = 1.00$

Furthermore, the National Annex gives a replacement to Table 6.5 of BS EN 1993-1-1 for the selection of the lateral-torsional buckling curve, which is reproduced below as Table 3.2.

Table 3.2 Recommendations for the selection of lateral-torsional buckling curve for different cross-sections

Cross-section	Limits	Buckling Curve
Rolled doubly symmetric I and H sections and hot-finished hollow sections	$h/b \leq 2.0$ $2.0 < h/b \leq 3.1$ $h/b > 3.1$	b c d
Angles (for moments in the major principal plane)		d
All other hot-rolled sections		d
Welded doubly symmetric sections and cold-formed hollow sections	$h/b \leq 2.0$ $2.0 \leq h/b < 3.1$	c d

The method given in Clause 6.3.2.3 includes an additional factor *f* that may be used to modify χ_{LT}. This modification factor $\chi_{LT,mod}$ is given by the following expression:

$$\chi_{LT,mod} = \frac{\chi_{LT}}{f} \quad \text{but} \quad \begin{array}{l} \chi_{LT,mod} \leq 1.0 \\ \chi_{LT,mod} \leq \dfrac{1}{\overline{\lambda}_{LT}^2} \end{array}$$

The factor, *f*, was developed by numerical study and is dependent on the shape of the bending moment diagram between lateral restraints and is given by the following expression.

$$f = 1 - 0.5(1 - k_c)[1 - 2.0(\overline{\lambda}_{LT} - 0.8)^2] \text{ but } f \leq 1.0$$

where:

k_c is a correction factor, defined in Clause NA.2.18 of the National Annex as:

$$k_c = \frac{1}{\sqrt{C_1}}$$

where:

$$C_1 = \frac{M_{cr} \text{ for the actual bending moment diagram}}{M_{cr} \text{ for the uniform bending moment diagram}}$$

Value of $\dfrac{1}{\sqrt{C_1}}$ are given in Tables 3.4 and 3.5.

3.2.2 Non-dimensional slenderness for lateral-torsional buckling

The value of the non-dimensional slenderness for lateral-torsional buckling, $\overline{\lambda}_{LT}$, is given by Clause 6.3.2.2(1) as follows:

$$\bar{\lambda}_{LT} = \sqrt{\frac{W_y f_y}{M_{cr}}}$$

where M_{cr} is the elastic critical moment for lateral-torsional buckling

The value of $\bar{\lambda}_{LT}$ requires the determination of the elastic critical moment for lateral-torsional buckling. However, BS EN 1993-1-1 gives no information on how to calculate this parameter, except to say that it should be based on gross cross-sectional properties and should take into account the loading conditions, the real moment distribution and the lateral restraints.

The elastic critical moment for lateral-torsional buckling of a beam of uniform symmetrical cross-section with equal flanges, under standard conditions of restraint at each end, loaded through the shear centre and subject to uniform moment is given by the following equation:

$$M_{cr} = \frac{\pi^2 EI_z}{L_{cr}} \left(\frac{I_w}{I_z} + \frac{L_{cr}^2 GI_T}{\pi^2 EI_z} \right)^{0.5}$$

where:

$$G = \frac{E}{2(1+v)}$$

I_T is the St Venant torsional constant
I_w is the warping constant
I_z is the second moment of area about the minor axis
L_{cr} is the length of the beam between points of lateral restraint

This expression is both complex and limited to particular types of beam.

The 'LTBeam' software may be used to determine M_{cr} for different sections with different loading and resistant condition. The 'LTBeam' software can be downloaded from the CTICM web site. SC1 is currently developing a design tool for the M_{cr} calculation of and this will be available in early 2014 from www.steelconstruction.info.

Simplified evaluation of non-dimensional slenderness
For straight segments of hot-rolled, doubly symmetric I and H sections with lateral restraints to the compression flange at both ends of the segment considered with no destabilizing loads, the value of $\bar{\lambda}_{LT}$ may be conservatively taken from Table 3.3.

Table 3.3 Value of $\bar{\lambda}_{LT}$ for different grades of steel

Grade of Steel				
S235	S275	S355	S420	S460
$\bar{\lambda}_{LT} = \frac{L/i_z}{104}$	$\bar{\lambda}_{LT} = \frac{L/i_z}{96}$	$\bar{\lambda}_{LT} = \frac{L/i_z}{85}$	$\bar{\lambda}_{LT} = \frac{L/i_z}{78}$	$\bar{\lambda}_{LT} = \frac{L/i_z}{75}$

Where:
L is the distance between points of restraint of the compression flange
i_z is the radius of gyration of the section about the minor axis

Improved economy, relative to that given by using Table 3.3, can be gained by using an expression for the slenderness, $\bar{\lambda}_{LT}$ that takes account of section geometry, variation of moment and destabilizing loading. For simply supported beams there is little to be gained but for members with double curvature bending with end moments the improvement can be significant. When the loading is not destabilizing, $\bar{\lambda}_{LT}$ is given by:

$$\bar{\lambda}_{LT} = \frac{1}{\sqrt{C_1}} UV\bar{\lambda}_z \sqrt{\beta_w}$$

where:

C_1 is a parameter depending of the shape of the bending moment diagram. Values of $\frac{1}{\sqrt{C_1}}$ for some bending moment diagrams are given in Table 3.4 and Table 3.5. Conservatively, C_1 may be taken as 1.00.

$$\bar{\lambda}_z = \frac{\lambda_z}{\lambda_1} \text{ and } \lambda_z = \frac{kL}{i_z}$$

$$\lambda_1 = \pi\sqrt{\frac{E}{f_y}}$$

k is an effective length parameter and should be taken as 1.0 unless it can be demonstrated otherwise

L is the distance between points of restraint to the compression flange

i_z is the radius of gyration of the section about the minor axis

U is a parameter depending on the section geometry and is given by:

$$U = \sqrt{\frac{W_{pl,y} g}{A}\sqrt{\frac{I_z}{I_w}}}$$

In which g allows for the curvature of the beam. If the beam has zero deflection before it is loaded then g is given by the following expression:

$$g = \sqrt{\left(1 - \frac{I_z}{I_y}\right)}$$

Conservatively g can be taken as 1.00.

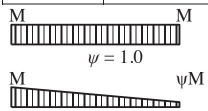
Conservatively U may be taken as 1.00, or as 0.9 for rolled section.

V is a parameter related to the slenderness. Where the loading is not destabilizing it may be taken either conservatively as $V = 1.00$ for all sections symmetric about the major axis or as

$$V = \frac{1}{\sqrt[4]{1 + \frac{1}{20}\left(\frac{\lambda_z}{h / t_f}\right)^2}}$$ for doubly symmetrical hot rolled I and H sections.

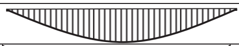
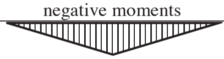
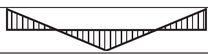
Table 3.4 Values of $\frac{1}{\sqrt{C_1}}$ for end moment bending, to be used with k=1.0

ψ	$\frac{1}{\sqrt{C_1}}$
+1.00	1.00
+0.75	0.92
+0.50	0.86
+0.25	0.80
0.00	0.75
- 0.25	0.71
- 0.50	0.67
- 0.75	0.63
- 1.00	0.60



$-1 \le \psi \le 1$

Table 3.5 Values of $\frac{1}{\sqrt{C_1}}$ for cases with transverse loading, to be used with k=1.0

Bending moment diagram	$\frac{1}{\sqrt{C_1}}$
	0.94
 Note: this is equal positive and negative moments	0.90
	0.86
	0.77

3.3 Example 3.1 – Simply supported beam with lateral restraint at load points

A beam is required to span 9.0 m and is to carry two intermediate point loads at third points 3.0 m apart. The design value of the loads for each point load is 100 kN. The beam is laterally restrained at the ends and at the point loads only. Select a suitable section assuming grade S275 steel.

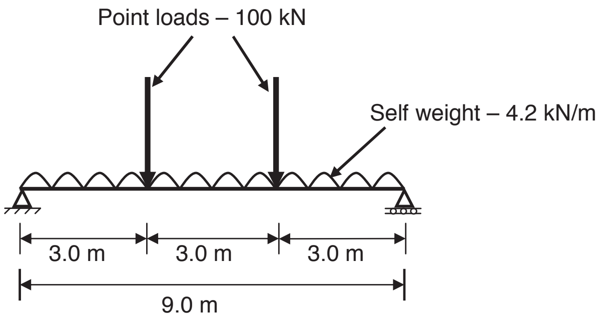


Figure. 3.2 Simply supported beam with lateral restraint at load points

Determine design moment
Maximum moment due to point loads = 300 kNm
Moment due to self weight, guess design value of self weight is 4.2 kN/m
Maximum moment due to self weight = 42.5 kNm

Maximum design moment, M_{Ed} = 300 + 42.5 = 342.5 kNm

Maximum shear force, V_{Ed} = 118.9 kN

Shear adjacent to point load = 106 kN

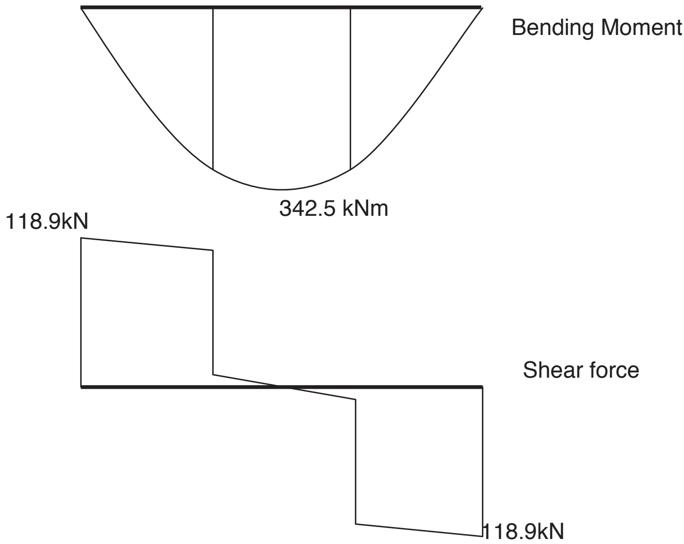


Figure 3.3 Bending moment and shear force diagrams

Try a 457 x 191 x 82 UB in grade S275 steel

From section property tables:

h	= 460.0 mm	b	= 191.3 mm	t_w	= 9.9 mm
t_f	= 16.0 mm	r	= 10.2 mm	i_z	= 4.23 cm
i_y	= 18.8 cm	A	= 104 cm^2	$W_{pl,y}$	= 1830 cm^3
I_z	= 1870 cm^4	I_y	= 37100 cm^4	I_w	= 0.922 dm^6
c_f/t_f	= 5.03	c_w/t_w	= 41.2		

For t_f = 16.0 mm, f_y = 275 N/mm^2.

Determine section classification

$$\varepsilon = \sqrt{235/f_y} = \sqrt{235/275} = 0.92$$

From Table 2.1 the Class 1 limit for an outstand flange is:

$c/t = 9.0\varepsilon = 9.0 \times 0.92 = 8.28$

5.03 < 8.28, therefore the flange is Class 1.

From Table 2.1 the Class 1 limit for an internal compression element subject to bending is:

$c/t = 72\varepsilon = 72 \times 0.92 = 66.24$

41.2 < 66.24, therefore the web is Class 1

Therefore the whole section is Class 1.

Resistance of cross-section

Shear resistance

Shear resistance $V_{\mathrm{pl,Rd}} = \dfrac{A_{\mathrm{v}}\left(f_{\mathrm{y}} / \sqrt{3}\right)}{\gamma_{\mathrm{M0}}}$

Shear area, $A_{\mathrm{v}} = A - 2bt_{\mathrm{f}} + \left(t_{\mathrm{w}} + 2r\right) \times t_{\mathrm{f}}$ but not less than $\eta h_{\mathrm{w}} t_{\mathrm{w}}$

$$A_v = 10400 - 2 \times 191.3 \times 16 + (9.9 + 2 \times 10.2)16.0 = 4763\,\mathrm{mm}^2$$

$\eta = 1.00$.

The depth of the web h_{w} is:

$h_{\mathrm{w}} = h - 2t_{\mathrm{f}} = 460 - 2 \times 16 = 428\,\mathrm{mm}$

Hence,

$$\eta h_{\mathrm{w}} t_{\mathrm{w}} = 1.0 \times 428 \times 9.9 = 4237.2\,\mathrm{mm}^2$$

Therefore $A_{\mathrm{v}} = 4763\ \mathrm{mm}^2$

Shear resistance $V_{\mathrm{pl,Rd}} = \dfrac{4763\left(275 / \sqrt{3}\right)}{1.0} \times 10^{-3} = 756\,\mathrm{kN}$

$V_{\mathrm{Ed}} = 118.9$ kN < $V_{\mathrm{pl,Rd}} = 756$ kN therefore the section is satisfactory

Bending resistance of cross-section

As the section is Class 1 the bending resistance $M_{\mathrm{c,Rd}}$ is given by:

$$M_{\mathrm{c,Rd}} = M_{\mathrm{pl,Rd}} = \frac{W_{\mathrm{pl,y}} f_{\mathrm{y}}}{\gamma_{\mathrm{M0}}} = 1830 \times 10^{3} \times 275 \times 10^{-6} / 1.0 = 503\,\mathrm{kNm}$$

$M_{\mathrm{Ed}} = 342.5$ kNm < $M_{\mathrm{c,Rd}} = 503$ kNm therefore the section is satisfactory.

The maximum shear force adjacent to the point load is less than 0.5 times the shear resistance of the section, therefore no reduction need be made to the moment resistance.

Buckling resistance

$$M_{\mathrm{b,Rd}} = \chi_{\mathrm{LT}} W_{\mathrm{y}} \frac{f_{\mathrm{y}}}{\gamma_{\mathrm{M1}}}$$

For a Class 1 section $W_{\mathrm{y}} = W_{\mathrm{pl,y}}$

Determine non-dimensional slenderness for lateral-torsional buckling
For straight segments of hot-rolled, doubly symmetric I and H sections with lateral restraints to the compression flange at both ends of the segment considered and with no destabilizing loads, the value of $\overline{\lambda}_{\mathrm{LT}}$ may conservatively be taken from Table 3.3.

For grade S275 steel

$$\overline{\lambda}_{\mathrm{LT}} = \frac{L/i_{\mathrm{z}}}{96} = \frac{3000/42.3}{96} = 0.74$$

Selection of buckling curve
To determine the buckling curve using Table 3.2 evaluate:

$h/b = 460/191.3 = 2.4$

Therefore, since the member is a rolled I section with h/b greater than 2 but less that 3.1, use buckling curve c.

For buckling curve c, Table 3.1 gives $\alpha_{\mathrm{LT}} = 0.49$.

Determine the reduction factor
The reduction factor is given by:

$$\chi_{\mathrm{LT}} = \frac{1}{\Phi_{\mathrm{LT}} + \sqrt{\Phi_{\mathrm{LT}}^{2} - \beta \overline{\lambda}_{\mathrm{LT}}^{2}}} \quad \text{but} \quad \begin{array}{l} \chi_{\mathrm{LT}} \leq 1.0 \\ \chi_{\mathrm{LT}} \leq \dfrac{1}{\overline{\lambda}_{\mathrm{LT}}^{2}} \end{array}$$

$$\Phi_{\mathrm{LT}} = 0.5\left[1 + \alpha_{\mathrm{LT}}\left(\overline{\lambda}_{\mathrm{LT}} - \overline{\lambda}_{\mathrm{LT,0}}\right) + \beta \overline{\lambda}_{\mathrm{LT}}^{2}\right]$$

For rolled sections:

$$\overline{\lambda}_{\mathrm{LT,0}} = 0.4$$
$$\beta = 0.75$$

$$\Phi_{\mathrm{LT}} = 0.5\left[1 + 0.49(0.74 - 0.4) + 0.75 \times 0.74^{2}\right] = 0.789$$

$$\chi_{\mathrm{LT}} = \frac{1}{0.789 + \sqrt{0.789^{2} - 0.75 \times 0.74^{2}}} = 0.8$$

To take account of the bending moment distribution, χ_{LT} , may be modified by the use of the '*f*' given by Clause 6.3.2.3(2) of BS EN 1993-1-1. In this example '*f*' is conservatively taken as 1.0.

$$\chi_{LT,mod} = \frac{\chi_{LT}}{f} = \frac{0.8}{1.0} = 0.8$$

Therefore,

$$M_{b,Rd} = 0.8 \times 1830 \times 10^3 \frac{275}{1.0} \times 10^{-6} = 402 \text{kNm}$$

$M_{Ed} = 342.5$ kNm therefore the section is satisfactory

3.4 Resistance of webs to transverse forces (web buckling and bearing)

At locations where concentrated forces are applied to the flanges of beams, the local resistance must be verified.

The design resistance of webs to local buckling under transverse forces is given by Clause 6.2 of BS EN 1993-1-5 as:

$$F_{Rd} = \frac{f_{yw} L_{eff} t_w}{\gamma_{M1}}$$

where:

γ_{M1} is the partial factor for the resistance of members to instability
t_w is the thickness of the web
f_{yw} is the yield strength of the web
L_{eff} is the effective length for resistance to transverse forces, which should be determined from

$$L_{eff} = \chi_F \ell_y$$

where:

χ_F is the reduction factor due to local buckling
ℓ_y is the effective loaded length appropriate to the length of stiff bearing, s_s

The above expression can be used where the load is applied in any one of the following ways:

a. through the flange and resisted by shear forces in the web, shown in Figure 3.4 (a)
b. through one flange and transferred through the web directly to the opposite flange, shown in Figure 3.4 (b)
c. through one flange adjacent to an unstiffened end, shown in Figure 3.4 (c)

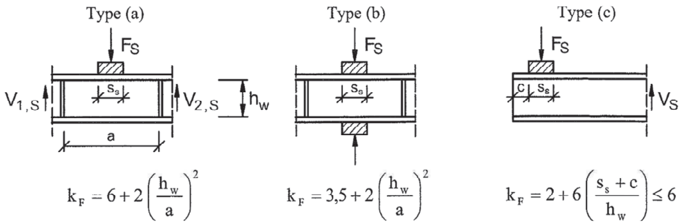


Figure 3.4 Different types of load application and the buckling coefficient, k_F

At locations where concentrated forces are applied, the web of the beam is required to act as a column. For an unstiffened web it is assumed that the compression flange of the rolled beam or welded girder is adequately restrained against lateral movement.

Conditions (a) and (b) are most common in practice and assume that the portion of the web being checked as a column is effectively held in position at both ends and effectively restrained in direction at both ends.

Determination of the reduction factor for local buckling
Clause 6.4(1) of BS EN 1993-1-5 gives the following expression for calculating the reduction factor:

$$\chi_F = \frac{0.5}{\bar{\lambda}_F} \le 1.0$$

where:

$$\bar{\lambda}_F = \sqrt{\frac{\ell_y t_w f_{yw}}{F_{cr}}}$$

and

$$F_{cr} = 0.9 k_F E \frac{t_w^3}{h_w}$$

and

$$h_w = h - 2t_f$$

For webs without longitudinal stiffeners, k_F should be determined from Figure 3.4. Clause 6.4(2) of BS EN 1993-1-5 gives an expression for calculating the reduction factor for webs with longitudinal stiffeners. However, this is beyond the scope of this publication.

Determination of the effective loaded length
Clause 6.5 of BS EN 1993-1-5 gives the following method for calculating the effective loaded length, ℓ_y

For load types (a) and (b) shown in Figure 3.4, ℓ_y should be calculated from the following expression:

$$\ell_y = s_s + 2t_f\left(1+\sqrt{m_1+m_2}\right) \text{ but } \ell_y \leq \text{the distance between adjacent transverse stiffeners}$$

where:

$$m_1 = \frac{f_{yf} b_f}{f_{yw} t_w}$$

$$m_2 = 0.02\left(\frac{h_w}{t_f}\right)^2 \qquad \text{if } \bar{\lambda}_F > 0.5$$

$$m_2 = 0 \qquad \text{if } \bar{\lambda}_F \leq 0.5$$

For box girders, b_f in the expression for m_1 should be limited to $15\varepsilon t_f$ on each side of the web.

For load type c) shown in Figure 3.4, ℓ_y is smaller of the values given by the following expressions:

$$\ell_y = \ell_e + t_f\sqrt{\left(\frac{m_1}{2}+\left(\frac{\ell_e}{t_f}\right)^2+m_2\right)}$$

$$\ell_y = \ell_e + t_f\sqrt{m_1+m_2}$$

where

$$\ell_e = \frac{k_F E t_w^2}{2 f_{yw} h_w} \leq s_s + c$$

Length of stiff bearing

The expression for ℓ_y requires the identification of a stiff bearing length s_s. This is the dimension, parallel to the longitudinal axis of the beam over which the load is effectively distributed to the outer face of the flange at a slope of 1:1. However, the stiff bearing length should never be larger that h_w (the height of the web). Figure 3.5 shows the stiff bearing length for a range of different loading conditions.

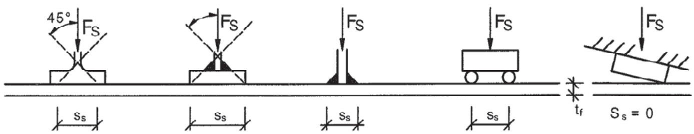


Figure 3.5 Length of stiff bearing

Where load is transferred through an I or H section, the stiff bearing length is given by

$$s_s = 2(t_f + r) \text{ but not more than } h_w$$

where

t_f is the thickness of the flange

r is the root radius

If several concentrated forces are closely spaced, the resistance should be verified for each individual concentrated load as well as for the total load with s_s taken as the centre to centre distance between the two outer loads.

3.5 Web stiffeners

Where heavy concentrated loads are applied to the flanges of sections parallel to the web, web stiffeners may be required to help carry the load. These stiffeners generally take the form of flat plates welded to the web between the flanges of the beam.

The cross-sectional resistance of the effective stiffener may be determined by considering the area of the effective stiffener in contact with the flange times the yield strength of the stiffener/web material divided by γ_{M0}. An allowance must be made for any coping adjacent to the web.

The buckling resistance of a stiffener is determined by examining the resistance of a cruciform section comprising the stiffeners plus a length of the web equal to a maximum value of $15\varepsilon t_w$ on either side of the stiffener, as shown in Figure 3.6. At an end support, the length on one side is limited by the end of the beam and is likely to be less than $15\varepsilon t_w$. Figure 3.6 shows such a cruciform section away from end effects.

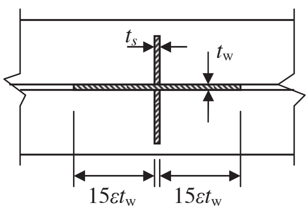


Figure 3.6 Effective cross-section of stiffener

Clause 9.4 of BS EN 1993-1-5 states that the out-of-plane buckling resistance of a transverse stiffener under transverse loads should be determined using the methods described in either Clause 6.3.3 or Clause 6.3.4 of BS EN 1993-1-1, using buckling curve c. Provided that both ends are fixed laterally, a buckling length, ℓ, of not less than $0.75\,h_w$ should be used, where h_w is the depth of the web. Where the end conditions provide less restraint, a larger value should be used for ℓ.

Where the stiffener is subjected to axial force only, the method described in Chapter 5 for members subject to compression should be used. To determine the buckling resistance it is necessary to calculate the second moment of area and the radius of gyration of the area of the cruciform section shown in Figure 3.6. The buckling resistance can then be determined from the following expression:

$$N_{b,Rd} = \frac{\chi A f_y}{\gamma_{M1}}$$

where:

χ is the reduction factor for flexural buckling and is given by the following expression:

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 + \bar{\lambda}^2}} \quad \text{but} \quad \chi \leq 1.0$$

and

$$\Phi = 0.5\left[1 + \alpha\left(\bar{\lambda} - 0.2\right) + \bar{\lambda}^2\right]$$

$\alpha = 0.49$ for buckling curve c

$$\bar{\lambda} = \frac{L_{cr}}{i}\frac{1}{\lambda_1}$$

and

L_{cr} is the buckling length taken as not less than 0.75 h_w if the ends are fixed laterally

i is the radius of gyration

3.6 Example 3.2 – Web subject to transverse forces

Check the beam in Section 3.3 at the loaded positions – under a point load of 100 kN.

Web bearing and buckling check

Assume that the load is transmitted to the beam via a 457 x 152 x 67 UB that sits on the top flange.

For this beam t_w = 9.0 mm; t_f = 15.0 mm; r = 10.2 mm

The resistance to local buckling under transverse force is given by:

$$F_{Rd} = \frac{f_{yw} L_{eff} t_w}{\gamma_{M1}}$$

The length of stiff bearing is:

$$s_s = 2(t_f + r) = 2(15.0 + 10.2) = 50.4 \text{ mm}$$

For webs without longitudinal stiffeners, k_F is obtained from Figure 3.4. For loading condition type a), k_F is given by:

$$k_F = 6 + 2\left(\frac{h_w}{a}\right)^2$$

Assuming there are no stiffeners and $a = \infty$, then:

$$k_F = 6$$

Therefore for the beam in Section 3.3:

$$h_w = h - 2 \times t_f = 460 - 2 \times 16 = 428\text{mm}$$

$$F_{cr} = 0.9 k_F E \frac{t_w^3}{h_w} = 0.9 \times 6 \times 210000 \times \frac{9.9^3}{428} \times 10^{-3} = 2571 \text{ kN}$$

$f_{yw} = 275 \text{ N/mm}^2$ (the yield strength of the web)

From Clause 6.5 of BS EN 1993-1-5 for type a) loading condition:

$\ell_y = s_s + 2t_f\left(1 + \sqrt{m_1 + m_2}\right)$ but $\ell_y \leq$ the distance between adjacent transverse stiffeners

$$m_1 = \frac{f_{yf} b_f}{f_{yw} t_w} = \frac{275 \times 191.3}{275 \times 9.9} = 19.3$$

Assume $\bar{\lambda}_F > 0.5$ therefore $m_2 = 0.02\left(\frac{h_w}{t_f}\right)^2 = 0.02\left(\frac{428}{16}\right)^2 = 14.31$

$$\ell_y = 50.4 + 2 \times 16 \times \left(1 + \sqrt{19.3 + 14.31}\right) = 267.9 \text{ mm}$$

$$\bar{\lambda}_F = \sqrt{\frac{\ell_y t_w f_{yw}}{F_{cr}}} = \sqrt{\frac{267.9 \times 9.9 \times 275}{2571 \times 10^3}} = 0.53$$

$$\chi_F = \frac{0.5}{\bar{\lambda}_F} = \frac{0.5}{0.53} = 0.943 < 1.0$$

$$L_{eff} = \chi_F \ell_y = 0.943 \times 267.9 = 252.6 \text{ mm}$$

$$\gamma_{M1} = 1.00$$

$$F_{\mathrm{Rd}} = \frac{f_{\mathrm{y}} L_{\mathrm{eff}} t_{\mathrm{w}}}{\gamma_{\mathrm{M1}}} = \frac{275 \times 252.6 \times 9.9}{1.00} 10^{-3} = 687.7\ \mathrm{kN}$$

687.7 kN > 100 kN

Therefore the web resistance to transverse forces is OK.

3.7 Example 3.3 –Web stiffener

Consider a 610 x 229 x 101 UB carrying a point load of 800 kN (design value) via a 457 x 191 x 98 UB supported on its top flange remote from the end of the beam.

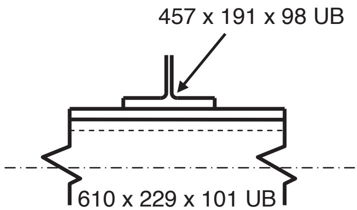


Figure. 3.7 610 x 229 x 101 UB supporting a 457 x 191 x 98 UB

Check unstiffened web

Length of stiff bearing
For a 457 x 191 x 98 UB t_{f} = 19.6 mm; r = 10.2 mm

$$s_{\mathrm{s}} = 2(t_{\mathrm{f}} + r) = 2(19.6 + 10.2) = 59.6\mathrm{mm}$$

Without a stiffener the situation corresponds to type (a) load introduction, as shown in Figure 3.4.

For a 610 x 229 x 101 UB

h=602.6 mm; b=227.6 mm; t_{w}=10.5 mm
t_{f}=14.8 mm; r=12.7 mm; h_{w}=573 mm

$$k_{\mathrm{F}} = 6 + 2\left(\frac{h_{\mathrm{w}}}{a}\right)^2 = 6 + 2\left(\frac{573.3}{\infty}\right)^2 = 6$$

Therefore

$$F_{\mathrm{cr}} = 0.9 k_{\mathrm{F}} E \frac{t_{\mathrm{w}}^3}{h_{\mathrm{w}}} = 0.9 \times 6 \times 210000 \times \frac{10.5^3}{573.3} \times 10^{-3} = 2290\ \mathrm{kN}$$

The effective loaded length for a type (a) loading condition is given by:

$\ell_y = s_s + 2t_f\left(1+\sqrt{m_1+m_2}\right)$ but $\ell_y \le$ the distance between adjacent transverse stiffeners

$$m_1 = \frac{f_{yf}b_f}{f_{yw}t_w} = \frac{275\times 227.6}{275\times 10.5} = 21.68$$

Assume $\bar{\lambda}_F > 0.5$ therefore $m_2 = 0.02\left(\frac{h_w}{t_f}\right)^2$

$$= 0.02\left(\frac{573.3}{14.8}\right)^2$$

$$= 30.01$$

$$\ell_y = 59.6 + 2\times 14.8\left(1+\sqrt{21.68+30.01}\right) = 302.0\text{ mm}$$

$$\bar{\lambda}_F = \sqrt{\frac{\ell_y t_w f_{yw}}{F_{cr}}} = \sqrt{\frac{302.0\times 10.5\times 275}{2290\times 10^3}} = 0.617$$

$$\chi_F = \frac{0.5}{\bar{\lambda}_F} = \frac{0.5}{0.617} = 0.81 < 1.0$$

$$L_{eff} = \chi_F\ell_y = 0.81\times 302.0 = 244.6\text{ mm}$$

$$F_{Rd} = \frac{f_y L_{eff} t_w}{\gamma_{M1}} = \frac{275\times 244.6\times 10.5}{1.00}10^{-3} = 706.3\text{ kN}$$

This is less that the design value of load 800 kN.

Design of transverse stiffeners

Try two plates, one on either side of the web as indicated in Figure 3.8.

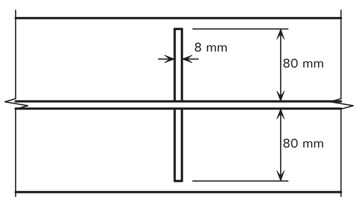


Figure 3.8 Details of the trial stiffener

Width available for each plate in bearing is given by:

$$b_s = (b - t_w - 2r)/2 = (227.6 - 10.5 - 2\times 12.7)/2 = 95.9 \text{ mm}$$

Therefore make each plate 80 mm wide with a 15 mm cope at the web corners. The width in bearing is therefore 65 mm. Assuming that the stiffeners are a Class 1, 2 or 3 cross-section, the thickness can be estimated by re-arranging the expression for compression resistance given in Clause 6.2.4(2) of BS EN 1993-1-1.

Choose an 8mm thick stiffener, as a minimum practical size.

Check stiffener's classification
Table 2.1 gives the following limit for a Class 3 outstand in compression:

$$c/t \le 14\varepsilon$$

For the stiffener $c/t = 80/8 = 10.0$

$$\varepsilon = \sqrt{235/f_y} = \sqrt{235/275} = 0.92$$

$$c/t = 14\varepsilon = 14\times 0.92 = 12.88$$

$$10.00 \le 12.88$$

Therefore the stiffener is Class 3 and the full dimensions of the stiffener can be used without restrictions due to local buckling.

Buckling resistance of the stiffener as a cruciform strut
Considering the cruciform section shown in Figure 3.6, the properties of the section are:

$$A_s = 2\times(t_s b_s) + (2\times 15\varepsilon t_w + t_s)t_w = 2(8\times 80) + (2\times 15\times 0.92\times 10.5 + 8)10.5 = 4407 \text{ mm}^2$$

$$I_s = \frac{t_s(2b_s + t_w)^3}{12} + 2\frac{(15\varepsilon t_w)t_w^3}{12} = \frac{8\times(2\times 80 + 10.5)^3}{12} + 2\frac{(15\times 0.92\times 10.5)\times 10.5^3}{12} = 3332\times 10^3 \text{ mm}^4$$

$$i = \sqrt{\frac{I_s}{A_s}} = \sqrt{\frac{3332\times 10^3}{4407}} = 27.50 \text{ mm}$$

The compression resistance is given by:

$$N_{b,Rd} = \frac{\chi A f_y}{\gamma_{M1}}$$

where χ is the reduction factor for flexural buckling and is given by the following expression:

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} \quad \text{but } \chi \leq 1.0$$

where $\Phi = 0.5\left[1 + \alpha\left(\bar{\lambda} - 0.2\right) + \bar{\lambda}^2\right]$

For flexural buckling;

$$\bar{\lambda} = \frac{L_{cr}}{i}\frac{1}{\lambda_1}$$

Buckling length, L_{cr}

Assuming that the flanges are fixed laterally, the buckling length ℓ is taken as $0.75\,h_w$

$$L_{cr} = 0.75h_w = 0.75 \times 573.3 = 430\,\text{mm}$$

$$\lambda_1 = 93.9\varepsilon = 93.9 \times 0.92 = 86.40$$

$$\bar{\lambda} = \frac{430}{27.5}\frac{1}{86.40} = 0.180$$

For buckling curve c, $\alpha = 0.49$

$$\Phi = 0.5\left[1 + 0.49(0.180 - 0.2) + 0.180^2\right] = 0.511$$

$$\chi = \frac{1}{0.511 + \sqrt{0.511^2 - 0.180^2}} = 1.00$$

$$N_{b,Rd} = \frac{1.00 \times 4407 \times 275}{1.0} \times 10^{-3} = 1212\,\text{kN}$$

The design load of 800kN is less than the resistance of the stiffener (1212 kN) therefore the stiffener is OK.

CHAPTER 4 – MEMBERS IN TENSION

Members that carry pure tension, generally referred to as ties, are relatively simple to design. In reality, the tension forces are frequently accompanied by moments and the member must be designed for the combined effects.

4.1 Resistance of cross-section

The design tension resistance, $N_{t,Rd}$, of a cross-section is given by Clause 6.2.3(2) of BS EN 1993-1-1 as the smaller of:

a) The design plastic resistance of the gross cross-section

$$N_{pl,Rd} = \frac{Af_y}{\gamma_{M0}}$$

b) The design ultimate resistance of the net cross-section at holes for fasteners

$$N_{u,Rd} = \frac{0.9 A_{net} f_u}{\gamma_{M2}}$$

For category C connections (as defined in clause 3.4.2(1) of BS EN 1993-1-8) the design tension resistance is given by the following expression:

$$N_{net,Rd} = \frac{A_{net} f_y}{\gamma_{M0}}$$

where:

A is the gross area of the cross-section

A_{net} is the net area of the cross-section and is taken as the gross area less appropriate deductions for all holes and other openings.

In members where the bolt holes are not staggered, the total area to be deducted for fasteners should be the gross cross-section of the holes in a cross-section perpendicular to the direction of the axial force, see critical fracture line 2 in Figure 4.1.

In members where the holes are staggered, the deduction should be the greater of the deduction for non-staggered holes, given above, and the deduction for staggered holes given in Clause 6.2.2.2(4)b) as:

$$t\left(nd_o - \sum \frac{s^2}{4p}\right)$$

where (as indicated in Figure 4.1):

s is the staggered pitch, the spacing of the centres of two consecutive holes in the chain measured parallel to the member axis,

p is the spacing of the centres of the same two holes measured perpendicular to the direction of the tensile force

t is the thickness of the material

n	is the number of holes extending in any diagonal or zig-zag line progressively across the member or part of the member; critical fracture line 1 in Figure 4.1
d_o	is the diameter of the hole
γ_{M2}	is the partial factor for the resistance of cross-sections in tension to fracture

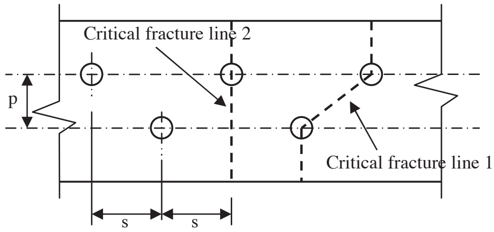


Figure 4.1 Net area at staggered holes

4.2 Resistance of angles connected by one leg

Angles subject to tension with moments caused by eccentric end connections can be designed as subject to concentric loading over a net section given by using the method in Clause 3.10.3(2) of BS EN 1993-1-8.

The design method in BS EN 1993-1-8 gives the design resistance as:

For single angles connected by one bolt:

$$N_{u,Rd} = \frac{2.0(e_2 - 0.5d_o)tf_u}{\gamma_{M2}}$$

For single angles connected by two bolts:

$$N_{u,Rd} = \frac{\beta_2 A_{net} f_u}{\gamma_{M2}}$$

For single angles connected by three or more bolts:

$$N_{u,Rd} = \frac{\beta_3 A_{net} f_u}{\gamma_{M2}}$$

where:

e_2	is the edge distance from the centre of a fastener hole to the adjacent edge of any part, measured at right angles to the direction of load transfer.
d_o	is the diameter of the bolt, rivet or pin
t	is the thickness of the angle
f_u	is the ultimate tensile strength
γ_{M2}	is the partial factor for the resistance of cross-sections in tension to fracture

A_{net} is the net area of the angle. For an unequal-leg angle connected by its smaller leg, A_{net} should be taken as equal to the net section of an equivalent equal-leg angle of leg size equal to that of the smaller leg.

β_2 and β_3 are the reduction factors dependant on the pitch p_1 as given in Table 4.1. For intermediate values of p_1 the value of β may be determined by linear interpolation.

Table 4.1 Reduction factors β_2 and β_3

Pitch p_1	**≤2.5 d_o**	**≥5.0 d_o**
2 bolts β_2	0.4	0.7
3 bolts or more β_3	0.5	0.7

A common detail is an angle connected by one leg using one or more rows of bolts as shown in Figure 4.2. Unfortunately BS EN 1993-1-8 does not give any guidance for calculating the resistance of angles connected in this way.

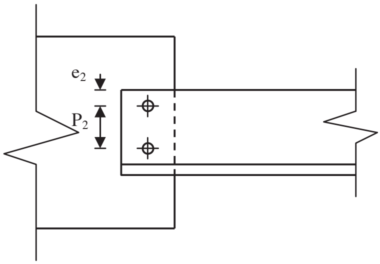


Figure 4.2 Angle connected by one leg with two bolt rows

The European connections committee, ECCS TC10, has considered this detail and suggested that the following expression may be used for calculating the design resistance of the section:

$$N_{u,Rd} = \frac{2.0(e_2 + p_2 - 1.5d_0)tf_u}{\gamma_{M2}}$$

where:

e_2 is the edge distance

p_2 is the spacing between the two bolts

d_o is the diameter of the bolt hole

γ_{M2} is the partial factor for the resistance of cross-section in tension to fracture

4.3 Example 4.1 - Angle connected by a single leg using two rows of bolts

A 200 x 200 x 16 mm angle section in grade S275 steel is to be used as a tie. The connection will be made by a single row of two M24 bolts in line across the width of the section. Determine the tension resistance.

From section tables: $A = 61.8\ \text{cm}^2$

$\gamma_{M2} = 1.10$

For $t_f \le 16$ mm, $f_y = 275\ \text{N/mm}^2$ and $f_u = 410\ \text{N/mm}^2$

The resistance is given by:

$$N_{u,Rd} = \frac{2.0(e_2 + p_2 - 1.5d_0)tf_u}{\gamma_{M2}}$$

For a 200 x 200 x 16 equal leg angle with two M24 bolts, e_2 is 50 mm and p_2 is 95 mm.

$$N_{u,Rd} = \frac{2.0(e_2 + p_2 - 1.5d_o)tf_u}{\gamma_{M2}} = \frac{2.0(50 + 95 - 1.5 \times 26) \times 16 \times 410 \times 10^{-3}}{1.1} = 1264\ \text{kN}$$

4.4 Members subject to bending and tension

Members that are subject to both tension and bending must be checked to ensure that the combined effects may be safely resisted. BS EN 1993-1-1 gives a number of methods for verifying the resistance of members subject to combined bending and axial force. The method described below is given in Clause 6.2.9.1(5) and is an approximation for standard Class 1 and Class 2, rolled I and H sections, and welded I and H sections with equal flanges, where fastener holes are not to be accounted for.

$$M_{N,y,Rd} = M_{pl,y,Rd}(1-n)/(1-0.5a) \text{ but } M_{N,y,Rd} \le M_{pl,y,Rd}$$

For $n \le a$: $\quad M_{N,z,Rd} = M_{pl,z,Rd}$

For $n > a$: $\quad M_{N,z,Rd} = M_{pl,z,Rd}\left[1 - \left(\frac{n-a}{1-a}\right)^2\right]$

where:

$n = N_{Ed} / N_{pl,Rd}$

$a = (A - 2bt_f)/A$ but $a \le 0.5$

$M_{N,y,Rd}$ is the design plastic resistance moment about the y-y axis (major) reduced due to the axial force N_{Ed}

$M_{N,z,Rd}$ is the design plastic resistance moment about the z-z axis (minor) reduced due to the axial force N_{Ed}

$M_{pl,y,Rd}$ is the design plastic resistance moment about the y-y axis (major)

$M_{pl,z,Rd}$ is the design plastic resistance moment about the z-z axis (minor)

N_{Ed} is the design tension force

$N_{pl,Rd}$ is the design plastic resistance of the gross cross-section

A is the area of the gross cross-section

b is the width of the cross-section

t_f is the flange thickness

This is not a sufficient check in all circumstances because if the axial load is small, then it can readily be seen that the member is essentially a beam and lateral-torsional buckling can occur. It is therefore necessary to check for lateral-torsional buckling under the bending moments alone, as outlined in Chapter 3, and to check the resistance of the cross-section to combined bending and axial force, as described in Chapter 2.

CHAPTER 5 – MEMBERS IN COMPRESSION

Members in compression have a limit on their resistance, which is equal to the yield strength of the material multiplied by the cross-sectional area. Long slender members will fail at much lower loads by elastic buckling. In most practical cases compression members have slenderness between these two extremes and fail by a combination of yielding and buckling. Furthermore, columns in buildings carry both axial compression and bending and must be designed for the combined effects.

5.1 Resistance of cross-section

The compression resistance, $N_{c,Rd}$, of a cross-section is given by Clause 6.2.4(2) of BS EN 1993-1-1 as:

$$N_{c,Rd} = \frac{A f_y}{\gamma_{M0}} \quad \text{for Class 1, 2 or 3 cross-sections}$$

$$N_{c,Rd} = \frac{A_{eff} f_y}{\gamma_{M0}} \quad \text{for Class 4 cross-sections}$$

where:

A	is the gross area of the cross-section
A_{eff}	is the effective area of the cross-section
f_y	is the yield strength
γ_{M0}	is the partial safety factor for resistance of cross-sections

Fastener holes, with the exception of slotted or oversize holes, need not be allowed for provided they are filled by fasteners.

5.2 Buckling resistance

The buckling resistance $N_{b,Rd}$ is given by Clause 6.3.1.1(3) of BS EN 1993-1-1 in terms of a reduction factor χ that depends on the non-dimensional slenderness $\bar{\lambda}$. The buckling resistance $N_{b,Rd}$ is given by:

$$N_{b,Rd} = \frac{\chi A f_y}{\gamma_{M1}} \quad \text{for Class 1, 2 and 3 cross-sections}$$

where:

χ is the reduction factor for the relevant buckling mode. The value of χ is given by Clause 6.3.1.2(1) as:

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} \quad \text{but} \quad \chi \le 1.0$$

and

$$\Phi = 0.5\left[1 + \alpha\left(\bar{\lambda} - 0.2\right) + \bar{\lambda}^2\right]$$

$\bar{\lambda}$ is the non-dimensional slenderness (see Section 5.3)

α is an imperfection factor. The imperfection factor corresponding to the appropriate buckling curve is given in Table 6.1 of BS EN 1993-1-1, reproduced below as Table 5.1.

Table 5.1 Imperfection factors for buckling curves

Buckling Curve	a_0	a	b	c	d
Imperfection factor α	0.13	0.21	0.34	0.49	0.76

5.3 Slenderness

In general a column can buckle in any one of the following three modes:

- Flexural (Euler) buckling
- Torsional buckling
- Torsional-flexural buckling

BS EN 1993-1-1 gives methods for calculating the slenderness for each of these modes of behaviour. The lowest of these values will govern. However, for columns in buildings, the slenderness for flexural buckling is usually lower than that for torsional and torsional-flexural buckling. For completeness, the methods given in BS EN 1993-1-1 for calculating the slenderness of each of these modes of failure are given below.

Slenderness for flexural bucking
Clause 6.3.1.3 of BS EN 1993-1-1 gives the following approach for calculating the slenderness for flexural buckling:

The non-dimensional slenderness is given by:

$$\bar{\lambda} = \sqrt{\frac{Af_y}{N_{cr}}} = \frac{L_{cr}}{i}\frac{1}{\lambda_1} \qquad \text{for Class 1, 2 and 3 cross-sections}$$

where:

L_{cr} is the buckling length in the buckling plane considered (see Section 5.4)
i is the radius of gyration about the relevant axis
N_{cr} is the elastic critical force for the relevant buckling mode based on the gross cross-sectional properties

$$\lambda_1 = \pi\sqrt{\frac{E}{f_y}} = 93.9\varepsilon$$

$$\varepsilon = \sqrt{\frac{235}{f_y}} \quad (f_y \text{ in N/mm}^2)$$

Slenderness for torsional and torsional-flexural buckling
The non-dimensional slenderness for torsional and torsional-flexural buckling is given by Clause 6.3.1.4(2) of BS EN 1993-1-1 as:

$$\bar{\lambda}_{T} = \sqrt{\frac{Af_{y}}{N_{cr}}} \text{ for Class 1, 2 and 3 cross-sections}$$

$$\bar{\lambda}_{T} = \sqrt{\frac{A_{eff} f_{y}}{N_{cr}}} \text{ for Class 4 cross-sections}$$

where:
$N_{cr} = N_{cr,TF}$ but $N_{cr} < N_{cr,T}$

$N_{cr,TF}$ is the elastic torsional-flexural buckling force

$N_{cr,T}$ is the elastic torsional bucking force

BS EN 1993-1-1 does not give expressions for calculating the elastic torsional-flexural buckling force and the elastic torsional buckling force. For sections that are symmetrical about the y-y axis (major) the following expressions may be used.

$$N_{cr,T} = \frac{1}{i_0^2}\left(GI_t + \frac{\pi^2 EI_W}{l_T^2}\right)$$

where:
$i_0^2 = i_y^2 + i_z^2 + y_0^2 + z_0^2$

G is the shear modulus
I_t is the torsion constant of the gross cross-section
I_W is the warping constant of the gross cross-section
i_y is the radius of gyration of the gross cross-section about the y-y axis
i_z is the radius of gyration of the gross cross-section about the z-z axis
l_T is the buckling length of the members for torsional buckling
y_0 is the distance from the shear centre to the centroid of the gross cross-section along the y axis
z_0 is the distance from the shear centre to the centroid of the gross cross-section along the z axis

$$N_{cr,TF} = \frac{N_{cr,y}}{2\beta}\left(1 + \frac{N_{cr,T}}{N_{cr,y}} \sqrt{\left(\left(1 - \frac{N_{cr,T}}{N_{cr,y}}\right)^2 + 4\left(\frac{y_0}{i_0}\right)^2 \frac{N_{cr,T}}{N_{cr,y}}\right)}\right)$$

where:

$$\beta = 1 - \left(\frac{y_0}{i_0}\right)^2$$

$N_{cr,y}$ is the critical force for flexural buckling about the y-y axis

Further information on torsional and torsional-flexural buckling, particularly for light-gauge construction, is given in reference [41].

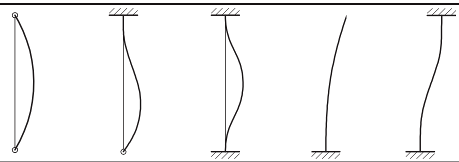
Expressions for calculating the elastic torsional-flexural force and torsional buckling force are given in reference [42].

5.4 Buckling Length, L_{cr}

The end restraint conditions of a column will affect the buckling shape of the column (see Table 5.2) and also the buckling resistance. The buckling length, L_{cr}, is best described as the length of a pin-ended member that has the same elastic critical buckling resistance as the real member with its actual end restraints. Thus a vital step in the design of any compression member is the identification of the buckling length.

Table 5.2 shows the buckled shapes and buckling lengths for some reference conditions. They are separated into non-sway and sway conditions. Relative movement of the ends of the column are restricted in a non-sway frame, this can be achieved by effective diagonal bracing or by the provision of shear walls – possibly the concrete core around lift shafts and stair wells. However, if the building relies on frame action for its lateral stability, it is more likely to be a sway-sensitive frame.

Table 5.2 Effective lengths of columns with various end conditions

Restraint	Position	Position and Direction	Position and Direction	None	Direction
Shape L is column length					
Restraint	Position	Position	Position and Direction	Position and Direction	Position and Direction
Practical L_E	1.0L	0.85L	0.7L	2.0L	1.2L

If the ends of a non-sway member have no rotational restraint, then the buckling length of the column is the actual length – by definition. If effective rotational restraint is present – for example from stiff beams that are effectively fastened to the column by stiff end-plate connections – then the member will have a greater elastic critical force and the buckling length will be reduced. In the extreme case of a non-sway member that is fully restrained against rotation, the buckling length will be one half of the actual length. This is an idealised reference case because full rotational restraint is not achievable in practice and therefore the buckling length is taken as 0.7L. It is important to recognise that rotational restraint is provided by the connected members and the stiffness of the connections to transmit this restraint.

The two cases at the right hand side of Table 5.2 show columns that can sway. Under these conditions the buckling length can never be less than the actual length. This lower limit implies complete rotational restraint at the column ends which is not achievable in practice.

To design a column, it is necessary to determine the length over which it can buckle, termed the segment length. The length over which a column can buckle is the length in any plane between restrained points in that plane. This is the distance between the intersections of the column and the restraining members and will usually be the storey height in a building frame. The restraining members will inhibit movement and/or rotation at the specific location. From the segment length, the buckling length may be determined using Table 5.3.

If the beams are attached to the columns using flexible connections, such as fin plates, then it would be unwise to assume any rotational restraint, whatever the stiffness of the beam. With connections such as partial depth end-plates or double angle cleats, provided that the beams are reasonably sized, partial restraint may be assumed. Stiff beams connected to the columns using substantial connections such as flush or extended end-plates will provide effective rotational restraint. The above is general advice based upon normal circumstances and the engineer must view each case on its merits.

Table 5.3 Buckling length, L_{cr} for a compression member

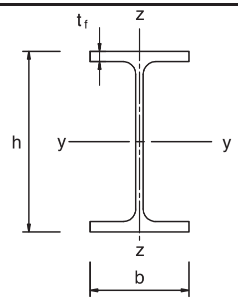
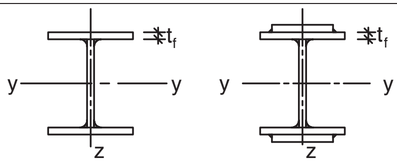
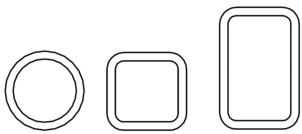
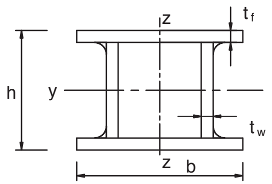
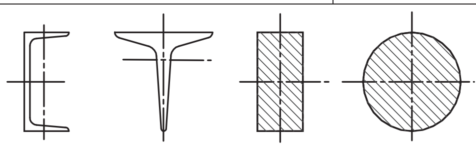
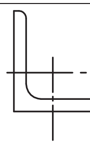
<table>
<tr><th colspan="4">a) Non-sway</th></tr>
<tr><td colspan="3">Restraint (in the plane under consideration) by other parts of the structure</td><td>Buckling length, L_{cr}</td></tr>
<tr><td rowspan="4">Effectively held in position at both ends</td><td colspan="2">Effectively restrained in direction at both ends</td><td>$0.7L$</td></tr>
<tr><td colspan="2">Partially restrained in direction at both ends</td><td>$0.85L$</td></tr>
<tr><td colspan="2">Restrained in direction at one end</td><td>$0.85L$</td></tr>
<tr><td colspan="2">Not restrained in direction at either end</td><td>$1.0L$</td></tr>
<tr><th colspan="4">b) Sway</th></tr>
<tr><td>One end</td><td colspan="2">Other end</td><td>Buckling length, L_{cr}</td></tr>
<tr><td rowspan="3">Effectively held in position and restrained in direction</td><td rowspan="3">Not held in position</td><td>Effectively restrained in direction</td><td>$1.2L$</td></tr>
<tr><td>Partially restrained in direction</td><td>$1.5L$</td></tr>
<tr><td>Not restrained in direction</td><td>$2.0L$</td></tr>
</table>

5.5 Buckling curves

The interaction of yielding and instability effects is influenced by a number of parameters including the section shape, the axis of bending, the initial out of straightness and the residual stresses within the section. Considerable research has shown that the effect of these parameters may be efficiently incorporated using an appropriate buckling curve from a family of five (shown in Figure 6.4 of BS EN 1993-1-1 as curves a_0, a, b, c and d). Table 6.2 of BS EN 1993-1-1 enables the designer to determine the appropriate curve. This table is reproduced here as Table 5.4.

For torsional and torsional-flexural buckling the appropriate buckling curve may be determined from Table 5.4 using the buckling curve related to the z-z axis.

Table 5.4 Selection of buckling curves for a cross-section

Cross section		Limits		Buckling about axis	Buckling curve: S 235, S 275, S 355, S 420	Buckling curve: S 460
Rolled sections		$h/b > 1,2$	$t_f \leq 40$ mm	y – y z – z	a b	a_0 a_0
			40 mm < $t_f \leq 100$	y – y z – z	b c	a a
		$h/b \leq 1,2$	$t_f \leq 100$ mm	y – y z – z	b c	a a
			$t_f > 100$ mm	y – y z – z	d d	c c
Welded I-sections		$t_f \leq 40$ mm		y – y z – z	b c	b c
		$t_f > 40$ mm		y – y z – z	c d	c d
Hollow sections		hot finished		any	a	a_0
		cold formed		any	c	c
Welded box sections		generally (except as below)		any	b	b
		thick welds: $a > 0,5t_f$ $b/t_f < 30$ $h/t_w < 30$		any	c	c
U-, T- and solid sections				any	c	c
L-sections				any	b	b

5.6 Example 5.1 – Simple compression member

A 7.0m long 152 x 152 x 30 UC in grade S275 steel is to be used with pinned ends to carry axial force only. Determine its compression resistance.

From section tables:

h	= 157.6 mm;	b	=152.9 mm;	h/b	= 1.03
c_f/t_f	= 6.98;	c_w/t_w	= 19.0;	t_f	= 9.4 mm;
A	= 38.3 cm^2;	i_y	= 6.76 cm;	i_z	= 3.83 cm.
t_w	= 6.5 mm;				

For t_f = 9.4 mm, from Table 7 of BS EN 10025-2; f_y = 275 N/mm^2;

Section classification
From Table 5.2 (Sheet 2 of 3) of BS EN 1993-1-1 the Class 1 limit for an outstand flange is $c/t = 9.0\varepsilon$

$$\varepsilon = \sqrt{235/f_y} = \sqrt{235/275} = 0.92$$

The Class 1 limit $c/t = 9.0\varepsilon = 8.28$

6.98 < 8.28, therefore the flange is Class 1.

From Table 5.2 (Sheet 1 of 3) of BS EN 1993-1-1 the Class 1 limit for an internal compression element is $c/t = 33\varepsilon = 30.36$

19.0 < 33.36, therefore the web is Class 1

Therefore the whole section is Class 1.

Buckling length
For a section with pinned ends, from Table 5.2, $L_{cr} = 1.0L = 7.0$ m for both axes.

Buckling curve
For an S275 rolled section with $h/b = 1.03$ and $t_f = 9.4$ the buckling curves from Table 6.2 of BS EN 1993-1-1 are:

Buckling about y-y axis (major) – Buckling curve b
Buckling about z-z axis (minor) – Buckling curve c

Non-dimensional slenderness
For flexural buckling about the z-z axis (minor) for a Class 1 section, the non-dimensional slenderness is given by Clause 6.3.1.3(1) of BS EN 1993-1-1 as:

$$\bar{\lambda}_z = \sqrt{\frac{Af_y}{N_{cr}}} = \frac{L_{cr}}{i_z}\frac{1}{\lambda_1}$$

where:

$$\lambda_1 = \pi\sqrt{\frac{E}{f_y}} = 93.9\varepsilon = 93.9 \text{ x } 0.92 = 86.39$$

Therefore $\bar{\lambda}_z = \frac{7000}{38.3} \frac{1}{86.39} = 2.12$

Similarly the non-dimensional slenderness about the y-y axis (major) is

$$\bar{\lambda}_y = \sqrt{\frac{Af_y}{N_{cr}}} = \frac{L_{cr}}{i_y} \frac{1}{\lambda_1} = \frac{7000}{67.6} \frac{1}{86.39} = 1.20$$

Buckling resistance, $N_{b,z,Rd}$ (flexural buckling about the z-z axis)
The buckling resistance, $N_{b,z,Rd}$, is given by Clause 6.3.1.2 of BS EN 1993-1-1, as:

$$N_{b,z,Rd} = \frac{\chi_z A f_y}{\gamma_{M1}} \text{ for Class 1, 2 and 3 cross-sections}$$

where:

γ_{M1} is given in the NA to EN1993-1-1 as 1.00

$$\chi_z = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}_z^{\,2}}} \text{ but} \leq 1.0$$

$$\Phi = 0.5\left[1 + \alpha\left(\bar{\lambda}_z - 0.2\right) + \bar{\lambda}_z^{\,2}\right]$$

For buckling curve c, Table 6.1 of EN 1993-1-1 gives $\alpha = 0.49$.

$$\Phi = 0.5\left[1 + 0.49(2.12 - 0.2) + 2.12^2\right] = 3.22$$

$$\chi_z = \frac{1}{3.22 + \sqrt{3.22^2 - 2.12^2}} = 0.177$$

Therefore $N_{b,z,Rd} = \frac{0.177 \times 3830 \times 275 \times 10^{-3}}{1.00} = 186 \text{ kN}$

Buckling resistance, $N_{b,y,Rd}$ (flexural buckling about the y-y axis)
The buckling resistance, $N_{b,y,Rd}$, is given by Clause 6.3.1.2 of BS EN 1993-1-1, as:

$$N_{b,y,Rd} = \frac{\chi_y A f_y}{\gamma_{M1}} \text{ for Class 1, 2 and 3 cross-sections}$$

where:

γ_{M1} is given in the NA to BS EN 1993-1-1 as 1.00

$$\chi_y = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}_y^{\,2}}} \text{ but} \leq 1.0$$

$$\Phi = 0.5\left[1 + \alpha\left(\bar{\lambda}_y - 0.2\right) + \bar{\lambda}_y^{\,2}\right]$$

For buckling curve b, Table 6.1 of BS EN 1993-1-1 gives $\alpha = 0.34$.

$$\Phi = 0.5\left[1 + 0.34(1.2 - 0.2) + 1.2^2\right] = 1.39$$

$$\chi_y = \frac{1}{1.39 + \sqrt{1.39^2 - 1.2^2}} = 0.478$$

Therefore $N_{b,y,Rd} = \dfrac{0.478 \times 3830 \times 275 \times 10^{-3}}{1.00} = 503$ kN

The bucking resistance is the lesser of $N_{b,z,Rd}$ and $N_{b,y,Rd}$ which is 186 kN.

In this example it is obvious that the minor axis buckling is the controlling factor but this is not always the case.

5.7 Example 5.2 – Simple compression member restrained at mid-height

A 254 x 254 x 89 UC in grade S275 steel is 6.00 m long and is pinned at its ends in both planes. It has a positional restraint located at its mid-height that prevents lateral movement parallel to the flanges. Determine its bucking resistance.

From section tables:

h	=260.5 mm;	b	= 256.3 mm;	h/b	= 1.02
c_f/t_f	= 6.38 ;	c_w/t_w	= 19.4;	t_f	= 17.3 mm;
A	= 113 cm^2;	i_y	= 11.2 cm;	i_z	= 6.55 cm.

For $t_f = 17.3$ mm; $f_y = 265$ N/mm^2;

Section classification
From Table 5.2 (Sheet 2 of 3) of BS EN 1993-1-1 the Class 1 limit for an outstand flange is $c/t = 9.0\varepsilon$

$$\varepsilon = \sqrt{235/f_y} = \sqrt{235/265} = 0.94$$

The Class 1 limit $c/t = 9.0\varepsilon = 8.46$

6.38 < 8.46, therefore the flange is Class 1.

From Table 5.2 (Sheet 1 of 3) of BS EN 1993-1-1 the Class 1 limit for an internal compression element is $c/t = 33\varepsilon = 31.02$

19.4 < 31.02, therefore the web is Class 1

Therefore the whole section is Class 1.

Buckling length
For a section with pinned ends, from Table 5.2, $L_{cr} = 1.0L = 6.0$ m for the major axis and because of the restraint at mid height $L_{cr} = 1.0 \times 3.0 = 3.0$ m for the minor axis.

Buckling curve
For an S275 rolled section with h/b = 1.02 and t_f = 17.3 the buckling curves from Table 6.2 of BS EN 1993-1-1 are:

Buckling about y-y axis (major) – Buckling curve b
Buckling about z-z axis (minor) – Buckling curve c

Non-dimensional slenderness
For flexural buckling about the z-z axis (minor) for a Class 1 section, the non-dimensional slenderness is given by Clause 6.3.1.3(1) of BS EN 1993-1-1 as:

$$\bar{\lambda}_z = \sqrt{\frac{Af_y}{N_{cr}}} \quad = \frac{L_{cr}}{i_z}\frac{1}{\lambda_1}$$

where:

$$\lambda_1 = \pi\sqrt{\frac{E}{f_y}} = 93.9\varepsilon \ = 93.9 \text{ x } 0.94 = 88.27$$

Therefore $\bar{\lambda}_z = \frac{3000}{65.5}\frac{1}{88.27} = 0.52$

Similarly the non-dimensional slenderness about the y-y axis (major) is

$$\bar{\lambda}_y = \sqrt{\frac{Af_y}{N_{cr}}} \quad = \frac{L_{cr}}{i_y}\frac{1}{\lambda_1} = \frac{6000}{112}\frac{1}{88.27} = 0.61$$

Buckling resistance, $N_{b,z,Rd}$ (flexural buckling about the z-z axis)
The buckling resistance, $N_{z,b,Rd}$, is given by Clause 6.3.1.2 of BS EN 1993-1-1, as:

$$N_{b,z,Rd} = \frac{\chi_z A f_y}{\gamma_{M1}} \text{ for Class 1, 2 and 3 cross-sections}$$

where:

γ_{M1} is given in the NA to BS EN 1993-1-1 as 1.00

$$\chi_z = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}_z^{\,2}}} \text{ but} \leq 1.0$$

$$\Phi = 0.5\left[1 + \alpha\left(\bar{\lambda}_z - 0.2\right) + \bar{\lambda}_z^{\,2}\right]$$

For buckling curve c, Table 6.1 of BS EN 1993-1-1 gives $\alpha = 0.49$.

$$\Phi = 0.5\left[1 + 0.49(0.52 - 0.2) + 0.52^2\right] = 0.714$$

$$\chi_z = \frac{1}{0.714 + \sqrt{0.714^2 - 0.52^2}} \quad = \quad 0.831$$

Therefore $N_{\text{b,z,Rd}} = \dfrac{0.831 \times 11300 \times 265 \times 10^{-3}}{1.00} = 2488 \text{ kN}$

Buckling resistance, $N_{\text{b,y,Rd}}$ (flexural buckling about the y-y axis)
The buckling resistance, $N_{\text{b,y,Rd}}$, is given by Clause 6.3.1.2 of BS EN 1993-1-1, as:

$$N_{\text{b,y,Rd}} = \frac{\chi_{\text{y}} A f_{\text{y}}}{\gamma_{\text{M1}}} \text{ for Class 1, 2 and 3 cross-sections}$$

where:

γ_{M1} is given in the NA to BS EN 1993-1-1 as 1.00

$$\chi_{\text{y}} = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}_{\text{y}}^{\,2}}} \text{ but} \leq 1.0$$

$$\Phi = 0.5\left[1 + \alpha\left(\bar{\lambda}_{\text{y}} - 0.2\right) + \bar{\lambda}_{\text{y}}^{\,2}\right]$$

For buckling curve b, Table 6.1 of BS EN 1993-1-1 gives $\alpha = 0.34$.

$$\Phi = 0.5\left[1 + 0.34(0.61 - 0.2) + 0.61^2\right] = 0.756$$

$$\chi_{\text{y}} = \frac{1}{0.756 + \sqrt{0.756^2 - 0.61^2}} = 0.832$$

Therefore $N_{\text{b,y,Rd}} = \dfrac{0.832 \times 11300 \times 265 \div 10^{-3}}{1.00} = 2491 \text{ kN}$

The bucking resistance is the lesser of $N_{\text{b,y,Rd}}$ and $N_{\text{b,z,Rd}}$ which is $N_{\text{b,z,Rd}}$ =2488 kN.

5.8 Buckling resistance of members in bending and axial compression

Compression members with moments are verified using the comprehensive interaction formulation given in Clause 6.3.3 of BS EN 1993-1-1. Two separate expressions are needed, the first deals primarily with in-plane buckling and the second deals with out-of-plane buckling.

These expressions are given by Clause 6.3.3(4) and are reproduced below:

$$\frac{N_{\text{Ed}}}{\dfrac{\chi_{\text{y}} N_{\text{Rk}}}{\gamma_{\text{M1}}}} + k_{\text{yy}} \frac{M_{\text{y,Ed}} + \Delta M_{\text{y,Ed}}}{\chi_{\text{LT}} \dfrac{M_{\text{y,Rk}}}{\gamma_{\text{M1}}}} + k_{\text{yz}} \frac{M_{\text{z,Ed}} + \Delta M_{\text{z,Ed}}}{\dfrac{M_{\text{z,Rk}}}{\gamma_{\text{M1}}}} \leq 1$$

$$\frac{N_{\text{Ed}}}{\dfrac{\chi_{\text{z}} N_{\text{Rk}}}{\gamma_{\text{M1}}}} + k_{\text{zy}} \frac{M_{\text{y,Ed}} + \Delta M_{\text{y,Ed}}}{\chi_{\text{LT}} \dfrac{M_{\text{y,Rk}}}{\gamma_{\text{M1}}}} + k_{\text{zz}} \frac{M_{\text{z,Ed}} + \Delta M_{\text{z,Ed}}}{\dfrac{M_{\text{z,Rk}}}{\gamma_{\text{M1}}}} \leq 1$$

where:

N_{Ed}, $M_{y,Ed}$ and $M_{z,Ed}$	are the design values of the compression force and the maximum moments about the y-y axis (major) and z-z axis (minor) along the member respectively
$\Delta M_{y,Ed}$ and $\Delta M_{z,Ed}$	are the moments due to the shift of the centroidal axis according to Clause 6.2.9.3 of BS EN 1993-1-1 for Class 4 sections.
χ_y and χ_z	are the reduction factors due to flexural buckling (see Section 5.2)
χ_{LT}	is the reduction factor due to lateral-torsional buckling (see Section 3.2.1)
k_{yy}, k_{yz}, k_{zy} and k_{zz}	are the interaction factors and are given in Annexes A and B of BS EN 1993-1-1.

These expressions look very complex but they can be reduced to something more familiar to UK engineers. For Class 1, 2 and 3 cross-sections the terms $\Delta M_{y,Ed}$ and $\Delta M_{z,Ed}$ can be set to zero as they only apply for Class 4 cross-sections.

The terms $\dfrac{\chi_y N_{Rk}}{\gamma_{M1}}$ and $\dfrac{\chi_z N_{Rk}}{\gamma_{M1}}$ are the buckling resistances of the compression member about the major and minor axes respectively and can be expressed as $N_{b,y,Rd}$ and $N_{b,z,Rd}$. Similarly, $\chi_{LT}\dfrac{M_{y,Rk}}{\gamma_{M1}}$ and $\dfrac{M_{z,Rk}}{\gamma_{M1}}$ are the lateral-torsional buckling resistance of the member about its y-y axis and the moment capacity of the section about its z-z axis respectively; these can be expressed as $M_{b,y,Rd}$ and $M_{b,z,Rd,0}$ respectively. Substituting these expressions into the above criteria gives the following, more familiar, expressions:

$$\frac{N_{Ed}}{N_{b,y,Rd}} + k_{yy}\frac{M_{y,Rd}}{M_{b,y,Rd}} + k_{yz}\frac{M_{z,Ed}}{M_{b,z,Rd,0}} \le 1.0$$

$$\frac{N_{Ed}}{N_{b,z,Rd}} + k_{zy}\frac{M_{y,Rd}}{M_{b,y,Rd}} + k_{zz}\frac{M_{z,Ed}}{M_{b,z,Rd,0}} \le 1.0$$

5.9 Columns in simple construction

In non-sway frames using simple construction joints are designed to be flexible. The distribution of forces and moments in the frame are determined assuming that the connections between beams and columns are pinned. The joint flexibility may include distortions which arise as a consequence of plastic deformations in all components of the connections except the bolts. The beams are designed as simply supported at their ends. A beam of span L measured between the column centrelines and subjected to uniformly distributed loading F_d, will be designed for a maximum moment of $F_d L^2/8$. In reality the beams are not supported on the column centrelines and thus some eccentricity will occur, leading to moments in the columns. A nominal eccentricity should therefore be assumed when designing columns in simple construction.

BS EN 1993-1-1 does not have any provisions for designing columns in simple construction and therefore the approach presented below is based on the well-established approach for the design of columns in simple construction but modified to take account of the symbols and resistances given in BS EN 1993-1-1

1. All beams should be taken as fully loaded and pattern loading may be ignored.

2. The nominal moments should be determined using the following.

   i) For a typical beam-column type connection, the eccentricity should be taken as the distance to the face of the column plus 100 mm.
   ii) For a beam supported on a cap plate, the reaction should be taken at the face of the member or the edge of any packing.
   iii) For a roof truss on a cap plate the eccentricity may be taken as zero provided that the simple connections do not develop adverse moments.

3. In multi-storey frames that are effectively continuous at their splices, the out of balance moments at every beam column joint may be divided equally between the column lengths above and below that point in proportion to their stiffness (*I*/*L*). However, if the value of *I*/*L* for these two lengths does not differ by a factor exceeding 1.5, then the out of balance moment may be divided equally. No moments should be carried over to adjacent levels (both above and below the beam level under consideration).

4. The adequacy of the column under the combined effects of the axial compression and the nominal moments should be verified as described in Section 5.8. Alternatively the simplified interaction criteria described below may be used.

Simplified interaction criteria

The following simplified interaction criteria may be used for the design of columns in simple construction:

$$\frac{N_{\mathrm{Ed}}}{N_{\mathrm{min,b,Rd}}} + \frac{M_{\mathrm{y,Ed}}}{M_{\mathrm{b,y,Rd}}} + 1.5\frac{M_{\mathrm{z,Ed}}}{M_{\mathrm{cb,z,Rd}}} \leq 1.0$$

where:

N_{Ed}, $M_{\mathrm{y,Ed}}$ and $M_{\mathrm{z,Ed}}$	are the design values of the compression force and the maximum moments about the y-y axis (major) and z-z axis (minor) along the member respectively
$N_{\mathrm{min,b,Rd}}$	is the lesser of $\frac{\chi_{\mathrm{y}} f_{\mathrm{y}} A}{\gamma_{\mathrm{M1}}}$ and $\frac{\chi_{\mathrm{z}} f_{\mathrm{y}} A}{\gamma_{\mathrm{M1}}}$
χ_{y} and χ_{z}	are the reduction factors due to flexural buckling (see Section 5.2) about the major and minor axes respectively
$M_{\mathrm{b,y,Rd}}$	is given by $\frac{\chi_{\mathrm{LT}} f_{\mathrm{y}} W_{\mathrm{pl,y}}}{\gamma_{\mathrm{M1}}}$
χ_{LT}	is the reduction factor due to lateral-torsional buckling (see section 3.2.1)
$M_{\mathrm{cb,z,Rd}}$	is given by $\frac{f_y W_{pl,z}}{\gamma_{M1}}$ for class 1 and 2 sections and $\frac{f_{\mathrm{y}} W_{\mathrm{el,z}}}{\gamma_{\mathrm{M1}}}$ for class 3 sections

These expressions can only be used subject to the following limitations:

- The column is a hot rolled I or H section, or rectangular hollow section
- The cross-section is class 1, 2 or 3 under compression
- The bending moment diagrams about each axis are linear
- The column is restrained laterally in both the y and z directions at each floor but unrestrained between floors

Furthermore these expressions are only valid for a range of bending moment diagrams specified by $\psi_y \leq -0.11$ and $\psi_z \leq -0.0625$, where ψ_y and ψ_z are the shape of the bending moment distribution about the y-y and z-z axes respectively and are defined in Tables 3.4 and 3.5. For hot rolled I and H sections $N_{b,y,Rd}$ is always greater than $N_{b,z,Rd}$. In cases where the base of the column is nominally pinned (i.e. ψ_y and ψ_z = 0.0) the above expression may still be used provided:

$$\frac{N_{Ed}}{N_{b,y,Rd}} \leq 0.83$$

where:

$N_{b,y,Rd}$ is the resistance to buckling about the y-y axis

The background to this simplified approach is given in reference [42].

5.10 Example 5.3 – Column under axial compression and bending

A 356 x 368 x 153 UC in S275 is part of a braced multi-storey frame that has been shown to be classified as a non-sway frame. The storey height between beam centres is 6.00 m. The column is attached to the beams using flush end plate connections and the beams support concrete floor slabs thus providing partial restraint against bending in both principal planes and full restraint against rotation in plan. The design axial force in the column is 1500 kN. At the upper end the design moment is 250 kNm about the major axis and 60 kNm about the minor axis. The corresponding values at the lower end are 200 kNm and 80 kNm respectively; tending to cause double curvature bending in both planes. Verify the adequacy of the column section for this storey.

Design moments and forces

Axial force in column, N_{Ed} = 1500 kN

Moments at both upper and lower ends of the column

a. Upper end
Moment about major axis $M_{y,Ed}$ = 250 kNm

Moment about minor axis $M_{z,Ed}$ = 60 kNm

b. Lower end
Moment about major axis $M_{y,Ed}$ = 200 kNm

Moment about minor axis $M_{z,Ed}$ = 80 kNm

Section properties
From section tables the properties of a 356 x 368 x 153 UC are:

h =362 mm; b = 370.5 mm h/b = 1.00
t_f = 20.7 mm; c_f/t_f = 7.92; c_w/t_w = 23.6;
i_z = 9.49 cm; $W_{pl,y}$ = 2960 cm^3; $W_{pl,z}$ = 1430 cm^3;
A = 195 cm^2 .

t_f > 16 mm therefore from Table 7 of BS EN10025-2 f_y = 265 N/mm^2

Section classification
From Table 5.2 (Sheet 2 of 3) of BS EN 1993-1-1 the Class 1 limit for an outstand flange is $c/t = 9.0\varepsilon$

$$\varepsilon = \sqrt{235/f_y} = \sqrt{235/265} = 0.94$$

Assume that half the flange is subject to compression. The Class 1 limit $c/t = 9.0\varepsilon$ = 8.46

7.92 < 8.46, therefore the flange is Class 1.

Assume that the web is subject to compression. The Class 1 limit for an internal part subject to compression is given in Table 5.2 (Sheet 2 of 3) of BS EN 1993-1-1 as:

$$c/t = 33\varepsilon = 33 \times 0.94 = 31.0$$

23.0< 31.0, therefore the web is Class 1

Therefore the whole section is Class 1.

Buckling length
The beams are connected to the column using full depth end-plates which supports a concrete slab and provides partial rotational restraint. Take L_{cr} as 0.85 L for both the major and minor axes.

L_{cr} = 0.85 x 6.0 = 5.1 m

Buckling curve
For an S275 rolled section with h/b = 1.00 and t_f = 20.7 mm the buckling curves from Table 6.2 of BS EN 1993-1-1 are:

Buckling about y-y axis (major) – Buckling curve b
Buckling about z-z axis (minor) – Buckling curve c

Non-dimensional slenderness
For flexural buckling about the z-z axis (minor) for a Class 1 section, the non-dimensional slenderness is given by Clause 6.3.1.3(1) of BS EN 1993-1-1 as:

$$\bar{\lambda}_z = \sqrt{\frac{Af_y}{N_{cr}}} = \frac{L_{cr}}{i_z}\frac{1}{\lambda_1}$$

where:

$$\lambda_1 = \pi\sqrt{\frac{E}{f_y}} = 93.9\varepsilon = 93.9 \text{ x } 0.94 = 88.27$$

Therefore $\bar{\lambda}_z = \frac{5100}{94.9}\frac{1}{88.27} = 0.61$

Buckling resistance, $N_{b,z,Rd}$ (flexural buckling about the z-z axis)
The buckling resistance, $N_{b,z,Rd}$, is given by Clause 6.3.1.2 of BS EN 1993-1-1, as:

$$N_{b,z,Rd} = \frac{\chi_z A f_y}{\gamma_{M1}} \text{ for Class 1, 2 and 3 cross-sections}$$

where:

γ_{M1} is given in the NA to BS EN 1993-1-1 as 1.00

$$\chi_z = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}_z^{\,2}}}$$

$$\Phi = 0.5\left[1 + \alpha\left(\bar{\lambda}_z - 0.2\right) + \bar{\lambda}_z^{\,2}\right]$$

For buckling curve c, Table 6.1 of BS EN 1993-1-1 gives $\alpha = 0.49$.

$$\Phi = 0.5\left[1 + 0.49(0.61 - 0.2) + 0.61^2\right] = 0.787$$

$$\chi_z = \frac{1}{0.787 + \sqrt{0.787^2 - 0.61^2}} = 0.779$$

Therefore $N_{b,z,Rd} = \frac{0.779 \times 19500 \times 265 \times 10^{-3}}{1.00} = 4025 \text{ kN}$

Buckling resistance moment, $M_{b,y,Rd}$
The buckling resistance moment $M_{b,y,Rd}$ is given by Clause 6.3.2.1(3) of BS EN 1993-1-1 as:

$$M_{b,y,Rd} = \chi_{LT} W_{pl,y} \frac{f_y}{\gamma_{M1}}$$

where:
From Clause 6.3.2.3(1) of BS EN 1993-1-1

$$\chi_{LT} = \frac{1}{\Phi_{LT} + \sqrt{\Phi^2{}_{LT} - \beta\bar{\lambda}_{LT}^2}} \text{ but } \chi_{LT} \le 1.0 \text{ and } \chi_{LT} \le \frac{1}{\bar{\lambda}_{LT}^2}$$

$$\Phi_{LT} = 0.5\left[1 + \alpha_{LT}\left(\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}\right) + \beta\bar{\lambda}_{LT}^2\right]$$

From the National Annex for BS EN 1993-1-1, use curve b, $\bar{\lambda}_{LT,0} = 0.4$ and $\beta = 0.75$ and from BS EN 1993-1-1 $\alpha_{LT} = 0.34$

Section 3.2.2 gives the following expression for the value of $\bar{\lambda}_{LT}$:

$$\bar{\lambda}_{LT} = \frac{1}{\sqrt{C_1}} UV\bar{\lambda}_z\sqrt{\beta_w}$$

For the above column

$\psi = -0.75$, from Table 3.4 in Section 3.2.2 $\frac{1}{\sqrt{C_1}} = 0.63$

$U = 0.9$ (see Section 3.2.2)
$V = 1.0$ (see Section 3.2.2)

Assuming that the flush end-plate connections together with the beams they support provide partial resistance about both axes the effective length factor, k, may be taken as 0.85.

$$\bar{\lambda}_z = \frac{\lambda_z}{\lambda_1} = \frac{kL}{i_z\lambda_1} = \frac{0.85 \times 6000}{94.9 \times 88.27} = 0.61$$

$\beta_w = 1.0$

$$\bar{\lambda}_{LT} = \frac{1}{\sqrt{C_1}} UV\bar{\lambda}_z\sqrt{\beta_w} = 0.63 \times 0.9 \times 1.0 \times 0.61 \times \sqrt{1.0} = 0.35$$

$$\Phi_{LT} = 0.5\left[1 + 0.34(0.35 - 0.4) + 0.75 \times 0.35^2\right] = 0.54$$

$$\chi_{LT} = \frac{1}{0.54 + \sqrt{0.54^2 - 0.75 \times 0.35^2}} = 1.0$$

In this example there is no benefit in using the f factor to account for the shape of the bending moment distribution as $\chi_{LT} = 1.0$.

$$M_{b,y,Rd} = 1.0 \times 2960000 \frac{265}{1.00} \times 10^{-6} = 784 \text{ kNm}$$

Moment resistance, $M_{pl,z,Rd}$

The moment resistance $M_{pl,z,Rd}$ is given in Clause 6.2.5(2) of BS EN 1993-1-1 as:

$$M_{pl,z,Rd} = \frac{W_{pl,z} f_y}{\gamma_{M0}}$$

From the National Annex to BS EN 1993-1-1 $\gamma_{M0} = 1.00$

$$M_{pl,z,Rd} = \frac{1430000 \times 265 \times 10^{-6}}{1.00} = 379 \text{ kNm}$$

Combined bending and axial compression
For I and H sections with $\psi_y \leq -0.11$ and $\psi_z \leq 0.0625$ the simplified interaction equation for combined bending and axial compression is given as:

$$\frac{N_{Ed}}{N_{b,z,Rd}} + \frac{M_{y,Rd}}{M_{b,y,Rd}} + 1.5\frac{M_{z,Ed}}{M_{cb,z,Rd}} \leq 1.0$$

Check limits on ψ_y and ψ_z
$\psi_y = -0.8 < -0.11$ and ψ_z $-0.75 \leq 0.0625$ therefore the above expression can be used.

Check top of column

As the National Annex for BS EN 1993-1-1 gives $\gamma_{M0} = \gamma_{M1} = 1.0$:

$$M_{cb,z,Rd} = M_{pl,z,Rd}$$

$$\frac{N_{Ed}}{N_{b,z,Rd}} + \frac{M_{y,Rd}}{M_{b,y,Rd}} + 1.5\frac{M_{z,Ed}}{M_{b,z,Rd}} = \frac{1500}{4025} + \frac{250}{784} + 1.5\times\frac{60}{379} = 0.929$$

0.929 < 1.0

Check bottom of column

$$\frac{N_{Ed}}{N_{b,z,Rd}} + \frac{M_{y,Rd}}{M_{b,y,Rd}} + 1.5\frac{M_{z,Ed}}{M_{cb,z,Rd}} = \frac{1500}{4025} + \frac{200}{784} + 1.5\times\frac{80}{379} = 0.944$$

0.944<1.0

Therefore the column is satisfactory in combined axial load and bending.

5.11 Example 5.4 – Column in simple construction

The continuous column shown in Figure 5.1 has a storey height of 4000 mm and has a design axial force of 450 kN. The beams are connected to the column using end-plates. At the upper end, two beams frame into the web without eccentricity from the major axis. One transfers a design force of R1 = 200 kN and the other a design force of R3 = 300 kN. Only one beam frames into the major axis transferring a design force of R2 = 400 kN without eccentricity about the major axis. The conditions at the lower end of the column are identical to those at the upper end. Verify the resistance of the column just above the lower beams.

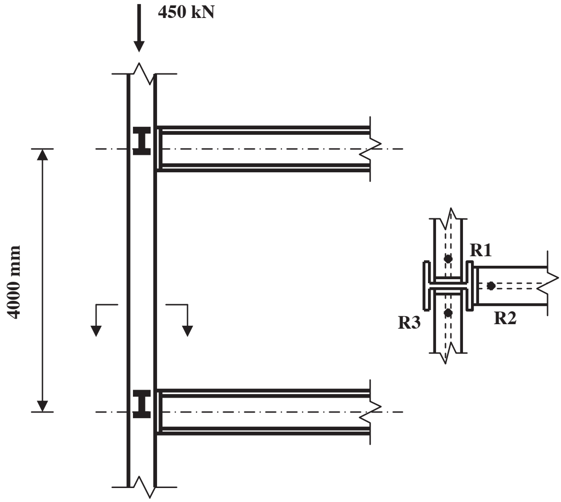


Figure 5.1 Column in simple construction

Design moments and forces

Axial force in column = 450 + 200 + 300 + 400 = 1350 kN

Moments at both upper and lower ends of the column

Moment about major axis $M_{y,Ed} = 400\ (h/2 + 100)$

Guess h (depth of cross-section) = 320 mm then $M_{y,Ed} = 400 \times 0.26 = 104$ kNm

Moment about minor axis $M_{z,Ed} = (300 - 200)(t_w/2 + 100)$

Guess $t_w = 20$ mm then $M_{y,Ed} = 100 \times 0.11 = 11$ kNm

As the column is continuous through the length under consideration the adjacent column lengths have I/L ratios differing by less than 1.5. Therefore the moments may be divided equally between the upper and lower column lengths at each beam level and no carry-overs to adjacent joints are made.

Thus the column needs to be designed for:

Axial load $N_{Ed} = 1350$ kN
Moment $M_{y,Ed} = 52.0$ kNm
Moment $M_{z,Ed} = 5.5$ kNm

Select trial section

From section tables the dimensions of a 254 x 254 x 73 UC are:

$h = 254.1$ mm;	$b = 254.6$ mm;	$h/b = 1.00$
$t_f = 14.2$ mm;	$c_f/t_f = 7.77$;	$c_w/t_w = 23.3$;
$i_z = 6.48$ cm;	$W_{pl,y} = 992$ cm^3;	$W_{pl,z} = 465$ cm^3;
$A = 93.1$ cm^2 .		

$t_f \leq 16$ mm therefore from Table 7 of BS EN 10025-2 $f_y = 275$ N/mm^2

Section classification
From Table 5.2 (Sheet 2 of 3) of BS EN 1993-1-1 the Class 1 limit for an outstand flange is $c/t = 9.0\varepsilon$

$$\varepsilon = \sqrt{235/f_y} = \sqrt{235/275} = 0.92$$

The Class 1 limit $c/t = 9.0\varepsilon = 8.28$

7.77 < 8.28, therefore the flange is Class 1.

From Table 5.2 (Sheet 1 of 3) of BS EN 1993-1-1 the Class 1 limit for an internal compression element is $c/t = 33\varepsilon = 30.36$

23.3< 30.36, therefore the web is Class 1

Therefore the whole section is Class 1.

Buckling length
The beams are connected to the column using partial depth end-plates therefore little rotational restraint will be provided and L_{cr} should be taken as 1.0 L for both the major and minor axes.

$L_{cr} = 1.0 \times 4.0 = 4.0$ m

Buckling curve
For an S275 rolled section with $h/b = 1.00$ and $t_f = 14.2$ the buckling curves from Table 6.2 of BS EN 1993-1-1 are:

Buckling about y-y axis (major) – Buckling curve b
Buckling about z-z axis (minor) – Buckling curve c

Non-dimensional slenderness
For flexural buckling about the z-z axis (minor) for a Class 1 section, the non-dimensional slenderness is given by Clause 6.3.1.3(1) of BS EN 1993-1-1 as:

$$\bar{\lambda}_z = \sqrt{\frac{Af_y}{N_{cr}}} = \frac{L_{cr}}{i_z}\frac{1}{\lambda_1}$$

where:

$$\lambda_1 = \pi\sqrt{\frac{E}{f_y}} = 93.9\varepsilon = 93.9 \times 0.92 = 86.39$$

Therefore $\bar{\lambda}_z = \frac{4000}{64.8}\frac{1}{86.39} = 0.715$

Buckling resistance, $N_{b,z,Rd}$ (flexural buckling about the z-z axis)
The buckling resistance, $N_{b,z,Rd}$, is given by Clause 6.3.1.2 of BS EN 1993-1-1, as:

$$N_{b,z,Rd} = \frac{\chi_z A f_y}{\gamma_{M1}} \text{ for Class 1, 2 and 3 cross-sections}$$

where

γ_{M1} is given in the NA to BS EN 1993-1-1 as 1.00

$$\chi_z = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}_z^{\,2}}}$$

$$\Phi = 0.5\left[1 + \alpha\left(\bar{\lambda}_z - 0.2\right) + \bar{\lambda}_z^{\,2}\right]$$

For buckling curve c, Table 6.1 of BS EN 1993-1-1 gives $\alpha = 0.49$.

$$\Phi = 0.5\left[1 + 0.49(0.715 - 0.2) + 0.715^2\right] = 0.882$$

$$\chi_z = \frac{1}{0.882 + \sqrt{0.882^2 - 0.715^2}} = 0.715$$

Therefore $N_{b,z,Rd} = \dfrac{0.715 \times 9310 \times 275 \times 10^{-3}}{1.00} = 1830 \text{ kN}$

Buckling resistance moment, $M_{b,y,Rd}$
The buckling resistance moment $M_{b,y,Rd}$ is given in Clause 6.3.2.1(3) of BS EN 1993-1-1 as:

$$M_{b,y,Rd} = \chi_{LT} W_{pl,y} \frac{f_y}{\gamma_{M1}}$$

where:
From Clause 6.3.2.3(1) of BS EN 1993-1-1

$$\chi_{LT} = \frac{1}{\Phi_{LT} + \sqrt{\Phi^2{}_{LT} - \beta\bar{\lambda}_{LT}^2}} \text{ but } \chi_{LT} \leq 1.0 \text{ and } \chi_{LT} \leq \frac{1}{\bar{\lambda}_{LT}^2}$$

$$\Phi_{LT} = 0.5\left[1 + \alpha_{LT}\left(\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}\right) + \beta\bar{\lambda}_{LT}^2\right]$$

From the National Annex for BS EN 1993-1-1 use buckling curve b, $\bar{\lambda}_{LT,0} = 0.4$ and $\beta = 0.75$ and from BS EN 1993-1-1 $\alpha_{LT} = 0.34$

For a column subject to negative values of ψ Section 3.2.2 gives the following expression for the value of $\bar{\lambda}_{LT}$:

$$\bar{\lambda}_{LT} = \frac{1}{\sqrt{C_1}} U V \bar{\lambda}_z \sqrt{\beta_w}$$

For the above column

$\psi = -1.0$, from Table 3.4 in section 3.2.2 $\dfrac{1}{\sqrt{C_1}} = 0.60$

$U = 0.9$ (see Section 3.2.2)
$V = 1.0$ (see Section 3.2.2)

$$\bar{\lambda}_z = \frac{\lambda_z}{\lambda_1} = \frac{kL}{i_z \lambda_1} = \frac{1.0 \times 4000}{64.8 \times 86.39} = 0.71$$

$\beta_w = 1.0$

$$\bar{\lambda}_{LT} = \frac{1}{\sqrt{C_1}} UV \bar{\lambda}_z \sqrt{\beta_w} = 0.60 \times 0.9 \times 1.0 \times 0.71 \times \sqrt{1.0} = 0.38$$

$$\Phi_{LT} = 0.5\left[1 + 0.34(0.38 - 0.4) + 0.75 \times 0.38^2\right] = 0.55$$

$$\chi_{LT} = \frac{1}{0.55 + \sqrt{0.55^2 - 0.75 \times 0.38^2}} = 1.0$$

In this example there is no benefit in taking account of the shape of the bending moment distribution using the factor *f* as $\chi_{LT} = 1.0$.

$$M_{b,y,Rd} = 1.0 \times 992000 \frac{275}{1.00} \times 10^{-6} = 272.8 \text{ kNm}$$

Moment resistance, $M_{cb,z,Rd}$
The moment resistance $M_{cb,z,Rd}$ is given in Clause 5.9 as:

$$M_{cb,z,Rd} = \frac{W_{pl,z} f_y}{\lambda_{M1}}$$

From the National Annex to BS EN 1993-1-1 $\gamma_{M1} = 1.00$

$$M_{cb,z,Rd} = \frac{465000 \times 275 \times 10^{-6}}{1.00} = 127.9 \text{ kNm}$$

Combined bending and axial compression
For I and H sections with $\psi_y \leq -0.11$ and $\psi_z \leq -0.0625$ the simplified interaction equation for combined bending and axial compression is given as:

$$\frac{N_{Ed}}{N_{b,z,Rd}} + \frac{M_{y,Rd}}{M_{b,y,Rd}} + 1.5 \frac{M_{z,Ed}}{M_{cb,z,Rd}} \leq 1.0$$

Check limits on ψ_y and ψ_z

ψ_y and ψ_z = - 1.00 < –0.11 and –0.0625 therefore the above expression can be used.

$$\frac{N_{Ed}}{N_{b,z,Rd}} + \frac{M_{y,Rd}}{M_{b,y,Rd}} + 1.5 \frac{M_{z,Ed}}{M_{cb,z,Rd}} = \frac{1350}{1830} + \frac{52}{272.8} + 1.5 \times \frac{5.5}{127.9} = 0.99$$

0.99 < 1.0

Therefore the column is satisfactory in combined axial load and bending.

Check assumptions concerning depth of section and thickness of flange on eccentricities.

Actual $h/2 = 254.1/2 = 127$ mm which is less than guessed 160 mm therefore safe.
Actual $t_w/2 = 8.6/2 = 4.3$ mm which is less than guessed 10 mm therefore safe.

Adopt this trial section.

CHAPTER 6 TRUSSES

6.1 Introduction

A truss is a triangulated framework of members in which loads are primarily resisted by axial forces in the individual members. The most commonly used truss is single span, simply supported and statically determinate with joints assumed to act as pins. Trusses can be pitched with sloping rafters as shown in Figure 6.1 or can have parallel top and bottom chords. Trusses with parallel chords are often referred to as lattice girders.

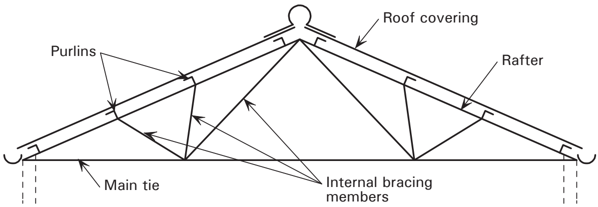


Figure 6.1 Typical roof structures

6.2 Typical uses

A common application of pitched trusses is for roofs. Lattice girders have a wider variety of uses including support of roof and floors particularly with long spans or heavier loads.

The support of long span flat roofs is generally accomplished by using trusses with parallel chords. Pitched roofs are normally supported by pitched trusses even for modest spans, the exception being the specialised area of pitched roof portal frames. Portal frames are beyond the scope of this publication.

One advantage of trusses is that they can be delivered to site as one complete unit, as several smaller units or even as individual members. The choice will depend upon the size of the truss, the ease of transport between the fabrication shop and the site and the availability of space on site.

6.2.1 Spans

The most efficient form of truss to be employed in any given situation is usually controlled by the span to be covered. Figure 6.2 shows a variety of pitched roof trusses together with the spans over which they are customarily used. For spans in excess of these values, lattice girders may be more practical. However, lattice girders are used for a whole range of spans (greater than approximately 7 m).

Figure 6.3 shows two types of lattice girder – the N-girder or Pratt truss and the Warren girder. These trusses have depth-to-span ratios typically in the range 1:10 to 1:14.

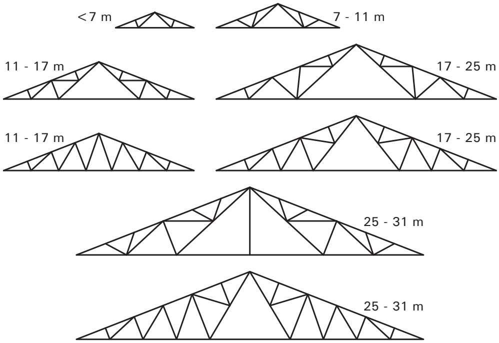


Figure 6.2 Typical roof trusses and associated spans

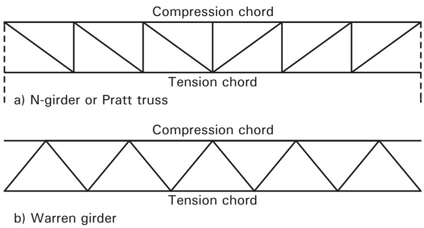


Figure 6.3 Lattice girders

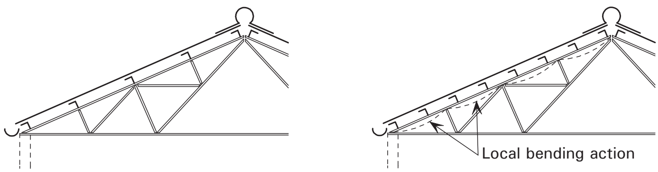
6.3 Design concept

Typical roof trusses are plane frames consisting of sloping rafters which meet at the apex or ridge of the frame (see Figure 6.1). The lower ends of the rafters are prevented from spreading by a horizontal main tie, whilst internal bracing members triangulate the truss and carry primarily axial forces. The internal members also reduce the segment lengths of the chords which enable lighter weight and therefore more efficient chords to be used.

6.3.1 Roof arrangement

The roof coverings may be made from a variety of materials ranging from traditional slates or tiles, profiled steel sheeting or more exotic materials. These coverings are supported on purlins (members running between the trusses), which are supported by the rafters and therefore apply loads to the rafters. The purlins also provide out-of-plane stability to the truss. Stability to the truss must be provided at all times, including during erection, when temporary bracing may be used.

The spacing of the purlins (which can range from as little as 900 mm to over 3.5 m) is normally dictated by the roofing material. If the purlins are only located at points where internal members meet (the panel points), then the truss members will be subjected primarily to axial forces. However, if the spacing is such that the purlins are supported between panel points, then rafters will need to be designed for combined axial load and bending. Figure 6.4 shows the two possible options.



a) Pulins at panel points b) Purlins between panel points

Figure 6.4 Purlins at or between panel points

6.3.2 Pre-cambering

Deflections of nominally flat trusses (Pratt trusses or Warren trusses) must be considered if ponding and therefore overloading are to be avoided. Two possible solutions are to either pre-camber the truss or to have a shallow slope in the top chord. The concept of pre-cambering is often extended to longer span pitched roof trusses where the nominally horizontal bottom chord may slope upwards slightly from the supports. This is done so that under loading the bottom chord does not deflect below the horizontal.

6.3.3 Typical sections

The sections used for the members of a typical roof truss may be hollow sections, single angles, double angles (single angles fastened back-to-back), single channels, double channels or single T sections. For members with more than one component (double angles or double channels) the elements may be connected directly to each other. Alternatively a gusset plate may be inserted between them which enables a connection to be made to other members so that eccentricities at the connections can be minimised. For single component members this is not possible and a lapped joint with its consequent eccentricity is unavoidable.

Hollow sections are often chosen for trusses. They are lightweight, structurally efficient and are often exposed. The joints are generally welded. With hollow section trusses checking the joint resistance is important because the selection of member, geometry and internal forces will fix the joint resistance (see Section 6.3.4).

If the members consist of angle, channel and T sections then the axial forces should be determined assuming that the joints are pinned. The moments caused by eccentricities at the ends need not be considered explicitly. Clause BB.1 of BS EN 1993-1-1 gives values for the buckling length for both the chord and web members about the relevant axes. These buckling lengths should be used to check the buckling resistances of the members in compression using the method described in Clause 6.3.1 of BS EN 1993-1-1. For built-up members, the method described in Clause 6.4 of BS EN 1993-1-1 should be used. Care must be taken to ensure that all possible modes of buckling are recognised and this will often involve consideration of buckling about the y-y, z-z, u-u and v-v axes. The assumption implied in this approach is that the members may be represented by lines meeting at a point located at the nodes. Any moments arising from minor eccentricities are allowed for in the choice of effective lengths. Figure 6.5 shows some typical details from an example of a bolted roof truss, using back-to-back angles for the members, with gusset plates at the connections.

Figure 6.6 shows a welded truss using T section; detail 2 show that the members node without any eccentricity. Figures 6.5 and 6.6 are only examples of a number of typical details from a wide variety of solutions which may be adopted.

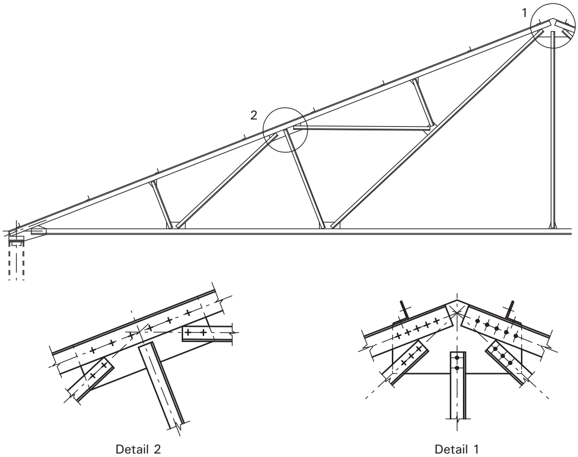


Figure 6.5 Bolted roof truss and typical details

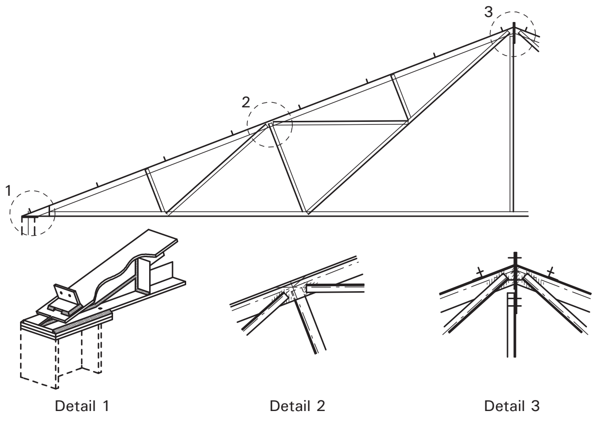


Figure 6.6 Welded roof truss and typical details

6.3.4 Joint resistances

The detailing of the joints is a vital part of truss design. The design of the truss may be controlled by the resistance of the joints as much as by the resistance of the members. If members are selected such that their resistance is almost fully utilised, the resulting joint details required to transmit the applied forces can be very impractical. The joints should therefore be considered at an early stage in the design, in conjunction with the selection of the members. As mentioned above, the joint eccentricities will affect design of the truss and its members. The joints adopted in practice must not invalidate the assumptions at the design stage.

GENERAL DESIGN DATA

BENDING MOMENT AND DEFLECTION FORMULAE FOR BEAMS

NOTATION

L	= Length of span in millimetres
W	= Total distributed or point load in Newtons
W_1 or W_2	= Point load in Newtons
Γ	= Resultant of point loads in Newtons
R_A, R_B, R_C, etc.	= Reaction at A, B or C, etc. in Newtons
F	= Shearing force in Newtons
m	= Applied moment in Newton millimetres
M_X	= Bending moment in Newton millimetres (At distance X from the left hand support A)
δ_X	= Deflection in millimetres (At distance X from the left hand support A)
i_X	= Slope in radians (At distance X from the left hand support A)
M_A or M_B	= End fixing moments in Newton millimetres
M_{max}	= Maximum bending moment in Newton millimetres
$M_{max\ max}$	= Absolute maximum bending moment in Newton millimetres
M_{load}	= Bending moment under the load in Newton millimetres
δ_{max}	= Maximum deflection in millimetres
$\delta_{max\ max}$	= Absolute maximum deflection in millimetres
$\delta_{negative}$	= Negative, i.e. upward, deflection in millimetres
i_A or i_B	= Slope at A or at B in radians
E	= Modulus of elasticity, 210,000 N/mm^2
I	= Second moment of area in mm^4

SIGN CONVENTION

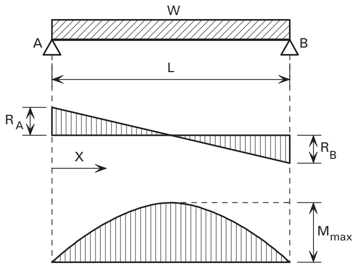
Loads	+	Positive when acting downward
Support Reaction	+	Positive when acting upward
Shearing force	+	Positive on a section where the upward left hand support reaction is greater than the algebraic sum of external loads located left of that section
Bending Moment	+	Positive (shown above base line on diagrams) when causing convexity downward
Deflection	+	Positive when downward
Slope		Appropriate values in radians are given, but the signs depend upon which support or which section is being considered, and can be readily ascertained by inspection

Where space permits, general equations for M_X and i_X at any point of the beam, and also the equation to the elastic line (δ_X) have been included.

Values for Slope. These may be used in evaluating the angle of rotation for rubber bearings and similar constructional elements.

FORMULAE FOR BEAMS

SIMPLY SUPPORTED BEAM — UNIFORM LOAD ON FULL SPAN



Span = L

Total Uniform Load = W

$R_A = R_B = \frac{W}{2}$

At mid-span: $M_{max} = \frac{WL}{8}$

$\delta_{max} = \frac{5}{384} \cdot \frac{WL^3}{EI}$

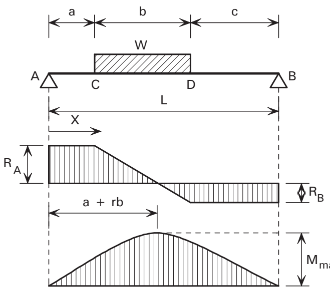
$i_A = i_B = \frac{WL^2}{24EI}$

At X from A: $M_X = \frac{WX}{2L}(L - X)$

$\delta_X = \frac{WX}{24EIL}(X^3 - 2X^2L + L^3)$

$i_X = \frac{W}{24EIL}(4X^3 - 6X^2L + L^3)$

SIMPLY SUPPORTED BEAM — UNIFORM LOAD ON PART OF SPAN



Span = L

Total Uniform Load = W

Let $r = \frac{0.5b + c}{L}$

$R_A = Wr$ $\quad$ $R_B = W(l - r)$

at $X = a + rb$ $\quad$ $M_{max} = Wr\,(a + 0.5rb)$

$I_A = \frac{Wr}{6EI}\left(L^2 - c^2 - Lbr\right)$

$I_B = \frac{W(l - r)}{6EI}\left[L^2 - a^2 - Lb(l - r)\right]$

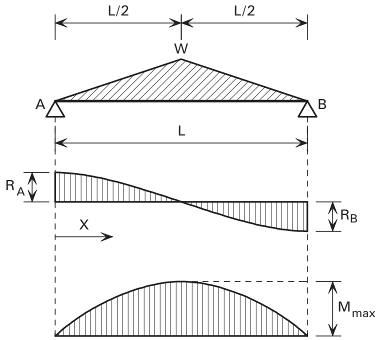
Equation to elastic line between C and D, i.e. $a \le X \le a + b$

$$\delta_x = -\frac{W}{24EIb}\left[X^4 - 4(a + rb)X^3 + 6a^2X^2 + 4\left\{rb\left(L^2 - c^2 - cb - \frac{b^2}{2}\right) - a^3\right\}X + a^4\right]$$

FORMULAE FOR BEAMS

SIMPLY SUPPORTED BEAM

TRIANGULAR LOAD ON FULL SPAN



Span = L

Total Load = W

$R_A = R_B = \frac{W}{2}$

At mid-span: $M_{max} = \frac{WL}{6}$

$\delta_{max} = \frac{WL^3}{60EI}$

$i_A = i_B = \frac{5WL^2}{96EI}$

At X from A between A & centre:

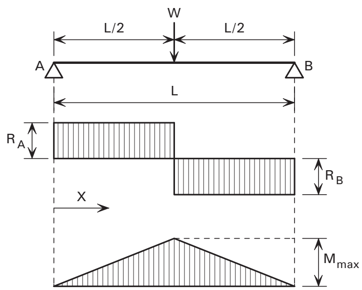
$$M_X = \frac{WX}{6L^2}\left(3L^2 - 4X^2\right)$$

$$\delta_X = \frac{WX}{480EIL^2}\left(16X^4 - 40X^2L^2 + 25L^4\right)$$

$$i_X = \frac{W}{96EIL^2}\left(16X^4 - 24X^2L^2 + 5L^4\right)$$

SIMPLY SUPPORTED BEAM

POINT LOAD AT MID-SPAN



Span = L

Point Load = W

$R_A = R_B = \frac{W}{2}$

at mid-span: $M_{max} = \frac{WL}{4}$

$\delta_{max} = \frac{1}{48}.\frac{WL^3}{EI}$

$i_A = i_B = \frac{WL^2}{16EI}$

at X from A between A & centre:

$$M_x = \frac{WX}{2}$$

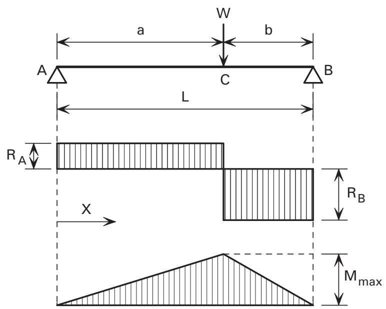
$$\delta_x = \frac{WX}{48EI}\left(3L^2 - 4X^2\right)$$

$$i_x = \frac{W}{16EI}\left(L^2 - 4X^2\right)$$

FORMULAE FOR BEAMS

SIMPLY SUPPORTED BEAM

POINT LOAD AT ANY POSITION



Span $= L$

Point Load $= W$

$$R_A = \frac{Wb}{L}$$

$$R_B = \frac{Wa}{L}$$

at C under load: $$M_{max} = \frac{Wab}{L}$$

$$\delta_C = \frac{Wa^2b^2}{3EIL}$$

$$i_A = \frac{Wab}{6EIL}(L+b) \qquad i_B = \frac{Wab}{6EIL}(L+a)$$

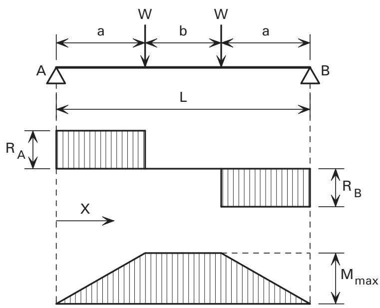
When $a > b$, δ_{max} is at X from A:

$$\delta_{max} = \frac{Wab\,(L+b)}{27EIL}\sqrt{3a(L+b)}$$

$$X = \sqrt{\frac{a\,(L+b)}{3}}$$

SIMPLY SUPPORTED BEAM

TWO EQUAL SYMMETRICAL POINT LOADS



Span $= L$

Two Point Loads each $= W$

$R_A = R_B = W$

M_{max} over length b $= Wa$

δ_{max} at mid-span $= \dfrac{Wa}{24EI}\left(3L^2 - 4a^2\right)$

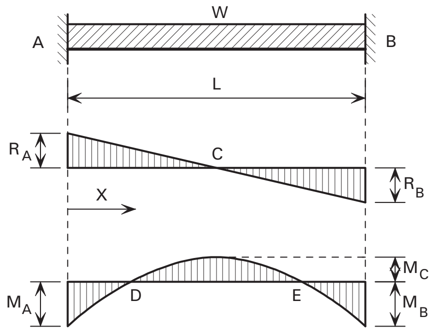
δ under either load $= \dfrac{Wa^2}{6EI}(3L - 4a)$;

$i_A = i_B = \dfrac{Wa}{2EI}(L - a)$

If $a = b = \dfrac{L}{3}$, $\delta_{max} = \dfrac{23}{648}.\dfrac{WL^3}{EI}$

FORMULAE FOR BEAMS

BEAM FIXED AT BOTH ENDS



at 0.211 L from either end $M_D = M_E = 0$

UNIFORM LOAD ON FULL SPAN

Span $= L$

Total uniform load $= W$

$R_A = R_B = \frac{W}{2}$

$M_A = M_B = \frac{WL}{12}$

at mid-span: $M_C = \frac{WL}{24}$

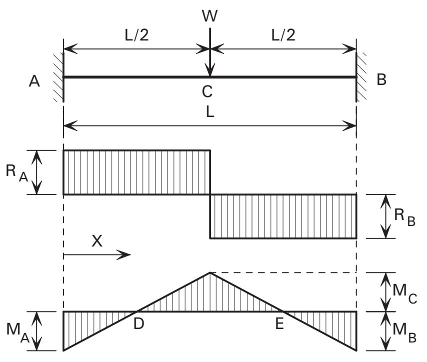
$\delta_{max} = \frac{WL^3}{384EI}$

at X from A: $M_x = \frac{W}{12L}(L^2 - 6LX + 6X^2)$

$\delta_X = \frac{WX^2}{24EIL}(L - X)^2$

$i_X = \frac{WX}{12EIL}(L^2 - 3LX + 2X^2)$

BEAM FIXED AT BOTH ENDS



at 0.25L from either end $M_D = M_E = 0$

POINT LOAD AT MID-SPAN

Span $= L$

Point Load $= W$

$R_A = R_B = \frac{W}{2}$

$M_A = M_B = -\frac{WL}{8}$

at mid-span: $M_C = \frac{WL}{8}$

$\delta_{max} = \frac{WL^3}{192EI}$

at X from A between A & C:

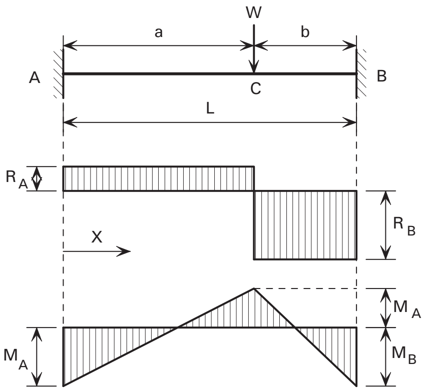
$M_x = \frac{W}{8}(4X - L)$

$\delta_x = \frac{WX^2}{48EI}(3L - 4X)$

$i_x = \frac{WX}{8EI}(L - 2X)$

FORMULAE FOR BEAMS

BEAM FIXED AT BOTH ENDS — POINT LOAD AT ANY POSITION



When $a > b$, the maximum deflection is at $X = \dfrac{2La}{L + 2a}$

Span = L

Point Load = W

$R_A = \dfrac{Wb^2(L + 2a)}{L^3}$ $\quad R_B = \dfrac{Wa^2(L + 2b)}{L^3}$

$M_A = \dfrac{Wab^2}{L^2}$ $\quad M_B = -\dfrac{Wa^2b}{L^2}$

at C under load $\quad M_C = \dfrac{2Wa^2b^2}{L^3}$

at X from A between A & C:

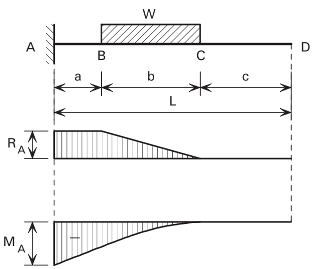
$$M_x = -\frac{Wab^2}{L^2} + \frac{Wb^2(L + 2a)X}{L^3}$$

$$\delta_x = \frac{Wb^2X^2(3La - (L + 2a)X)}{6EIL^3}$$

$$i_x = \frac{Wb^2X(2La - (L + 2a)X)}{2EIL^3}$$

$$\delta_{max} = \frac{2Wa^3b^2}{3EI(L + 2a)^2}$$

CANTILEVER — UNIFORM LOAD ON PART OF SPAN



Span = L

Uniform Load = W

$R_A = W$

$M_A = -W\left(a + \dfrac{b}{2}\right)$

$i_C =$

$i_D = \dfrac{W}{6EI}(3a^2 + 3ab + b^2)$

$$\delta_D = \frac{W}{24EI}[8a^3 + 18a^2b + 12ab^2 + 3b^3 + 4c(3a^2 + 3ab + b^2)]$$

SPECIAL CASE: UNIFORM LOAD ON FULL SPAN

Span = L = b

a = c = 0

Uniform Load = W

$R_A = W$

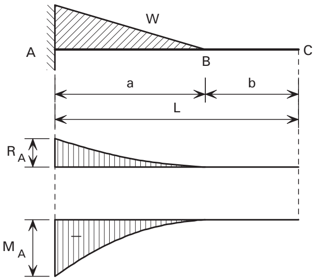
$M_A = -\dfrac{WL}{2}$

$i_D = \dfrac{WL^2}{6EI}$

$\delta_D = \dfrac{WL^3}{8EI}$

FORMULAE FOR BEAMS

CANTILEVER — TRIANGULAR LOAD ON PART OF SPAN



Span $= L$

Triangular Load $= W$

$R_A = W$

$$M_A = -\frac{Wa}{3}$$

$$\delta_C = \frac{Wa^2}{15EI}\left(L + \frac{b}{4}\right)$$

$$i_B = i_C = \frac{Wa^2}{12EI}$$

SPECIAL CASE: TRIANGULAR LOAD ON FULL SPAN

Span $= L = a$

$b = 0$

Triangular Load $= W$

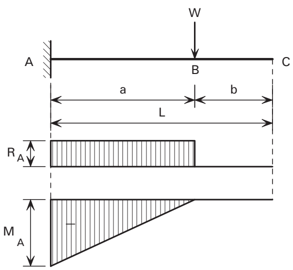
$R_A = W$

$$M_A = -\frac{WL}{3}$$

$$\delta_C = \frac{WL^3}{15EI}$$

$$i_C = \frac{WL^2}{12EI}$$

CANTILEVER — POINT LOAD AT ANY POSITION



Span $= L$

Point Load $= W$

$R_A = W$

$M_A = -Wa$

$$\delta_C = \frac{Wa^2}{3EI}\left(L + \frac{b}{2}\right)$$

$$i_B = i_C = \frac{Wa^2}{2EI}$$

SPECIAL CASE: POINT LOAD AT FREE END

Span $= L = a$

$b = 0$

Point Load $= W$

$R_A = W$

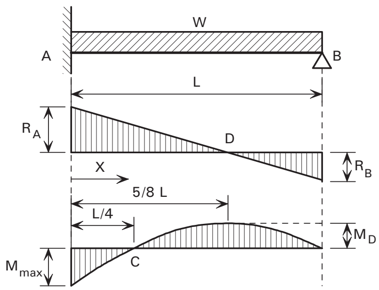
$M_A = -WL$

$$\delta_C = \frac{WL^3}{3EI}$$

$$i_C = \frac{WL^2}{2EI}$$

FORMULAE FOR BEAMS

PROPPED CANTILEVER



UNIFORM LOAD ON FULL SPAN

Span = L

Total Uniform Load = W

$R_A = \frac{5}{8}W$ $\qquad R_B = \frac{3}{8}W$

at A $\qquad M_{max} = -\frac{WL}{8}$

at $\frac{5}{8}$ L from A $\qquad M_D = \frac{9}{128}WL$

at 0.5785L from A $\qquad \delta_{max} = \frac{WL^3}{185EI}$

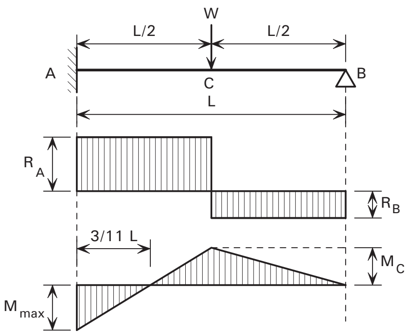
at B $\qquad i_B = \frac{WL^2}{48EI}$

at X from A: $M_X = -\frac{W}{8L}\left(L^2 - 5LX + 4X^2\right)$

$$\delta_X = \frac{WX^2}{48EIL}\left(3L^2 - 5LX + 2X^2\right)$$

$$i_X = \frac{WX}{48EIL}\left(6L^2 - 15LX + 8X^2\right)$$

PROPPED CANTILEVER



at $\frac{3}{11}$ L from A, M = 0

POINT LOAD AT MID-SPAN

Span = L

Point Load = W

$R_A = \frac{11}{16}W$ $\qquad R_B = \frac{5}{16}W$

at A, $M_{max} = -\frac{3}{16}WL$

at mid-span under load $\qquad M_C = \frac{5}{32}WL$

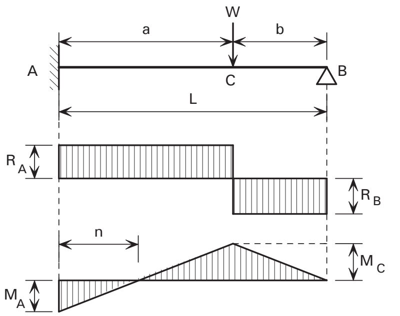
$\delta_C = \frac{7WL^3}{768EI}$

at 0.5528L from A, $\qquad \delta_{max} = \frac{WL^3}{107EI}$

at B $\qquad i_B = \frac{WL^2}{32EI}$

FORMULAE FOR BEAMS

PROPPED CANTILEVER



at $n = aL \dfrac{L+b}{3L^2 - b^2}$ from A, M = 0

POINT LOAD AT ANY POSITION

Span = L

Point Load = W

$$R_A = \frac{Wb(3L^2 - b^2)}{2L^3} \qquad R_B = \frac{Wa^2(2L+b)}{2L^3}$$

$$M_A = \frac{Wab\,(L+b)}{2L^2} \qquad M_C = \frac{Wa^2b(2L+b)}{2L^3}$$

$$i_B = \frac{Wa^2b}{4EIL}$$

Absolute max deflection is under the load when

$$a = b/2 = 0.5858L \qquad \delta_{max\,max} = \frac{WL^3}{102EI}$$

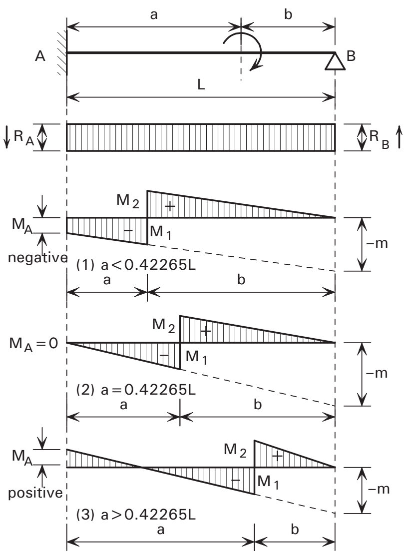
When a > b/2 max deflection is between A & C

$$\delta_{max} = \frac{Wa^3b}{3EI} \cdot \frac{(L+b)^3}{(3L^2 - b^2)^2}$$

When a < b/2 max deflection is between C & B

$$\delta_{max} = \frac{Wa^2b}{6EI}\sqrt{\frac{b}{2L+b}}$$

PROPPED CANTILEVER



MOMENT APPLIED AT ANY POINT

Span = L Applied Moment = m

$$M_A = \frac{L^2 - 3b^2}{2L^2}m \qquad i_B = \frac{ma}{4EIL}(2b - a)$$

$$R_A = -R_B = -\frac{3(L^2 - b^2)}{2L^3}m = -\frac{m + M_A}{L}$$

For case (1)

$$M_1 = -\frac{m}{L^3}\left(a^3 + \frac{3}{2}a^2b + b^3\right)$$

$$M_2 = -\frac{3\,mab}{L^3}\left(b + \frac{a}{2}\right) = m + M_1$$

For case (2)

M_1 = −0.42265 m

M_2 = 0.57735 m

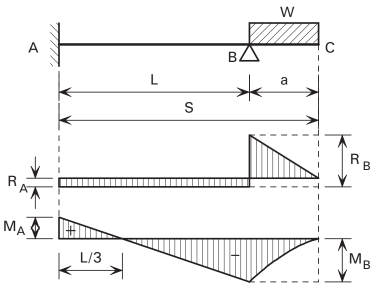
For case (3)

M_1 = as for (1)

M_2 = as for (1)

FORMULAE FOR BEAMS

PROPPED CANTILEVER



at $X = \frac{L}{3}$ from A, M = 0

UNIFORM LOAD ON LENGTH BEYOND PROP

Span = L Full Length = S

Uniform Load = W

$R_A = -\frac{3Wa}{4L}$ $R_B = \frac{W}{L}\left(S - \frac{a}{4}\right)$

$M_A = \frac{Wa}{4}$ $M_B = -\frac{Wa}{2}$

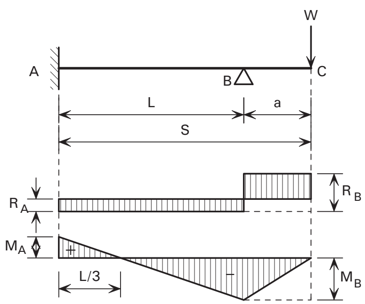
Deflection at C $= \delta_{max} = -\frac{Wa^2S}{8EI}$

Max. Negative Deflection at $X = \frac{2}{3}L$

$\delta_{neg} = -\frac{WL^2a}{54EI}$

Slope at C $= I_C = \frac{Wa}{8EI}\left(S + \frac{a}{3}\right)$

PROPPED CANTILEVER



at $X = \frac{L}{3}$ from A, M = 0

POINT LOAD AT FREE END

Span = L Full Length = S

Point Load = W

$R_A = -\frac{3Wa}{2L}$ $R_B = \frac{W}{L}\left(S + \frac{a}{2}\right)$

$M_A = \frac{Wa}{2}$ $M_B = -Wa$

Deflection at C $= \delta_{max} = \frac{Wa^2}{4EI}\left(S + \frac{a}{3}\right)$

Max. Negative Deflection at $X = \frac{2}{3}L$

$\delta_{neg} = -\frac{WL^2a}{27EI}$

Slope at C $= I_C = \frac{Wa}{4EI}(S + a)$

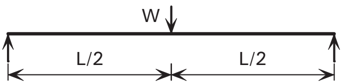
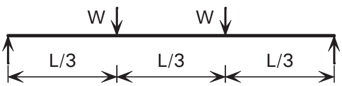
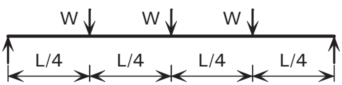
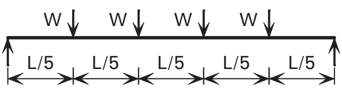
FORMULAE FOR BEAMS

Concentrated Load Conditions

The load tables on pages 208 to 213 and 323 to 328 are also applicable to laterally supported simple span beams with equal concentrated loads spaced as shown in the accompanying table of equivalent uniform loads. Except for short spans where shear controls the design, the beam load tables may be entered with this equivalent uniform load.

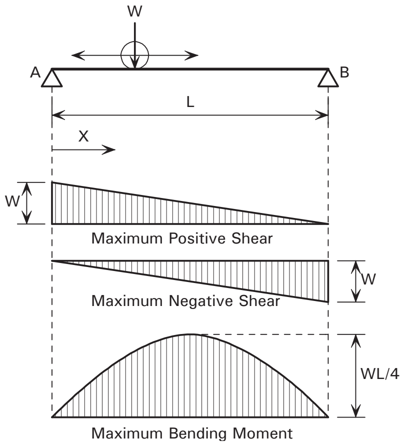
Note:

The equivalent uniform loads produce the same maximum bending moment as the concentrated load arrangement, but will not produce equivalent shear forces or deflections.

TABLE OF EQUIVALENT UNIFORM LOADS	
Type of Loading: **Equal Loads, Equal Spaces**	**Equivalent Uniform** **Load**
	2.00 W
	2.67 W
	4.00 W
	4.80 W

FORMULAE FOR BEAMS

SIMPLY SUPPORTED BEAM



SINGLE CONCENTRATED MOVING LOAD

Maximum Positive Shear at any section occurs when the load is immediately to the right of the section. Similarly, Maximum Negative Shear occurs when the load is to the left. For a section distance X from A:

$$\text{Positive } F_{Xmax} = W \frac{L - X}{L}$$

$$\text{Negative } F_{Xmax} = -W \frac{X}{L}$$

Maximum Bending Moment at any section occurs when the load is over the section. For a section distance X from A:

$$M_{Xmax} = W \frac{X(L - X)}{L}$$

The Absolute Maximum Bending Moment and Deflection occur under the load at mid span:

$$M_{max.max} = \frac{WL}{4}$$

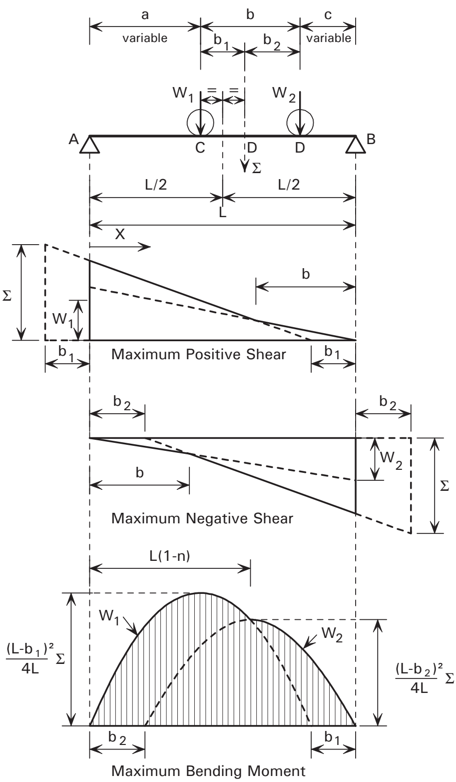
$$\delta_{max\ max} = \frac{WL^3}{48EI}$$

Maximum end slope at A occurs with the load at X = 0.42265L from A

$$i_{Amax} = 0.06415 \frac{WL^2}{EI}$$

FORMULAE FOR BEAMS

SIMPLY SUPPORTED BEAM



TWO CONCENTRATED MOVING LOADS

Assume:

$W_1 > W_2$ $\quad W_1 + W_2 = 3$ $\quad W_2 = n3$

Fixed Distance $b = mL$

$b_1 = \frac{W_2}{W_1 + W_2} b = nmL$ $\qquad b_2 = (m - nm)L$

Maximum Reaction at A and Absolute Maximum Positive Shear occur when W_1 is immediately to the right of A:

$$R_{A\,max} = \text{Positive } F_{max\,max} = W_1 + W_2 = \frac{L-b}{L}$$

For a section distance X from A:

$X \leq L - b$

$$\text{Positive } F_{max} = \frac{L-X}{L}\Sigma - mW_2$$

$L - b \leq x$

$$\text{Positive } F_{max} = \frac{L-X}{L}W_1$$

Note:

For R_{Bmax}, interchange values of W_1 and W_2 in the formula for R_{Amax}.

For Negative Shear, interchange W_1 and W_2 in formulae for Positive Shear, measuring X from B towards A

If $m > \frac{n}{l-n}$, calculate R_{Bmax} and Negative Shear values for W_1 only as single load.

Absolute Maximum Bending Moment occurs under W_1 when that load and the resultant of both loads are equidistant from mid-span (see loading diagram):

$$M_{max\,max} = \frac{(L-b_1)^2}{4L}\Sigma$$

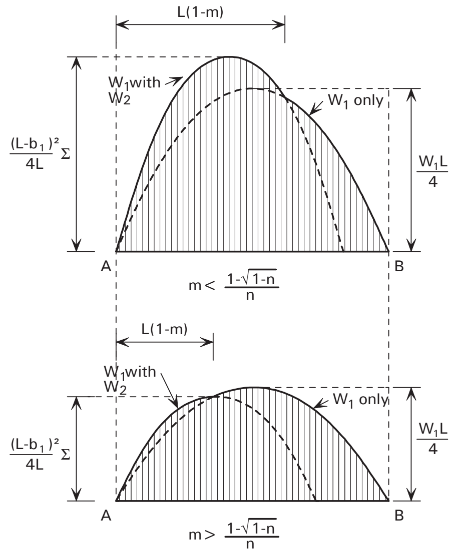
If $m < n$, the Maximum Bending Moment at any section occurs under one of the loads. For a section distance X from A:

$$X \leq L(l-n)\; M_{max} \text{ under } W_1 = \frac{(L-b_1-X)X}{L}\Sigma$$

$$L(l-n) \leq X\; M_{max} \text{ under } W_2 = \frac{(X-b_2)(L-X)}{L}\Sigma$$

FORMULAE FOR BEAMS

SIMPLY SUPPORTED BEAM



TWO CONCENTRATED MOVING LOADS (continued)

If m>n, the Maximum Bending Moment at any section always occurs under W_1 (the heavier load), whether W_2 is on or off the span.

For a section distance X from A:

$X \le L(l-m)$

$$M_{max} = \frac{(L - b_1 - X)X}{L}\Sigma$$

$L(l-m) \le X$

$$M_{max} = \frac{(L - X)X}{L}W_1$$

If $n < m < \frac{1-\sqrt{l-n}}{n}$ the Absolute Maximum Bending Moment occurs under W_1 with W_2 on the span.

If $n < m > \frac{1-\sqrt{l-n}}{n}$ the Absolute Maximum Bending Moment occurs under W_1 at mid-span with W_2 off the span.

Note: When the two loads are equal ($W_1 = W_2$ and $n = ½$) the critical value of $\frac{1-\sqrt{l-n}}{n}$ = 0.5858.

SIMPLY SUPPORTED BEAMS

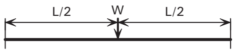
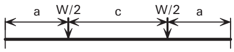
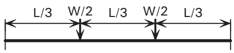
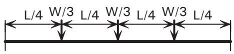
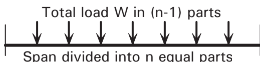
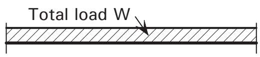
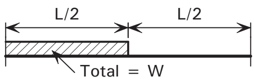
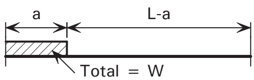
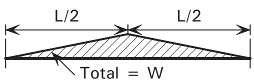
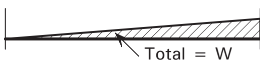
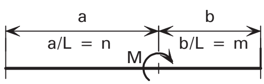
CARRYING SEVERAL MOVING CONCENTRATED LOADS

The Maximum Reaction and the Maximum Shear due to several moving concentrated loads occur at one support with one of the loads at that support. The location producing the Absolute Maximum must be found by trial.

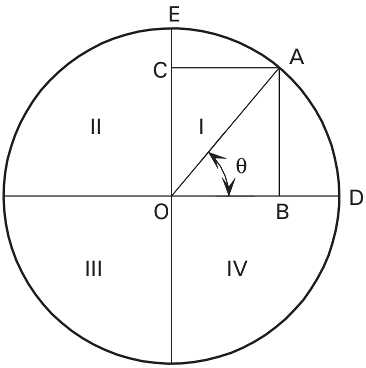
The Maximum Bending Moment due to several moving concentrated loads occurs under one of the loads when that load and the gravity centre of all loads are equidistant from mid-span. The Absolute Maximum must be determined by trial.

FIXED END MOMENTS

For use in analysis by 'Moment Distribution'

Fixing Moment at LH End		LOADING	Fixing Moment at RH End	
Both Ends Fixed	**This End only Fixed**	**Span = L (in all cases)**	**Both Ends Fixed**	**This End only Fixed**
$\frac{WL}{8}$	$\frac{3WL}{16}$		$\frac{WL}{8}$	$\frac{3WL}{16}$
$\frac{Wab^2}{L^2}$	$\frac{Wab(a+2b)}{2L^2}$		$\frac{Wa^2b}{L^2}$	$\frac{Wab(2a+b)}{2L^2}$
$\frac{Wa(a+c)}{2L}$	$\frac{3Wa(a+c)}{4L}$		$\frac{Wa(a+c)}{2L}$	$\frac{3Wa(a+c)}{4L}$
$\frac{WL}{9}$	$\frac{WL}{6}$		$\frac{WL}{9}$	$\frac{WL}{6}$
$\frac{5WL}{48}$	$\frac{5WL}{32}$		$\frac{5WL}{48}$	$\frac{5WL}{32}$
$\frac{WL}{12}\left(\frac{n+1}{n}\right)$	$\frac{WL}{8}\left(\frac{n+1}{n}\right)$		$\frac{WL}{12}\left(\frac{n+1}{n}\right)$	$\frac{WL}{8}\left(\frac{n+1}{n}\right)$
$\frac{WL}{12}$	$\frac{WL}{8}$		$\frac{WL}{12}$	$\frac{WL}{8}$
$\frac{11WL}{96}$	$\frac{9WL}{64}$		$\frac{5WL}{96}$	$\frac{7WL}{64}$
$\frac{Wa}{12L^2}\left(6L^2-8aL+3a^2\right)$	$\frac{Wa}{8L^2}(2L-a)^2$		$\frac{Wa}{12L^2}(4L-3a)$	$\frac{Wa}{8L^2}(2L-a)^2$
$\frac{5WL}{48}$	$\frac{5WL}{32}$		$\frac{5WL}{48}$	$\frac{5WL}{32}$
$\frac{WL}{15}$	$\frac{7WL}{60}$		$\frac{WL}{10}$	$\frac{2WL}{15}$
$\frac{Mb}{L^2}(3a-L)$	$\frac{M}{2}\left(2-6n+3n^2\right)$		$\frac{Ma}{L^2}(3b-L)$	$\frac{M}{2}\left(2-6m+3m^2\right)$

TRIGONOMETRICAL FORMULAE



$$\text{Sin } 2 = \frac{AB}{OA} = \frac{1}{\text{cosec } \theta} = \text{Cos}\left(90^{0} - \theta\right)$$

$$\text{Cos } 2 = \frac{OB}{OA} = \frac{1}{\text{sec } \theta} = \text{Sin}\left(90^{0} - \theta\right)$$

$$\text{Tan } 2 = \frac{AB}{OB} = \frac{\sin\theta}{\cos\theta} = \text{Cotan}\left(90^{0} - \theta\right)$$

$$\text{Cosec } 2 = \frac{OA}{AB} = \frac{1}{\sin\theta} = \text{Sec}\left(90^{0} - \theta\right)$$

$$\text{Sec } 2 = \frac{OA}{AB} = \frac{1}{\cos\theta} = \text{Cosec}\left(90^{0} - \theta\right)$$

$$\text{Cotan } 2 = \frac{OB}{AB} = \frac{1}{\tan\theta} = \text{Tan}\left(90^{0} - \theta\right)$$

In quadrant

I	All ratios are positive	
II	Sin, Cosec are positive	Cos, Tan, Sec, Cotan are negative
III	Tan, Cotan are positive	Sin, Cosec, Cos, Sec are negative
IV	Cos, Sec are positive	Sin, Tan, Cosec, Cotan are negative

$\text{Sin}^2\,\theta + \text{Cos}^2\,\theta = 1$

$\text{Sin}\,(\theta \pm \varphi) = \text{Sin}\,\theta\,\text{Cos}\,\varphi \pm \text{Cos}\,\theta\,\text{Sin}\,\varphi$

$\text{Cos}\,(\theta \pm \varphi) = \text{Cos}\,\theta\,\text{Cos}\,\varphi \pm \text{Sin}\,\theta\,\text{Sin}\,\varphi$

$$\text{Tan}\,(\theta + \varphi) = \frac{\text{Tan}\,\theta + \text{Tan}\,\varphi}{1 - \text{Tan}\,\theta\text{Tan}\,\varphi}$$

$$\text{Tan}\,(\theta - \varphi) = \frac{\text{Tan}\,\theta - \text{Tan}\,\varphi}{1 + \text{Tan}\,\theta\,\text{Tan}\,\varphi}$$

$$\text{Sin}\,2\theta = 2\,\text{Sin}\,\theta\,\text{Cos}\,\theta \qquad \text{Sin}\,\tfrac{1}{2}\,\theta = \sqrt{\frac{1 - \text{Cos}\,\theta}{2}}$$

$$\text{Cos}\,2\theta = \text{Cos}2\theta - \text{Sin}2\theta \qquad \text{Cos}\,\tfrac{1}{2}\,\theta = \sqrt{\frac{1 + \text{Cos}\,\theta}{2}}$$

$$\text{Tan}\,2\theta = \frac{2\,\text{Tan}\,\theta}{1 - \text{Tan}^2\,\theta} \qquad \text{Tan}\,\tfrac{1}{2}\,\theta = \frac{1 - \text{Cos}\,\theta}{\text{Sin}\,\theta}$$

$$\text{Sin}\,\theta + \text{Sin}\,\varphi = 2\,\sin\left(\frac{\theta + \varphi}{2}\right)\,\text{Cos}\left(\frac{\theta - \varphi}{2}\right)$$

$$\text{Sin}\,\theta - \text{Sin}\,\varphi = 2\,\cos\left(\frac{\theta + \varphi}{2}\right)\,\text{Sin}\left(\frac{\theta - \varphi}{2}\right)$$

$$\text{Cos}\,\theta + \text{Cos}\,\varphi = 2\,\cos\left(\frac{\theta + \varphi}{2}\right)\,\text{Cos}\left(\frac{\theta - \varphi}{2}\right)$$

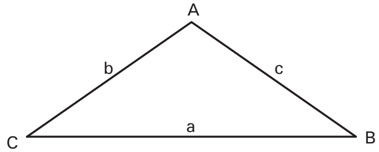
$$\text{Cos}\,\theta - \text{Cos}\,\varphi = -\,2\,\text{Sin}\left(\frac{\theta + \varphi}{2}\right)\,\text{Sin}\left(\frac{\theta - \varphi}{2}\right)$$

$\text{Tan}\,\theta + \text{Tan}\,\varphi = \text{Sin}\,(\theta + \varphi) + \text{Cos}\,\theta\,\cos\,\varphi$

$\text{Tan}\,\theta - \text{Tan}\,\varphi = \text{Sin}\,(\theta - \varphi) + \text{Cos}\,\theta\,\cos\,\varphi$

SOLUTION OF TRIANGLES

General



A, B, C are the angles of the triangle

a, b, c are the sides opposite the angles A, B & C

A + B + C = 180^0 = B radians

$$\frac{a}{\text{Sin A}} = \frac{b}{\text{Sin B}} = \frac{c}{\text{Sin C}}$$

$$\text{Cos A} = \frac{b^2 + c^2 - a^2}{2bc}$$

$$\text{Cos B} = \frac{c^2 + a^2 - b^2}{2ca}$$

$$\text{Cos C} = \frac{a^2 + b^2 - c^2}{2ab}$$

$$s = \frac{a + b - c}{2}$$

$$\text{Area} = \sqrt{s\,(s - a)\,(s - b)\,(s - c)}$$

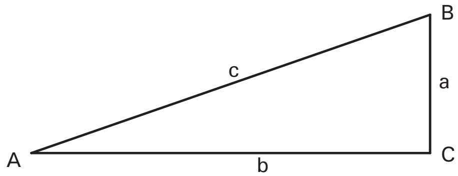
Oblique Angled Triangles

Known	Required					
	A	**B**	**C**	**b**	**c**	**Area**
a, b, c	Cos A = $\frac{b^2 + c^2 - a^2}{2bc}$	Cos B = $\frac{c^2 + a^2 - b^2}{2ca}$	Cos C = $\frac{a^2 + b^2 - c^2}{2ab}$	–	–	$\sqrt{s\,(s - a)\,(s - b)\,(s - c)}$
a, A, B	–	–	$180^0 - (A + B)$	$\frac{a\text{SinB}}{\text{Sin A}}$	$\frac{a\text{SinC}}{\text{Sin A}}$	–
a, b, A	–	Sin B = $\frac{b \text{ Sin A}}{a}$	–	–	$\frac{b \text{ Sin C}}{\text{Sin B}}$	–
a, b, C	tan A = $\frac{a \text{ Sin C}}{b - a \cos C}$	–	–	–	$\sqrt{a^2 + b^2 - 2ab \cos C}$	½ ab sin C

SOLUTION OF TRIANGLES

Right Angled Triangles

$a^2 = c^2 - b^2$
$b^2 = c^2 - a^2$
$c^2 = a^2 + b^2$

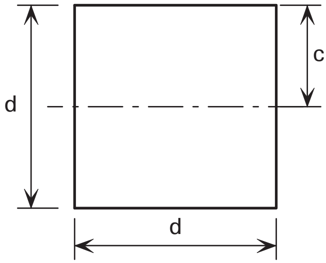


Known	Required					
	A	**B**	**a**	**b**	**c**	**Area**
a, b	$\tan A = \frac{a}{b}$	$\tan B = \frac{b}{a}$	–	–	$\sqrt{a^2 + b^2}$	$\frac{ab}{2}$
a, c	$\text{Sin } A = \frac{a}{c}$	$\text{Cos } B = \frac{a}{c}$	–	$\sqrt{c^2 - a^2}$	–	$\frac{a\sqrt{c^2 - a^2}}{2}$
A, a	–	$90^0 - A$	–	a cot A	$\frac{a}{\text{Sin } A}$	$\frac{a^2 \cot A}{2}$
A, b	–	$90^0 - A$	b tan A	–	$\frac{b}{\text{Cos } A}$	$\frac{b^2 \tan A}{2}$
A, c	–	$90^0 - A$	c sin A	c cos A	–	$\frac{c^2 \sin 2A}{4}$

PROPERTIES OF GEOMETRICAL FIGURES

Square

Axis of moments through centre



$A = d^2$

$c = \frac{d}{2}$

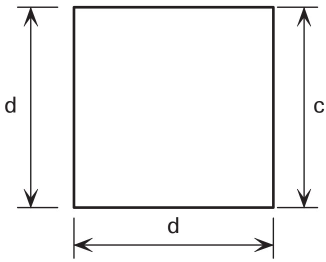
$I = \frac{d^4}{12}$

$w = \frac{d^3}{6}$

$i = \frac{d}{\sqrt{12}} = 0.288675\ d$

Square

Axis of moments on base



$A = d^2$

$c = d$

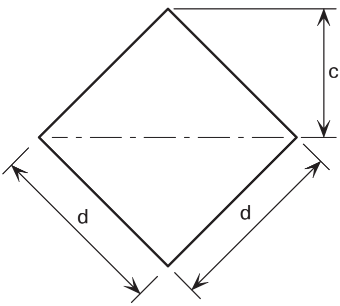
$I = \frac{d^4}{3}$

$w = \frac{d^3}{3}$

$i = \frac{d}{\sqrt{3}} = 0.577350\ d$

Square

Axis of moments on diagonal



$A = d^2$

$c = \frac{d}{\sqrt{2}} = 0.707107d$

$I = \frac{d^4}{12}$

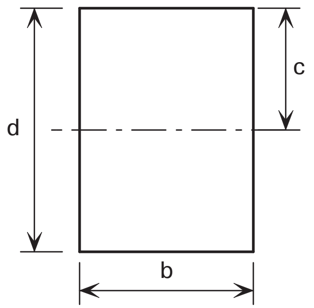
$w = \frac{d^3}{6\sqrt{2}} = 0.117851\ d^3$

$i = \frac{d}{\sqrt{12}} = 0.288675\ d$

PROPERTIES OF GEOMETRICAL FIGURES

Rectangle

Axis of moments through centre



$$A = bd$$

$$c = \frac{d}{2}$$

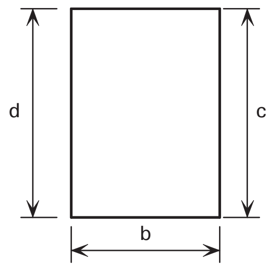
$$I = \frac{bd^3}{12}$$

$$w = \frac{bd^2}{6}$$

$$i = \frac{d}{\sqrt{12}} = 0.288675\ d$$

Rectangle

Axis of moments on base



$$A = bd$$

$$c = d$$

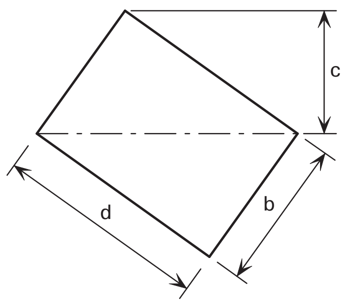
$$I = \frac{bd^3}{3}$$

$$w = \frac{bd^2}{3}$$

$$i = \frac{d}{\sqrt{3}} = 0.577350\ d$$

Rectangle

Axis of moments on diagonal



$$A = bd$$

$$c = \frac{bd}{\sqrt{b^2 + d^2}}$$

$$I = \frac{b^3 d^3}{6(b^2 + d^2)}$$

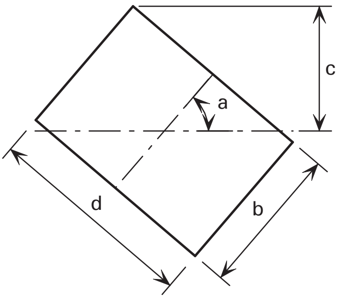
$$w = \frac{b^2 d^2}{6\sqrt{b^2 + d^2}}$$

$$i = \frac{bd}{\sqrt{6(b^2 + d^2)}}$$

PROPERTIES OF GEOMETRICAL FIGURES

Rectangle

Axis of moments any line through centre of gravity



$$A = bd$$

$$c = \frac{b \sin a + d \cos a}{2}$$

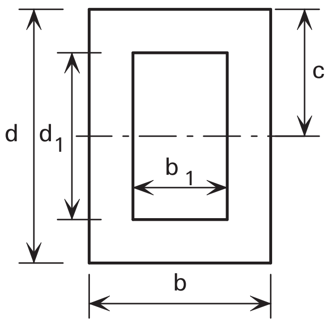
$$I = \frac{bd\,(b^2 \sin^2 a + d^2 \cos^2 a)}{12}$$

$$w = \frac{bd\,(b^2 \sin^2 a + d^2 \cos^2 a)}{6\,(b \sin a + d \cos a)}$$

$$i = \sqrt{\frac{b^2 \sin^2 a + d^2 \cos^2 a}{12}}$$

Hollow Rectangle

Axis of moments through centre



$$A = bd - b_1 d_1$$

$$c = \frac{d}{2}$$

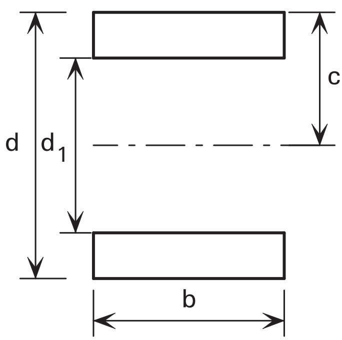
$$I = \frac{bd^3 - b_1 d_1^3}{12}$$

$$w = \frac{bd^3 - b_1 d_1^3}{6d}$$

$$i = \sqrt{\frac{bd^3 - b_1 d_1^3}{12A}}$$

Equal Rectangles

Axis of moments through centre of gravity



$$A = b(d - d_1)$$

$$c = \frac{d}{2}$$

$$I = \frac{b(d^3 - d_1^3)}{12}$$

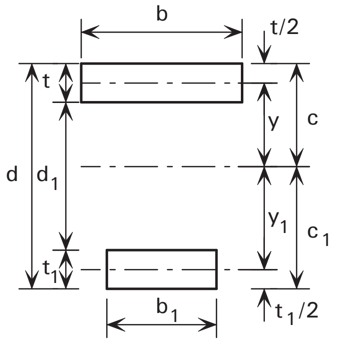
$$w = \frac{b(d^3 - d_1^3)}{6d}$$

$$i = \sqrt{\frac{d^3 - d_1^3}{12(d - d_1)}}$$

PROPERTIES OF GEOMETRICAL FIGURES

Unequal Rectangles

Axis of moments through centre of gravity



$$A = bt + b_1t_1$$

$$c = \frac{\frac{1}{2}bt^2 + b_1t_1\left(d - \frac{1}{2}t_1\right)}{A}$$

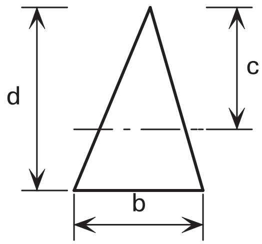
$$I = \frac{bt^3}{12} + bty^2 + \frac{b_1t_1^3}{12} + b_1t_1y_1^2$$

$$w = \frac{I}{c} \quad z_1 = \frac{I}{c_1}$$

$$i = \sqrt{\frac{1}{A}}$$

Triangle

Axis of moments through centre of gravity



$$A = \frac{bd}{2}$$

$$c = \frac{2d}{3}$$

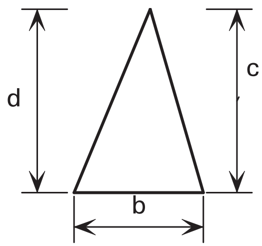
$$I = \frac{bd^3}{36}$$

$$w = \frac{bd^2}{24}$$

$$i = \frac{d}{\sqrt{18}} = 0.235702\ d$$

Triangle

Axis of moments on base



$$A = \frac{bd}{2}$$

$$c = d$$

$$I = \frac{bd^3}{12}$$

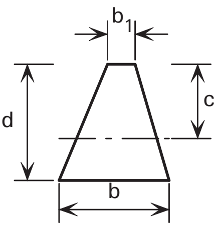
$$w = \frac{bd^2}{12}$$

$$i = \frac{d}{\sqrt{6}} = 0.408248\ d$$

PROPERTIES OF GEOMETRICAL FIGURES

Trapezoid

Axis of moments through centre of gravity



$$A = \frac{d(b + b_1)}{2}$$

$$c = \frac{d(2b + b_1)}{3(b + b_1)}$$

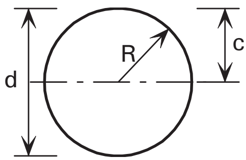
$$I = \frac{d^3(b^2 + 4bb_1 + b_1^2)}{36\,(b + b_1)}$$

$$w = \frac{d^2(b^2 + 4\,bb_1 + b_1^2)}{12\,(2b + b_1)}$$

$$i = \frac{d}{6(b + b_1)}\sqrt{2(b^2 + 4bb_1 + b_1^2)}$$

Circle

Axis of moments through centre



$$A = \frac{\pi d^2}{4} = BR^2 = 0.785398\ d^2 = 3.141593\ R^2$$

$$C = \frac{d}{2} = R$$

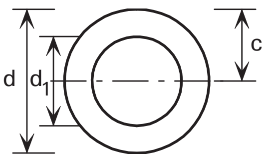
$$I = \frac{\pi d^4}{64} = \frac{\pi R^4}{4} = 0.049087\ d^4 = 0.785398\ R^4$$

$$w = \frac{\pi d^3}{32} = \frac{\pi R^3}{4} = 0.098175\ d^3 = 0.785398\ R^3$$

$$i = \frac{d}{4} = \frac{R}{2}$$

Hollow Circle

Axis of moments through centre



$$A = \frac{\pi(d^2 - d_1^2)}{4} = 0.785398\ (d^2 - d_1)$$

$$C = \frac{d}{2}$$

$$I = \frac{\pi(d^4 - d_1^4)}{64} = 0.049087\ (d^4 - d_1^4)$$

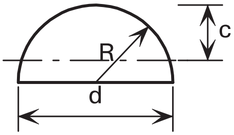
$$w = \frac{\pi(d^4 - d_1^4)}{32d} = 0.098175\ \frac{d^4 - d_1^4}{d}$$

$$i = \frac{\sqrt{d^2 + d_1^2}}{4}$$

PROPERTIES OF GEOMETRICAL FIGURES

Half Circle

Axis of moments through centre of gravity



$$A = \frac{\pi R^2}{2} = 1.570796\ R^2$$

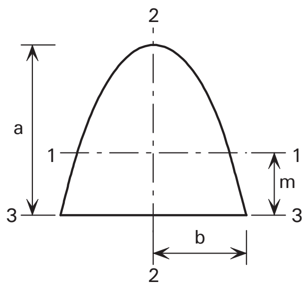
$$c = R\left(1 - \frac{4}{3\pi}\right) = 0.575587\ R$$

$$I = R^4\left(\frac{\pi}{8} - \frac{8}{9\pi}\right) = 0.109757\ R^4$$

$$w = \frac{R^3(9\pi^2 - 64)}{24\,(3\pi - 4)} = 0.190687\ R^3$$

$$i = R\frac{\sqrt{9\pi^2 - 64}}{6\pi} = 0.264336\ R$$

Parabola



$$A = \frac{4}{3}ab$$

$$m = \frac{2}{5}a$$

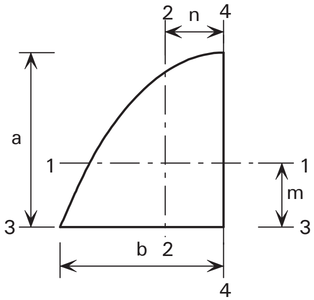
$$I_1 = \frac{16}{175}a^3b$$

$$I_2 = \frac{4}{15}ab^3$$

$$I_3 = \frac{32}{105}a^3b$$

PROPERTIES OF GEOMETRICAL FIGURES

Half Parabola



$$A = \frac{2}{3}ab$$

$$m = \frac{2}{5}a$$

$$n = \frac{3}{8}b$$

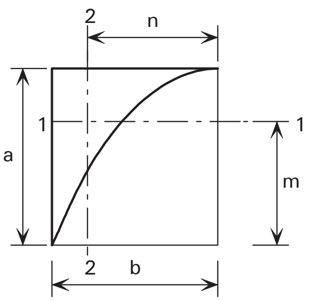
$$I_1 = \frac{8}{175}a^3b$$

$$I_2 = \frac{19}{480}ab^3$$

$$I_3 = \frac{16}{105}a^3b$$

$$I_4 = \frac{2}{15}ab^3$$

Complement of half parabola



$$A = \frac{1}{3}ab$$

$$m = \frac{7}{10}a$$

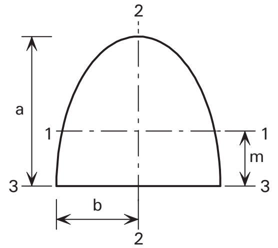
$$n = \frac{3}{4}b$$

$$I_1 = \frac{37}{2100}a^3b$$

$$I_2 = \frac{1}{80}ab^3$$

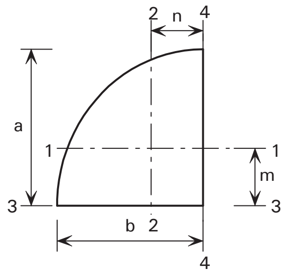
PROPERTIES OF GEOMETRICAL FIGURES

Half Ellipse or Circle



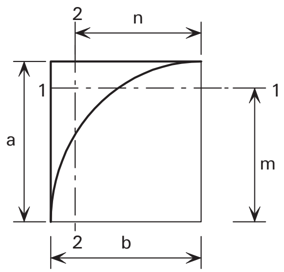
	Ellipse	Circle
A	$= \frac{1}{2}\pi ab$	$= \frac{\pi}{2} R^2$ or $1.5708R^2$
m	$= \frac{4a}{3\pi}$	$= \frac{4}{3\pi} R$ or $0.5756R$
I_1	$= a^3b\left(\frac{\pi}{8} - \frac{8}{9\pi}\right)$	$= \left(\frac{\pi}{8} - \frac{8}{9\pi}\right) R^4$ or $0.1096R^4$
I_2	$= \frac{1}{8}\pi ab^3$	$= \frac{\pi}{8} R^4$ or $0.3927R^4$
I_3	$= \frac{1}{8}\pi a^3 b$	

Quarter Ellipse or Circle



	Ellipse	Circle
A	$= \frac{1}{4}\pi ab \}$	$= \frac{\pi}{4} R^2$ or $0.7854R^2$
m	$= \frac{4a}{3\pi} \}$	$= \frac{4}{3\pi} R$ or $0.5756R^2$
n	$= \frac{4b}{3\pi} \}$	
I_1	$= a^2b\left(\frac{\pi}{16} - \frac{4}{9\pi}\right)$	$= \left(\frac{\pi}{16} - \frac{4}{9\pi}\right) R^4$ or $0.0548R^4$
I_2	$= ab^3\left(\frac{\pi}{16} - \frac{4}{9\pi}\right)$	
I_3	$= \frac{1}{16}\pi a^3 b$	$= \frac{\pi}{16} R^4$ or $0.0625R^4$
I_4	$= \frac{1}{16}\pi ab^3$	

Elliptic Complement or ¼ circle



$A = ab\left(1 - \frac{\pi}{4}\right)$ $\quad = \left(1 - \frac{\pi}{4}\right) R^2$ or $0.2146R^2$

$m = \frac{a}{6\left(1 - \frac{\pi}{4}\right)}$, $n = \frac{b}{6\left(1 - \frac{\pi}{4}\right)}$ $\quad = \frac{R}{6(1 - \pi/4)}$ or $0.7767R$

$$I_1 = a^3b\left(\frac{1}{3} - \frac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right)$$

$$I_2 = ab^3\left(\frac{1}{3} - \frac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right)$$

$$= \left(\frac{1}{3} - \frac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right) R^4$$

or $0.0075R^4$

METRIC CONVERSIONS

Basic conversion factors

The following equivalents of SI units are given in imperial and, where applicable, metric technical units.

1mm	=0.03937in	1in	= 25.4mm	1 hect.	= 2.471 acres	1 acre	= 0.405 hect
1m	= 3.281ft	1ft	= 0.3048m	1mm^3	= 0.00006102 in^3	1in^3	= 16.390mm^3
	= 1.094yd	1yd	= 0.9144m	1m^3	= 35.31ft^2	1ft^3	= 0.02832m^3
1km	= 0.6214 mile	1 mile	= 1.609km		= 1.308yd^3	1yd^3	= 0.7646m^3
1mm^2	= 0.00155 in^2	1in^2	= 645.2mm^2	1mm^4	= 0.000002403in^4	1in^4	= 416,200mm^4
1m^2	= 10.76ft^2	1ft^2	= 0.0929m^2				
1m^2	= 1.196yd^2	1yd^2	= 0.8361m^2				

Force

1 N	= 0.2248 lbf	= 0.1020 kgf	1 kN	= 0.1004 tonf	= 102.0 kgf	= 0.1020 tonf
4.448 N	= 1 lbf	= 0.4536 kgf	9.964 kN	= 1 tonf	= 1,16 kgf	= 1016 tonf
9.807 N	= 2.205 lbf	= 1 kgf	9.807 kN	= 0.9842 tonf	= 1,000 kgf	= 1 tonf

Force per unit length

1 N/m	= 0.06852 lbf/ft	=0.1020 kgf/m	1 kN/m	= 0.0306 tonf/ft	= 0.1020 tonf/m
14.59 N/m	= 1 lbf/ft	= 1.488 kgf/m	32.69 kN/m	= 1 ton/ft	= 3.33 tonne f/m
9.807 N/m	= 0.672 lbf/ft	= 1 kgf/m	9.807 kN/m	= 0.3000 tonf/ft	= 1 tonf/m

Force per unit area

1 N/mm^2	= 145 lbf/in^2	= 10.20 kgf/cm^2	1 N/mm^2	= 0.0648 tonf/in^2	= 10.2 kgf/cm^2
0.0069 N/mm^2	= 1 lbf/in^2	= 0.070kgf/cm^2	15.44 N/mm^2	= 1 tonf/in^2	= 157.5 kgf/cm^2
0.0981 N/mm^2	= 14.22lbf/in^2	= 1kgf/cm^2	0.0981 N/mm^2	= 0.00635 tonf/in^2	= 1 kgf/cm^2
1 N/m^2	= 0.0210 lbf/ft^2	= 0.102 kgf/m^2	1 N/mm^2	= 9.32 tonf/ft^2	= 10.2 kgf/cm^2
47.88 N/m^2	= 1 lbf/ft^2	= 4.882 kgf/m^2	0.1073 N/mm^2	= 1 tonf/ft^2	= 1.094 kgf/cm^2
9.807 N/m^2	= 0.2048 lbf/ft^2	= 1kgf/m^2	0.0981 N/mm^2	= 0.914 tonf/ft^2	= 1kgf/cm^2

Force per unit volume

1 N/m^3	= 0.00637 lbf/ft^2	= 0.102 kgf/m^3	1 kN/m^3	= 0.00284 tonf/ft^3	= 0.102 tonf/m^3
157.1 N/m^3	= 1lbf/ft^3	= 16.02 kgf/m^3	351.9 kN/m^3	= 1 tonf/ft^3	= 35.88 tonf/m^3
9.807 N/m^3	= 0.0624 lbf/ft^3	= 1 kgf/m^3	9.807 kN/m^3	= 0.0279 tonf/ft^3	= 1 tonf/m^3
1 kN/m^3	= 0.0037 lbf/in^3	= 0.102 tonf/m^3			
271 kN/m^3	= 1 lbf/in^3	= 27.68 tonf/m^3			
9.81 kN/m^3	= 0.0362 lbf/in^3	= 1 tonf/m^3			

Moment

1 N-m	= 8.851 lbf-in	= 0.7376 lbf-ft	= 0.1020 kgf-m
0.1130 N-m	= 1 lbf-in	= 0.08333 lbf-ft	= 0.01152 kgf-m
1.356 N-m	= 12 lbf-in	= 1 lbf-ft	= 0.1383 kgf-m
9.807 N-m	= 86.80 lbf-in	= 7.233 lbf-ft	= 1 kgf-m

Fluid capacity

1 litre	= 0.22 imperial gallons	= 0.2642 USA gallons
4.564 litres	= 1 imperial gallon	= 1.201 USA gallons
3.785 litres	= 0.8327 imperial gallons	= 1 USA gallon

EXPLANATORY NOTES

1 GENERAL

This publication presents design data in tabular formats as assistance to engineers who are designing buildings in accordance with BS EN 1993-1-1: 2005[35], BS EN 1993-1-5: 2006[39] and BS EN 1993-1-8: 2005[31], and their respective National Annexes. Where these Parts do not give all the necessary expressions for the evaluation of data, reference is made to other published sources.

The symbols used are generally the same as those in these standards or the referred product standards. Where a symbol does not appear in the standards, a symbol has been chosen following the designation convention as closely as possible.

1.1 Material, section dimensions and tolerances

The structural sections referred to in this design guide are of weldable structural steels conforming to the relevant British Standards given in the table below:

Table – Structural steel products

<table>
<tr><th rowspan="2">Product</th><th colspan="2">Technical delivery requirements</th><th rowspan="2">Dimensions</th><th rowspan="2">Tolerances</th></tr>
<tr><th>Non alloy steels</th><th>Fine grain steels</th></tr>
<tr><td>Universal beams,
Universal columns,
and universal bearing piles</td><td rowspan="5">BS EN 10025-2[36]</td><td rowspan="5">BS EN 10025-3[43]
BS EN 10025-4[44]</td><td>BS 4-1[45]</td><td>BS EN 10034[46]</td></tr>
<tr><td>Joists</td><td>BS 4-1</td><td>BS 4-1
BS EN 10024[47]</td></tr>
<tr><td>Parallel flange channels</td><td>BS 4-1</td><td>BS EN 10279[48]</td></tr>
<tr><td>Angles</td><td>BS EN 10056-1[49]</td><td>BS EN 10056-2[50]</td></tr>
<tr><td>Structural tees cut from universal beams and universal columns</td><td>BS 4-1</td><td>—</td></tr>
<tr><td>ASB (asymmetric beams)
Slimflor® beam</td><td colspan="2">Generally BS EN 10025,
but see note b)</td><td>See note a)</td><td>Generally
BS EN 10034[46],
but also see note b)</td></tr>
<tr><td>Hot finished structural hollow sections</td><td colspan="2">BS EN 10210-1[51]</td><td>BS EN 10210-2[52]</td><td>BS EN 10210-2[52]</td></tr>
<tr><td>Cold formed hollow sections</td><td colspan="2">BS EN 10219-1[53]</td><td>BS EN 10219-2[54]</td><td>BS EN 10219-2[54]</td></tr>
<tr><td colspan="5">Notes:
For full details of the British Standards, see the reference list at the end of the Explanatory Notes.
a) See Tata Steel publication, Advance® Sections: CE marked structural sections [55].
b) For further details, consult Tata Steel.
Note that EN 1993 refers to the product standards by their CEN designation, e.g. EN 10025-2. The CEN standards are published in the UK by BSI with their prefix to the designation, e.g. BS EN 10025-2.</td></tr>
</table>

1.2 Dimensional units

The dimensions of sections are given in millimetres (mm).

1.3 Property units

Generally, the centimetre (cm) is used for the calculated properties but for surface areas and for the warping constant (I_w), the metre (m) and the decimetre (dm) respectively are used.

Note: 1 dm	=	0.1 m	=	100 mm
$1\ dm^6$	=	$1 \times 10^{-6}\ m^6$	=	$1 \times 10^{12}\ mm^6$

1.4 Mass and force units

The units used are the kilogram (kg), the Newton (N) and the metre per second squared (m/s^2), so that $1\ N = 1\ kg \times 1\ m/s^2$. For convenience, a standard value of the acceleration due to gravity has been accepted as $9.80665\ m/s^2$. Thus, the force exerted by 1 kg under the action of gravity is 9.80665 N and the force exerted by 1 tonne (1000 kg) is 9.80665 kiloNewtons (kN).

1.5 Axis convention

The axis system used in BS EN 1993 is:

x along the member

y major axis, or axis perpendicular to web

z minor axis, or axis parallel to web

This system is convenient for structural analysis using computer programs. However, it is different from the axis system previously used in UK standards such as BS 5950.

2 DIMENSIONS OF SECTIONS

2.1 Masses

The masses per metre have been calculated assuming that the density of steel is 7850 kg/m^3.

In all cases, including compound sections, the tabulated masses are for the steel section alone and no allowance has been made for connecting material or fittings.

2.2 Ratios for local buckling

The ratios of the flange outstand to thickness (c_f / t_f) and the web depth to thickness (c_w / t_w) are given for I, H and channel sections.

$$c_f = \frac{1}{2}[b - (t_w + 2r)] \qquad \text{for I and H sections}$$

$$c_f = [b - (t_w + r)] \qquad \text{for channels}$$

$$c_w = d = [h - 2(t_f + r)] \qquad \text{for I, H and channel sections}$$

For circular hollow sections the ratios of the outside diameter to thickness (d / t) are given.

For square and rectangular hollow sections the ratios (c_f / t) and (c_w / t) are given where:

$c_f = b - 3t$ and $c_w = h - 3t$

For square hollow sections c_f and c_w are equal. Note that these relationships for c_f and c_w are applicable to both hot-finished and cold-formed sections.

The dimensions c_f and c_w are not precisely defined in BS EN 1993-1-1 and the internal profile of the corners is not specified in either BS EN 10210-2 or BS EN 10219-2. The above expressions give conservative values of the ratio for both hot-finished and cold-formed sections.

2.3 Dimensions for detailing

The dimensions *C, N* and *n* have the meanings given in the figures at the heads of the tables and have been calculated according to the formulae below. The formulae for *N* and *C* make allowance for rolling tolerances, whereas the formulae for *n* make no such allowance.

2.3.1 UB sections, UC sections and bearing piles

$N = (b - t_w)/2 + 10$ mm (rounded to the nearest 2 mm above)

$n = (h - d)/2$ (rounded to the nearest 2 mm above)

$C = t_w/2 + 2$ mm (rounded to the nearest mm)

2.3.2 Joists

$N = (b - t_w)/2 + 6$ mm (rounded to the nearest 2 mm above)

$n = (h - d)/2$ (rounded to the nearest 2 mm above)

$C = t_w/2 + 2$ mm (rounded to the nearest mm)

Note: Flanges of BS 4-1 joists have an 8^o taper.

2.3.3 Parallel flange channels

$N = (b - t_w) + 6$ mm (rounded up to the nearest 2 mm above)

$n = (h - d)/2$ (taken to the next higher multiple of 2 mm)

$C = t_w + 2$ mm (rounded up to the nearest mm)

3 SECTION PROPERTIES

3.1 General

All section properties have been accurately calculated and rounded to three significant figures. They have been calculated from the metric dimensions given in the appropriate standards (see Section 1.1). For angles, BS EN 10056-1 assumes that the toe radius equals half the root radius.

3.2 Sections other than hollow sections

3.2.1 Second moment of area (*I*)

The second moment of area has been calculated taking into account all tapers, radii and fillets of the sections. Values are given about both the *y-y* and *z-z* axes.

3.2.2 Radius of gyration (*i*)

The radius of gyration is a parameter used in the calculation of buckling resistance and is derived as follows:

$i \quad = [I / A]^{1/2}$

where:

I is the second moment of area about the relevant axis

A is the area of the cross-section.

3.2.3 Elastic section modulus (W_{el})

The elastic section modulus is used to calculate the elastic design resistance for bending or to calculate the stress at the extreme fibre of the section due to a moment. It is derived as follows:

$W_{el,y} = I_y / z$

$W_{el,z} = I_z / y$

where:

z, y are the distances to the extreme fibres of the section from the elastic *y-y* and *z-z* axes, respectively.

For parallel flange channels, the elastic section modulus about the minor (*z-z*) axis is given for the extreme fibre at the toe of the section only.

For angles, the elastic section moduli about both axes are given for the extreme fibres at the toes of the section only. For elastic section moduli about the principal axes *u-u* and *v-v*, see AD 340[57].

For asymmetric beams, the elastic section moduli about the *y-y* axis are given for both top and bottom extreme fibres, and about the *z-z* axis for the extreme fibre.

3.2.4 Plastic section modulus (W_{pl})

The plastic section moduli about both *y-y* and *z-z* axes are tabulated for all sections except angle sections.

3.2.5 Buckling parameter (*U*) and torsional index (*X*)

UB sections, UC sections, joists and parallel flange channels

The buckling parameter (*U*) and torsional index (*X*) have been calculated using expressions in Access Steel document SN002 *Determination of non-dimensional slenderness of I and H sections*[63].

$$U = \left(\frac{W_{pl,y}\, g}{A} \right)^{0.5} \times \left(\frac{I_z}{I_w} \right)^{0.25}$$

$$X = \sqrt{\frac{\pi^2 E A I_w}{20 G I_T I_z}}$$

where:

$W_{pl,y}$ is the plastic modulus about the major axis

$g = \sqrt{1 - \frac{I_z}{I_y}}$

I_y is the second moment of area about the major axis

I_z is the second moment of area about the minor axis

E	$= 210\ 000\ \text{N/mm}^2$ is the modulus of elasticity
G	is the shear modulus where $G = \dfrac{E}{2(1+\nu)}$
ν	is Poisson's ratio (= 0.3)
A	is the cross–sectional area
I_w	is the warping constant
I_T	is the torsional constant.

Tee sections and ASB sections

The buckling parameter (U) and the torsional index (X) have been calculated using the following expressions:

$$U = [(4\ W_{pl,y}^{\ 2}\ g^2 / (A^2\ h^2)]^{1/4}$$

$$X = 0.566\ h\ [A/ I_T]^{1/2}$$

where:

$W_{pl,y}$	is the plastic modulus about the major axis
g	$= \sqrt{1 - \dfrac{I_z}{I_y}}$
I_y	is the second moment of area about the major axis
I_z	is the second moment of area about the minor axis
A	is the cross-sectional area
h	is the distance between shear centres of flanges (for T sections, h is the distance between the shear centre of the flange and the toe of the web)
I_T	is the torsional constant.

3.2.6 Warping constant (I_w) and torsional constant (I_T)

Rolled I sections

The warping constant and St Venant torsional constant for rolled I sections have been calculated using the formulae given in the SCI publication P057 *Design of members subject to combined bending and torsion*[56].

In Eurocode 3 terminology, these formulae are as follows:

$$I_w = \frac{I_z h_s^{\ 2}}{4}$$

where:

I_z	is the second moment of area about the minor axis
h_s	is the distance between shear centres of flanges (i.e. $h_s = h - t_f$)

$$I_T = \frac{2}{3} b t_f^{\ 3} + \frac{1}{3}(h - 2t_f) t_w^{\ 3} + 2\alpha_1 D_1^{\ 4} - 0.420 t_f^{\ 4}$$

where:

$$\alpha_1 = -\ 0.042 + 0.2204\ \frac{t_w}{t_f} + 0.1355\ \frac{r}{t_f} - 0.0865\ \frac{r t_w}{t_f^{\ 2}} - 0.0725\ \frac{t_w^{\ 2}}{t_f^{\ 2}}$$

$$D_1 = \frac{(t_f + r)^2 + (r + 0.25\, t_w)\, t_w}{2r + t_f}$$

b is the width of the section

h is the depth of the section

t_f is the flange thickness

t_w is the web thickness

r is the root radius.

Tee sections

For Tee sections cut from UB and UC sections, the warping constant (I_w) and torsional constant (I_T) have been derived as given below.

$$I_w = \frac{1}{144} t_f^3 b^3 + \frac{1}{36}\left(h - \frac{t_f}{2}\right)^3 t_w^3$$

$$I_T = \frac{1}{3} b t_f^3 + \frac{1}{3}(h - t_f)\, t_w^3 + \alpha_1 D_1^4 - 0.21\, t_f^4 - 0.105\, t_w^4$$

where:

$$\alpha_1 = -0.042 + 0.2204 \frac{t_w}{t_f} + 0.1355 \frac{r}{t_f} - 0.0865 \frac{t_w\, r}{t_f^2} - 0.0725 \frac{t_w^2}{t_f^2}$$

D_1 is as defined above

Note: These formulae do not apply to Tee sections cut from joists, which have tapered flanges. For such sections, expressions are given in SCI Publication 057[56].

Parallel flange channels

For parallel flange channels, the warping constant (I_w) and torsional constant (I_T) have been calculated as follows:

$$I_w = \frac{(h - t_f)^2}{4}\left[I_z - A\left(c_z - \frac{t_w}{2}\right)^2 \left(\frac{(h - t_f)^2 A}{4 I_y} - 1\right)\right]$$

$$I_T = \frac{2}{3} b t_f^3 + \frac{1}{3}(h - 2t_f) t_w^3 + 2\alpha_3 D_3^4 - 0.42\, t_f^4$$

where:

c_z is the distance from the back of the web to the centroidal axis

$$\alpha_3 = -0.0908 + 0.2621 \frac{t_w}{t_f} + 0.1231 \frac{r}{t_f} - 0.0752 \frac{t_w\, r}{t_f^2} - 0.0945 \left(\frac{t_w}{t_f}\right)^2$$

$$D_3 = 2\left[(3r + t_w + t_f) - \sqrt{2(2r + t_w)(2r + t_f)}\right]$$

Note: The formula for the torsional constant (I_T) is applicable to parallel flange channels only and does not apply to tapered flange channels.

Angles

For angles, the torsional constant (I_T) is calculated as follows:

$$I_T = \frac{1}{3}bt^3 + \frac{1}{3}(h-t)t^3 + \alpha_3 D_3^{\,4} - 0.21t^4$$

where:

$$\alpha_3 = 0.0768 + 0.0479\frac{r}{t}$$

$$D_3 = 2\left[(3r+2t) - \sqrt{2(2r+t)^2}\right]$$

ASB sections

For ASB sections the warping constant (I_w) and torsional constant (I_T) are as given in Tata brochure, *Advance® sections* [55].

3.2.7 Equivalent slenderness coefficient (ϕ) and monosymmetry index (ψ)

Angles

The buckling resistance moments for angles have not been included in the bending resistance tables of this publication as angles are predominantly used in compression and tension only. Where the designer wishes to use an angle section in bending, BS EN 1993-1-1 6.3.2 enables the buckling resistance moment for angles to be determined. The procedure is quite involved.

As an alternative to the procedure in BS EN 1993-1-1, supplementary section properties have been included for angle sections in this publication which enable the designer to adopt a much simplified method for determining the buckling resistance moment. The method is based on that given in BS 5950-1:2000 Annex B.2.9 and makes use of the equivalent slenderness coefficient and the monosymmetry index.

The equivalent slenderness coefficient (ϕ_a) is tabulated for both equal and unequal angles. Two values of the equivalent slenderness coefficient are given for each unequal angle. The larger value is based on the major axis elastic section modulus ($W_{el,u}$) to the toe of the short leg and the lower value is based on the major axis elastic section modulus to the toe of the long leg.

The equivalent slenderness coefficient (ϕ_a) is calculated as follows:

$$\phi_a = \frac{W_{el,u}\, g}{\sqrt{A I_T}}$$

where:

$W_{el,u}$ is the elastic section modulus about the major axis u-u

$$g = \sqrt{1 - \frac{I_v}{I_u}}$$

I_v is the second moment of area about the minor axis

I_u is the second moment of area about the major axis

A is the area of the cross-section

I_T is the torsional constant.

The monosymmetry index (ψ_a) is calculated as follows:

$$\psi_a = \left[2v_0 - \frac{\int v_i \left(u_i^2 + v_i^2\right) dA}{I_u} \right] \frac{1}{t}$$

where:

u_i and v_i are the coordinates of an element of the cross-section

v_0 is the coordinate of the shear centre along the v-v axis, relative to the centroid

t is the thickness of the angle.

Tee sections

The monosymmetry index is tabulated for Tee sections cut from UBs and UCs. It has been calculated as:

$$\psi = \left(2z_0 - \frac{z_0 b^3 t_f / 12 + b t_f z_0^3 + \frac{t_w}{4}\left[(c - t_f)^4 - (h - c)^4\right]}{I_y} \right) \frac{1}{(h - t_f / 2)}$$

where:

z_0 $= c - t_f / 2$

c is the width of the flange outstand ($= (b - t_w - 2r)/2$)

b is the flange width

t_f is the flange thickness

t_w is the web thickness

h is the depth of the section.

The above expression is based on BS 5950-1, Annex B.2.8.2.

ASB sections

The monosymmetry index is tabulated for ASB sections. It has been calculated using the equation in BS 5950-1, Annex B.2.4.1, re-expressed in BS EN 1993-1-1 nomenclature:

$$\psi = \frac{1}{h_s} \left(\frac{2(I_{zc} h_c - I_{zt} h_t)}{(I_{zc} + I_{zt})} - \frac{(I_{zc} h_c - I_{zt} h_t) + (b_c t_c h_c^3 - b_t t_t h_t^3) + \frac{t}{4}(d_c^4 - d_t^4)}{I_y} \right)$$

where:

h_s $= \left(h - \frac{t_c + t_t}{2} \right)$

d_c $= h_c - t_c / 2$

d_t $= h_t - t_t / 2$

I_{zc} $= b_c^3 t_c / 12$

I_{zt} $= b_t^3 t_t / 12$

h_c is the distance from the centre of the compression flange to the centroid of the section

h_t is the distance from the centre of the tension flange to the centroid of the section

b_c	is the width of the compression flange
b_t	is the width of the tension flange
t_c	is the thickness of the compression flange
t_t	is the thickness of the tension flange.

For ASB sections $t_c = t_t$ and this is shown as t_f in the tables.

3.3 Hollow sections

Section properties are given for both hot-finished and cold-formed hollow sections (but not for cold-formed elliptical hollow sections). For the same overall dimensions and wall thickness, the section properties for square and rectangular hot-finished and cold-formed sections are different because the corner radii are different.

3.3.1 Common properties

For general comment on second moment of area, radius of gyration, elastic and plastic modulus, see Sections 3.2.1, 3.2.2, 3.2.3 and 3.2.4.

For hot-finished square and rectangular hollow sections, the section properties have been calculated using corner radii of 1.5*t* externally and 1.0*t* internally, as specified by BS EN 10210-2[52].

For cold-formed square and rectangular hollow sections, the section properties have been calculated using the external corner radii of 2*t* if $t \le 6$ mm, 2.5*t* if 6 mm $< t \le 10$ mm and 3*t* if $t > 10$ mm, as specified by BS EN 10219-2[54]. The internal corner radii used are 1.0*t* if $t \le 6$ mm, 1.5*t* if 6 mm $< t \le 10$ mm and 2*t* if $t > 10$ mm, as specified by BS EN 10219-2[54].

3.3.2 Plastic section modulus of hollow sections (W_{pl})

The plastic section moduli (W_{pl}) about both principal axes are given in the tables.

3.3.3 Torsional constant (I_T)

For circular hollow sections:

$$I_T = 2I$$

For square, rectangular and elliptical hollow sections:

$$I_T = \frac{4A_p^{\,2}t}{p} + \frac{t^3 p}{3}$$

where:

I is the second moment of area of a CHS

t is the thickness of the section

p is the mean perimeter length

For square and rectangular hollow sections: $p = 2\,[(b - t) + (h - t)] - 2\,R_c\,(4 - \pi)$

For elliptical hollow sections: $p = \frac{\pi}{2}(h + b - 2t)\left(1 + 0.25\left(\frac{h - b}{h + b - 2t}\right)^2\right)$

A_p is the area enclosed by the mean perimeter

For square and rectangular hollow sections: $A_p = (b - t)\,(h - t) - R_c^{\,2}\,(4 - \pi)$

For elliptical hollow sections: $A_p = \frac{\pi(h-t)(b-t)}{4}$

R_c is the average of the internal and external corner radii

3.3.4 Torsional section modulus (W_t)

$W_t = 2W_{el}$ for circular hollow sections

$$W_t = \frac{I_T}{\left(t + \frac{2A_p}{p}\right)}$$ for square, rectangular and elliptical hollow sections

where:

W_{el} is the elastic modulus and I_T, t, A_p and p are as defined in Section 3.3.3.

4 INTRODUCTION TO RESISTANCE TABLES

Reference

4.1 General

EN 1993-1-1 unless otherwise noted

The design resistances given in the tables have been calculated using exact values of the section properties calculated from the specified dimensions. The values obtained have then been rounded to 3 significant figures.

Design resistance tables are given for steel grades S275 and S355. The scope of the resistance tables follows that originally adopted in the BCSA publication *Structural Steelwork Handbook*. Where further information is required, including resistances of both hot finished and cold formed structural hollow sections, reference should be made to the comprehensive publication P363 *Steel Building Design: Deign Data*[59] (the Blue Book).

The following partial factors for resistance have been used throughout the publication for the calculation of the design resistances. The values are those given in the relevant UK National Annexes to Eurocode 3:

$\gamma_{M0} = 1.0$ for the resistance of cross-sections

$\gamma_{M1} = 1.0$ for the resistance of members

$\gamma_{M2} = 1.25$ for bolts

$\gamma_{M2} = 1.25$ for welds

$\gamma_{M3} = 1.25$ for slip resistance at ULS

$\gamma_{M3,ser} = 1.1$ for slip resistance at SLS

4.2 Yield strength

The member resistance tables are based on the following values of yield strength f_y. 3.2.1

Steel Grade	Maximum Thickness less than or equal to (mm)	Yield strength f_y (N/mm^2)
S275	16	275
	40	265
	63	255
	80	245
S355	16	355
	40	345
	63	335
	80	325

EN 10025-2

EN 10210-1

EN 10219-1

The above values are those given in the product standards BS 10025-2:2004 for open sections, BS EN 10210-1:2006 for hot-finished hollow sections and BS EN 10219-1:2006 for cold-formed hollow sections. The use of the values in the product standards is specified in the National Annex to BS EN 1993-1-1.

5 BENDING TABLES

5.1 Bending: UB, UC joists and parallel flange channels

(a) The design shear resistance

6.2.6 (1), (2)

The design shear resistance $V_{c,Rd}$ is given by:

$$V_{c,Rd} = V_{pl,Rd} = \frac{A_v \left(\frac{f_y}{\sqrt{3}} \right)}{\gamma_{M0}}$$

where:

A_v is the shear area
for rolled sections, $A_v = A - 2bt_f + (t_w + 2r)\, t_f$ but not less than $\eta h_w t_w$
for parallel flange channels, $A_v = A - 2bt_f + (t_w + r)\, t_f$

f_y is the yield strength

γ_{M0} is the partial factor for resistance of cross-sections (γ_{M0} = 1.0 as given in the National Annex).

(b) Design resistance of cross-section

The design resistance for bending about the major axes of the cross-section is given by: 6.2.8 (2)

(i) For Class 1, 2 cross-sections:

$$M_{c,y,Rd} = \frac{W_{pl,y}\, f_y}{\gamma_{M0}}$$

(ii) For Class 3 cross-sections with a Class 1 or 2 flange:

$$M_{c,y,Rd} = \frac{W_{pl,eff,y}\, f_y}{\gamma_{M0}}$$

where $W_{pl,eff,y}$ is calculated according to BS EN 1993-1-5, 4.4.

(iii) For other Class 3 cross-sections:

$$M_{c,y,Rd} = \frac{W_{el,y}\, f_y}{\gamma_{M0}}$$

Note:

- Where the design shear force is high (> 50% of the shear resistance), a reduced value of resistance for bending $M_{v,y,Rd}$ should be calculated. The quoted values of $M_{c,y,Rd}$ assume that the shear force is not high.

(c) Ultimate UDL resistances for restrained beams

The ultimate UDL for restrained beams is given for a range of beam lengths. The values take account of reductions due to high shear (if necessary) and the shear resistance of the section. 6.2.8

In the presence of high shear, the reduced moment resistance is calculated as: 6.2.8(5)

$$M_{y,V,Rd} = \frac{\left[W_{pl,y} - \frac{\rho A_w^{\ 2}}{4t_w}\right] f_y}{\gamma_{M0}}$$

where:

$A_w \quad = h_w t_w$

$$\rho = \left(\frac{2V_{Ed}}{V_{pl,Rd}} - 1\right)^2$$

Deflections at SLS have been calculated assuming that the characteristic (unfactored) value of the variable action is 40% of the ultimate load.

If the design combination of actions is determined using expression 6.10 of BS EN 1990, the ultimate load is given by:

$1.35g + 1.5q$

where:

g is the permanent action

q is the variable action

If $g = 3.6$ kN/m and $q = 5$ kN/m, the design combination of actions becomes:

$1.35 \times 3.6 + 1.5 \times 5 = 12.36$ kN/m

In this case, the unfactored variable actions are 5/12.36 = 0.4 or 40% of the ultimate load.

6 RESISTANCE TO TRANSVERSE FORCES TABLES (WEB BEARING AND BUCKLING)

6.1 UB sections, UC sections, joists and parallel flange channels

(a) The design shear resistance

The design shear resistance is calculated as described in Section 5.1(a)

(b) Design resistance to local buckling

EN 1993-1-5

The design resistance of an unstiffened web, F_{Rd}, to local buckling under transverse forces is given by: 6.2 (1)

$$F_{Rd} = \frac{f_y L_{eff} t_w}{\gamma_{M1}}$$

where:

f_y is the yield strength

t_w is the thickness of the web

L_{eff} is the effective length for resistance to transverse force ($= \chi_F \ell_y$)

$\chi_F = \frac{0.5}{\bar{\lambda}_F} \leq 1.0$

ℓ_y is the effective loaded length

γ_{M1} is the partial factor for resistance of members ($\gamma_{M1} = 1.0$ as given in the National Annex)

$\bar{\lambda}_F = \sqrt{\frac{\ell_y t_w f_y}{F_{cr}}}$

$F_{cr} = 0.9 k_F E \frac{t_w^3}{h_w}$ Figure 6.1

$k_F = 2 + 6\left(\frac{s_s + c}{h_w}\right)$ but $k_F \leq 6$

h_w is the depth between flanges $= h - 2t_f$

s_s is the length of stiff bearing (see figure 6.2 of BS EN 1993-1-5)

c is the distance from the end of the stiff bearing to the end of the section.

The effective loaded length ℓ_y has been calculated as the least value given by the following three expressions:

$$\ell_{y1} = s_s + 2t_f\left(1 + \sqrt{m_1 + m_2}\right) \quad \text{Eq (6.10)}$$

$$\ell_{y2} = \ell_e + t_f\sqrt{\frac{m_1}{2} + \left(\frac{\ell_e}{t_f}\right)^2 + m_2} \quad \text{Eq (6.11)}$$

$$\ell_{y3} = \ell_e + t_f\sqrt{m_1 + m_2} \quad \text{Eq (6.12)}$$

where:

$$\ell_e = \frac{k_F E t_w^2}{2 f_y h_w} \leq s_s + c \qquad \text{Eq (6.13)}$$

$$m_1 = \frac{b_f}{t_w}$$

$$m_2 = 0.02\left(\frac{h_w}{t_f}\right)^2 \qquad \text{if } \bar{\lambda}_F > 0.5$$

$$m_2 = 0 \qquad \text{if } \bar{\lambda}_F \leq 0.5$$

(Note that, at present, BS EN 1993-1-5, 6.5(3) erroneously refers to Equations 6.11, 6.12 and 6.13. This error is due to be corrected by CEN.)

Values of F_{Rd} have been calculated for two values of c, where c is the distance from the end of the member to the adjacent edge of the stiff bearing length, as shown in Figure 6.1 of EN 1993-1-5. The values are: EN 1993-1-5 6.1 (4)

$c = 0$ for a stiff bearing positioned at the end of the section

$c = c_{lim}$ for a stiff bearing positioned at a distance c_{lim} from the end of the section. This position represents the minimum value of c at which the maximum resistance of the web for a given stiff bearing length, s_s is attained.

where:

$$c_{lim} = \max\left(c_{buckling} ; c_{bearing}\right)$$

$$c_{buckling} = \frac{2h_w}{3} - s_s$$

$$c_{bearing} = 2t_f + t_f\sqrt{m_1 + m_2}$$

For the case where the stiff bearing is positioned at an intermediate distance (i.e. $c < c_{lim}$) the resistance given for $c = 0$ is conservative.

7 TENSION TABLES

EN 1993-1-1 6.2.3

7.1 Tension members: Single angles

For angles in tension connected through one leg, BS EN 1993-1-1, 6.2.3(5) refers to BS EN 1993-1-8, 3.10.3. However the Eurocode does not cover the case of more than one bolt in the direction perpendicular to the applied load. Therefore the resistance has been calculated using expressions from BS 5950-1 for angles bolted and welded through one leg. The resistance is independent of the number of bolts along the angle and their spacing. Tables only give values for the cross-sectional check; see AD351[58] for more information.

The value of the design resistance to tension $N_{t,Rd}$ has been calculated as follows: 6.2.3(2)

$$N_{t,Rd} = \frac{A_{eq} f_y}{\gamma_{M0}}$$

where:

A_{eq} is the equivalent tension area of the angle

f_y is the yield strength

γ_{M0} is the partial factor for resistance of cross-sections (γ_{M0} = 1.0, as given in the National Annex).

The equivalent tension area of the section A_{eq} is given by:

For bolted sections: $A_{eq} = A_e - 0.5a_2$

For welded sections: $A_{eq} = A_e - 0.3a_2$

where:

$A_e = a_{e1} + a_{e2}$ but $A_e \leq 1.2\,(a_{n1} + a_{n2})$

$a_{e1} = K_e\,a_{n1}$ but $a_{e1} \leq a_1$

$a_{e2} = K_e\,a_{n2}$ but $a_{e2} \leq a_2$

K_e = 1.2 for grade S275
= 1.1 for grade S355

$a_{n1} = a_1 - n_{bolts}\,d_0 t$

$a_1 = h \times t$ if the long leg is connected
$= b \times t$ if the short leg is connected

n_{bolts} is the number of bolts across the angle

d_0 is the diameter of the hole

$a_{n2} = a_2$

$a_2 = A - a_1$

A is the gross area of a single angle.

Note: A block tearing check (BS EN 1993-1-8, 3.10.2) is also required for tension members. However, block tearing resistances have not been tabulated, as there are too many variables in the possible bolt arrangements.

8 COMPRESSION TABLES

8.1 Compression members: UB and UC sections 6.2.4

(a) Design resistance of the cross-section $N_{c,Rd}$ 6.2.4 (2)

The design resistance is given by:

(i) For Class 1, 2 or 3 cross-sections:

$$N_{c,Rd} = \frac{A\,f_y}{\gamma_{M0}}$$

(ii) For Class 4 cross-sections:

$$N_{c,Rd} = \frac{A_{eff}\,f_y}{\gamma_{M0}}$$

where:

A is the gross area of the cross-section

f_y is the yield strength

A_{eff} is the effective area of the cross-section in compression

γ_{M0} is the partial factor for resistance of cross-sections (γ_{M0} = 1.0 as given in the National Annex)

For Class 1, 2 and 3 cross-sections the value of $N_{c,Rd}$ is the same as the plastic resistance, $N_{pl,Rd}$ given in the tables for axial force and bending, and is therefore not given in the compression tables.

For Class 4 sections the value of $N_{c,Rd}$ can be calculated using the effective areas tabulated in section B of this publication. The values are not shown in the tables.

None of the universal columns are Class 4 under axial compression alone according to BS EN 1993-1-1, but some universal beams are Class 4 and these sections are marked thus *.

The sections concerned are UB where the width to thickness ratio for the web in compression is: Table 5.2

$c / t = d / t_w > 42\varepsilon$

where:

d is the depth of straight portion of the web (i.e. the depth between fillets)

t_w is the thickness of the web

ε $= (235/f_y)^{0.5}$

f_y is the yield strength.

(b) Design buckling resistance 6.3.1.1

Design buckling resistances for two modes of buckling are given in the tables:

- Flexural buckling resistance, about each of the two principal axes: $N_{b,y,Rd}$ and $N_{b,z,Rd}$
- Torsional buckling resistance, $N_{b,T,Rd}$

No resistances are given for torsional-flexural buckling because this mode of buckling does not occur in doubly symmetrical cross-sections.

(i) Design flexural buckling resistance, $N_{b,y,Rd}$ and $N_{b,z,Rd}$

The design flexural buckling resistances $N_{b,y,Rd}$ and $N_{b,z,Rd}$ depend on the non-dimensional slenderness ($\bar{\lambda}$), which in turn depends on:

- The buckling lengths (L_{cr}) given at the head of the table
- The properties of the cross-section.

The non-dimensional slenderness has been calculated as follows: 6.3.1.3

For Class 1, 2 or 3 cross-sections:

$$\bar{\lambda}_y = \frac{L_{cr,y}}{93.9\varepsilon i_y} \qquad \text{for } y\text{-}y \text{ axis buckling}$$

$$\bar{\lambda}_z = \frac{L_{cr,z}}{93.9\varepsilon i_z} \qquad \text{for } z\text{-}z \text{ axis buckling}$$

For Class 4 cross-sections:

$$\bar{\lambda}_y = \frac{L_{cr,y}}{93.9\varepsilon i_y}\sqrt{\frac{A_{eff}}{A}} \qquad \text{for } y\text{-}y \text{ axis buckling}$$

$$\bar{\lambda}_z = \frac{L_{cr,z}}{93.9\varepsilon i_z}\sqrt{\frac{A_{eff}}{A}} \qquad \text{for } z\text{-}z \text{ axis buckling}$$

where:

$L_{cr,y}$, $L_{cr,z}$ are the buckling lengths for the *y-y* and *z-z* axes respectively

i_y, i_z are the radii of gyration about *y-y* and *z-z* axes respectively.

The tabulated buckling resistance is only based on Class 4 cross-section properties if this value of force is sufficient to make the cross-section Class 4 under combined axial force and bending. The value of n (= $N_{Ed}/N_{pl,Rd}$) at which the cross-section becomes Class 4 is shown in the tables for axial force and bending. Otherwise, the buckling resistance is based on Class 3 cross-section properties. Tabulated values based on the Class 4 cross-section properties are printed in italic type.

An example is given below:

533 × 210 × 101 UB S275

For this section, $c/t = d/t_w = 44.1 > 42\varepsilon = 39.6$

Hence, the cross-section is Class 4 under compression alone.

The value of axial force at which the section becomes Class 4 is $N_{Ed} = 2890$ kN (see axial force and bending table, where $n = 0.845$ and $N_{pl,Rd} = 3420$ kN).

For $L_{cr,y} = 4$ m, $N_{b,y,Rd} = 3270$ kN

The table shows *3270* kN in italic type because the value is greater than the value at which the cross-section becomes Class 4

For $L_{cr,y} = 14$ m, $N_{b,y,Rd} = 2860$ kN

The table shows 2860 kN in normal type because the value is less than the value at which cross–section becomes Class 4 (2890 kN).

(ii) Design torsional buckling resistance, $N_{b,T,Rd}$

The design torsional buckling resistance $N_{b,T,Rd}$ depends on the non-dimensional slenderness ($\bar{\lambda}_T$), which in turn depends on: 6.3.1.4

- The buckling lengths (L_{cr}) given at the head of the table
- The properties of the cross-section.

The non-dimensional slenderness has been calculated as follows:

$$\bar{\lambda}_{T} = \sqrt{\frac{A f_{y}}{N_{cr,T}}}$$ for Class 1, 2 or 3 cross-sections

$$\bar{\lambda}_{T} = \sqrt{\frac{A_{eff} f_{y}}{N_{cr,T}}}$$ for Class 4 cross-sections

where:

$N_{cr,T}$ is the elastic torsional buckling force, given by $\frac{1}{i_0^{2}}\left(GI_{T} + \frac{\pi^{2} EI_{w}}{L_{cr}^{2}}\right)$ — Access Steel document SN001[64]

where:

$i_0 = \sqrt{i_y^2 + i_z^2 + y_0^2}$

y_0 is the distance from the shear centre to the centroid of the gross cross-section along the *y-y* axis (zero for doubly symmetric sections).

(c) Design buckling resistance — 6.3.1.1

Design buckling resistances for flexural buckling are given in the tables.

The design flexural buckling resistances $N_{b,y,Rd}$ and $N_{b,z,Rd}$ depend on the non-dimensional slenderness ($\bar{\lambda}$), which in turn depends on:

- The buckling lengths (L_{cr}) given at the head of the table
- The properties of the cross-section.

The non-dimensional slenderness has been calculated as follows: 6.3.1.3

For Class 1, 2 or 3 cross-sections:

$$\bar{\lambda}_{y} = \frac{L_{cr,y}}{93.9 \varepsilon i_{y}}$$ for *y-y* axis buckling

$$\bar{\lambda}_{z} = \frac{L_{cr,z}}{93.9 \varepsilon i_{z}}$$ for *z-z* axis buckling

For Class 4 cross-sections:

$$\bar{\lambda}_{y} = \frac{L_{cr,y}}{93.9 \varepsilon i_{y}} \sqrt{\frac{A_{eff}}{A}}$$ for *y-y* axis buckling

$$\bar{\lambda}_{z} = \frac{L_{cr,z}}{93.9 \varepsilon i_{z}} \sqrt{\frac{A_{eff}}{A}}$$ for *z-z* axis buckling

where:

$L_{cr,y}$, $L_{cr,z}$ are the buckling lengths for the *y-y* and *z-z* axes respectively.

i_y, i_z are the radii of gyration about the *y-y* and *z-z* axes respectively.

8.2 Compression members: parallel flange channels 6.2.4

(a) Design resistance of the cross-section $N_{c,Rd}$ 6.2.4(2)

The design resistance is given by:

$$N_{c,Rd} = \frac{A f_y}{\gamma_{M0}}$$

where:

A is the gross area of the cross-section

f_y is the yield strength

γ_{M0} is the partial factor for resistance of cross-sections (γ_{M0} = 1.0 as given in the National Annex).

The value of $N_{c,Rd}$ is the same as the plastic resistance, $N_{pl,Rd}$ given in the tables for axial force and bending, and is therefore not given in the compression tables.

(b) Design buckling resistance 6.3.1

Design buckling resistance values are given for the following cases:

- Single channel subject to concentric axial force
- Single channel connected only through its web, by two or more bolts arranged symmetrically in a single row across the web.

1. Single channel subject to concentric axial force

Design buckling resistances for two modes of buckling are given in the tables:

- Flexural buckling resistance about the two principal axes: $N_{b,y,Rd}$ and $N_{b,z,Rd}$
- Torsional or torsional-flexural buckling resistance, whichever is less, $N_{b,T,Rd}$

(i) Design flexural buckling resistance, $N_{b,y,Rd}$ and $N_{b,z,Rd}$

The design flexural buckling resistances $N_{b,y,Rd}$ and $N_{b,z,Rd}$ depend on the non-dimensional slenderness ($\bar{\lambda}$) which in turn depends on:

- The buckling lengths (L_{cr}) given at the head of the table
- The properties of the cross-section.
- The non-dimensional slenderness, which has been calculated as follows:

6.3.1.3

$$\bar{\lambda}_y = \frac{L_{cr,y}}{93.9 \varepsilon i_y} \quad \text{for } y\text{-}y \text{ axis buckling}$$

$$\bar{\lambda}_z = \frac{L_{cr,z}}{93.9 \varepsilon i_z} \quad \text{for } z\text{-}z \text{ axis buckling}$$

where:

$L_{cr,y}$, $L_{cr,z}$ are the buckling lengths for the *y-y* and *z-z* axes respectively.

(ii) Design torsional and torsional-flexural buckling resistance, $N_{b,T,Rd}$ 6.3.1.4

The resistance tables give the lesser of the torsional and the torsional-flexural buckling resistances. These resistances depend on the non-dimensional slenderness ($\bar{\lambda}_T$), which in turn depends on:

- The buckling lengths (L_{cr}) given at the head of the table
- The properties of the cross-section
- The non-dimensional slenderness, which has been calculated as follows:

$$\bar{\lambda}_T = \max\left(\sqrt{\frac{A f_y}{N_{cr,T}}};\sqrt{\frac{A f_y}{N_{cr,TF}}}\right)$$

where:

$N_{cr,T}$ is the elastic torsional buckling force, $= \dfrac{1}{i_0^{\,2}}\left(GI_T + \dfrac{\pi^2 EI_w}{L_{cr}^{\,2}}\right)$

$i_0 = \sqrt{i_y^{\,2} + i_z^{\,2} + y_0^{\,2}}$

y_0 is the distance along the y- axis from the shear centre to the centroid of the gross cross-section.

$N_{cr,TF}$ is the elastic torsional-flexural buckling force, $= A\sigma_{TF}$

$\sigma_{TF} = \dfrac{1}{2\beta}\left((\sigma_{Ey} + \sigma_T) - \sqrt{(\sigma_{Ey} + \sigma_T)^2 - 4\beta\sigma_{Ey}\sigma_T}\right)$

$\sigma_{Ey} = \dfrac{\pi^2 E}{(L_{ey}/i_y)^2}$

$\sigma_T = N_{cr,T}/A$

$\beta = 1 - (y_0/i_0)^2$

L_{ey} is the unrestrained length considering buckling about the y-y axis.

2. Single channel connected only through its web, by two or more bolts arranged symmetrically in a single row across the web

Design buckling resistances for two modes of buckling are given in the tables:

- Flexural buckling resistance about each of the two principal axes: $N_{b,y,Rd}$ and $N_{b,z,Rd}$ 6.3.1
- Torsional or torsional-flexural buckling resistance, whichever is less, $N_{b,T,Rd}$

(i) Design flexural buckling resistance, $N_{b,y,Rd}$ and $N_{b,z,Rd}$

The design flexural buckling resistances $N_{b,y,Rd}$ and $N_{b,z,Rd}$ depend on the non-dimensional slenderness ($\bar{\lambda}$), which in turn depends on:

- The system length (L) given at the head of the tables. L is the distance between intersections of the centroidal axes of the channel and the members to which it is connected.
- The properties of the cross-section.

- The non-dimensional slenderness, which has been calculated as follows:

$$\bar{\lambda}_y = \frac{L_y}{93.9\varepsilon i_y} \quad \text{for } y\text{-}y \text{ axis buckling}$$ Annex BB.1.2

$$\bar{\lambda}_{eff,z} \geq 0.5 + 0.7\bar{\lambda}_z \quad \text{where} \quad \bar{\lambda}_z = \frac{L_z}{93.9\varepsilon i_z} \quad \text{for } z\text{-}z \text{ axis buckling}$$

(Based on a similar rationale given in Annex BB.1.2 for angles)

where:

$L_{cr,y}$, $L_{cr,z}$	are the lengths between intersections
i_y, i_z	are the radii of gyration about the *y-y* and *z-z* axes.
ε	$= (235/f_y)^{0.5}$.

(ii) Design torsional and torsional-flexural buckling resistance, $N_{b,T,Rd}$ 6.3.1.4

The torsional and torsional-flexural buckling resistance has been calculated as given above for single channels subject to concentric force.

8.3 Compression members: single angles

(a) Design buckling resistance 6.3.1.1

Design buckling resistances for 2 modes of buckling, noted as F and T, are given in the tables:

- F: Flexural buckling resistance (taking torsional-flexural buckling effects into account), $N_{b,y,Rd}$ and $N_{b,z,Rd}$
- T: Torsional buckling resistance, $N_{b,T,Rd}$.

(i) Design flexural buckling resistance, $N_{b,y,Rd}$, $N_{b,z,Rd}$

The tables give the lesser of the design flexural buckling resistance and the torsional - flexural buckling resistance.

The design flexural buckling resistances $N_{b,y,Rd}$ and $N_{b,z,Rd}$ depend on the non-dimensional slenderness ($\bar{\lambda}_{eff}$), which in turn depends on:

- The system length (*L*) given at the head of the tables. *L* is the distance between intersections of the centroidal axes (or setting out line of the bolts) of the angle and the members to which it is connected.
- The properties of the cross-section.
- The non-dimensional slenderness, which has been calculated as follows:

For two or more bolts in standard clearance holes in line along the angle at each end or an equivalent welded connection, the slenderness has been taken as:

For Class 3 cross-sections:

$$\bar{\lambda}_{eff,y} = 0.5 + 0.7\bar{\lambda}_y \quad \text{where} \quad \bar{\lambda}_y = \frac{L_y}{93.9\varepsilon i_y}$$ EN 1993-1-1 BB.1.2(2

$$\bar{\lambda}_{eff,z} = 0.5 + 0.7\bar{\lambda}_z \quad \text{where} \quad \bar{\lambda}_z = \frac{L_z}{93.9\varepsilon i_z}$$

$$\bar{\lambda}_{\text{eff,v}} = 0.35 + 0.7\,\bar{\lambda}_{\text{v}} \quad \text{where} \quad \bar{\lambda}_{\text{v}} = \frac{L_{\text{v}}}{93.9\,\varepsilon\, i_{\text{v}}}$$

For Class 4 cross-sections:

$$\bar{\lambda}_{\text{eff,y}} = 0.5 + 0.7\,\bar{\lambda}_{\text{y}} \quad \text{where} \quad \bar{\lambda}_{\text{y}} = \frac{L_{\text{y}}}{93.9\,\varepsilon\, i_{\text{y}}}\sqrt{\frac{A_{\text{eff}}}{A}}$$

$$\bar{\lambda}_{\text{eff,z}} = 0.5 + 0.7\,\bar{\lambda}_{\text{z}} \quad \text{where} \quad \bar{\lambda}_{\text{z}} = \frac{L_{\text{z}}}{93.9\,\varepsilon\, i_{\text{z}}}\sqrt{\frac{A_{\text{eff}}}{A}}$$

$$\bar{\lambda}_{\text{eff,v}} = 0.35 + 0.7\,\bar{\lambda}_{\text{v}} \quad \text{where} \quad \bar{\lambda}_{\text{v}} = \frac{L_{\text{v}}}{93.9\,\varepsilon\, i_{\text{v}}}\sqrt{\frac{A_{\text{eff}}}{A}}$$

where:

L_y, L_z and L_v are the system lengths between intersections.

These expressions take account of the torsional flexural buckling effects as well as the flexural buckling effects.

For the case of a single bolt at each end, BS EN 1993-1-1 refers the user to 6.2.9 to take account of the eccentricity. (Note: no values are given for this case).

(ii) Design torsional buckling resistance, $N_{b,T,Rd}$

The design torsional buckling resistance $N_{b,T,Rd}$ depends on the non-dimensional slenderness ($\bar{\lambda}_T$), which in turn depends on: 6.3.1.3

- The system length (L) given at the head of the table
- The properties of the cross-section
- The non-dimensional slenderness, which has been calculated as follows:

$$\bar{\lambda}_{\text{T}} = \sqrt{\frac{A f_{\text{y}}}{N_{\text{cr,T}}}} \quad \text{for Class 1, 2 or 3 cross-sections}$$ 6.3.1.4(2)

$$\bar{\lambda}_{\text{T}} = \sqrt{\frac{A_{\text{eff}} f_{\text{y}}}{N_{\text{cr,T}}}} \quad \text{for Class 4 cross-sections}$$

where:

$N_{cr,T}$ is the elastic torsional buckling force $= \dfrac{AGI_{\text{T}}}{I_0}$

$G = \dfrac{E}{2(1+\nu)}$ is the shear modulus

E	is the modulus of elasticity
ν	is Poisson's ratio (= 0.3)
I_T	is the torsional constant
I_0	$= I_u + I_v + A\left(u_0^2 + v_0^2\right)$
I_u	is the second moment of area about the *u-u* axis
I_v	is the second moment of area about the *v-v* axis
u_0	is the distance from shear centre to the *v-v* axis
v_0	is the distance from shear centre to the *u-u* axis.

9 BENDING TABLES

In this publication, separate tables of lateral-torsional buckling resistance are not provided. Lateral torsional buckling resistances can be obtained from the tables of Axial force and Bending resistance (see Section 10), for a range of buckling lengths.

It should be noted that the lateral-torsional buckling resistances ($M_{b,Rd}$) conservatively assume that the factor C_1 factor = 1.0.

Lateral-torsional buckling resistances for a range of C_1 factors may be obtained from Reference 59.

10 AXIAL FORCE & BENDING TABLES

EN 1993-1-1

Generally, members subject to axial compression forces and bending should be verified for cross-section resistance (BS EN 1993-1-1, 6.2.9) and for member buckling resistance (BS EN 1993-1-1, 6.3.3(4)).

The relevant parameters required to evaluate the interaction equations given in the above clauses are presented in tabular form.

The tables are applicable to members subject to combined tension and bending and to members subject to combined compression and bending. However, the values in the tables are conservative for tension, as the more onerous compression section classification limits have been used for calculating resistances to axial force.

Tables are given for cross-section resistances and for member buckling resistances, as explained below.

10.1 Axial force and bending: UB sections, UC sections, joists and parallel flange channels

6.2.9

10.1.1 Cross-section resistance check

For Class 1,2 and 3 cross-sections the following conservative approximation may be used: 6.2.1(7)

$$\frac{N_{Ed}}{N_{pl,Rd}} + \frac{M_{y,Ed}}{M_{c,y,Rd}} + \frac{M_{z,Ed}}{M_{c,z,Rd}} \leq 1.0 \qquad \text{Eq (6.2)}$$

Values of $N_{pl,Rd}$, $M_{c,y,Rd}$ and $M_{c,z,Rd}$ are given in the tables. The section classification depends on the axial force applied and therefore $M_{c,Rd}$ values are given for different values of $N_{Ed}/N_{pl,Rd}$. The values of these resistances have been calculated as given in the following sections.

No values are given for combined axial force and bending on Class 4 sections. Refer to BS EN 1993-1-1, 6.2.9.3(2).

(a) Design resistance for axial force

$$N_{pl,Rd} = \frac{A f_y}{\gamma_{M0}}$$ Eq (6.6)

where:

A is the gross area of the cross-section

f_y is the yield strength

γ_{M0} is the partial factor for cross-sections ($\gamma_{M0} = 1.0$ as given in the National Annex).

(b) Design resistances for bending about the principal axes of the cross-section

The design resistances for bending about the major and minor axes, $M_{c,y,Rd}$ and $M_{c,z,Rd}$ have been calculated as in Section 8.1 using $W_{pl,y}$, $W_{el,y}$, $W_{pl,z}$ and $W_{el,z}$ as appropriate. No values are given for the reduced resistances in the presence of high shear. 6.2.5 (2)

$M_{c,Rd}$ values for Class 4 cross-sections are not given in the tables. For checks of Class 4 cross-sections, see BS EN 1993-1-1, 6.2.9.3(2).

The symbol ✕ indicates that the section is Class 4 for a given value of $N_{Ed}/N_{pl,Rd}$.

The symbol $ indicates that the section is Class 4 and that it would be overloaded due to compressive axial force alone i.e. the section is Class 4 and $N_{Ed} > A_{eff} f_y$ for the given value of $N_{Ed} / N_{pl,Rd}$.

The Class 2 and Class 3 limits for the section subject to bending and compression are the maximum values of $N_{Ed} / N_{pl,Rd}$ up to which the section is either Class 2 or Class 3 respectively. The Class 2 limit is given in bold type. 5.5.2 (8)

As an alternative to Equation (6.2) for Class 1 and 2 sections a less conservative criterion may be used as follows: 6.2.9.1(2)

$$M_{Ed} \leq M_{N,Rd}$$ Eq (6.31)

Values of $M_{N,Rd}$ are given in the tables.

(c) Design moment resistance about the *y-y* axis reduced due to axial force 6.2.9

The reduced moment resistance $M_{N,y,Rd}$ has been calculated as follows:

(i) Where both the following criteria are satisfied:

$$N_{Ed} \leq 0.25 N_{pl,Rd} \text{ and } N_{Ed} \leq \frac{0.5 h_w t_w f_y}{\gamma_{M0}}$$ Eq (6.33 and 6.34)

where:

h_w is the clear web depth between flanges $= h - 2t_f$ 6.2.9.1(4)

γ_{M0} is a partial factor ($\gamma_{M0} = 1.0$ as given in the National Annex).

The reduced design moment resistance is equal to the plastic resistance moment

$$M_{N,y,Rd} = M_{pl,y,Rd}$$

(ii) Where the above criteria are not satisfied the reduced design moment resistance is given by:

$$M_{N,y,Rd} = M_{pl,y,Rd}\left(\frac{1-n}{1-0.5\,a}\right) \quad \text{but} \quad \leq M_{pl,y,Rd} \qquad \text{Eq (6.36)}$$ 6.2.9.1(5)

where:

$M_{pl,y,Rd}$ is the plastic resistance moment about the y-y axis

n is the ratio $N_{Ed} / N_{pl,Rd}$

a $= (A - 2bt_f)/A$ but ≤ 0.5.

(d) Design moment resistance about the *z-z* axis reduced due to axial force

The reduced moment resistance $M_{N,z,Rd}$ has been calculated as follows:

(i) Where the following criteria is satisfied:

$$N_{Ed} \leq \frac{h_w\, t_w\, f_y}{\gamma_{M0}} \qquad \text{Eq (6.35)}$$ 6.2.9.1(4)

where:

h_w is the clear web depth between flanges $= h - 2t_f$

γ_{M0} is the partial factor for cross-sections ($\gamma_{M0} = 1.0$ as given in the National Annex)

In this case, no allowance has been made for the effect of the axial force on the plastic resistance moment about the *z-z* axis and the reduced design moment resistance in this case is equal to the plastic resistance moment

$$M_{N,z,Rd} = M_{pl,z,Rd}$$

(ii) Where the above criterion is not satisfied the reduced design moment resistance is given by: 6.2.9.1(5)

For $n \leq a$ $\quad M_{N,z,Rd} = M_{pl,z,Rd}$ Eq (6.37)

For $n > a$ $\quad M_{N,z,Rd} = M_{pl,z,Rd}\left[1 - \left(\frac{n-a}{1-a}\right)^2\right]$ but $\leq M_{pl,z,Rd}$ Eq (6.38) 6.2.9.5

where:

$M_{pl,z,Rd}$ is the plastic resistance moment about the *z-z* axis

n is the ratio $N_{Ed} / N_{pl,Rd}$

a is as given in (c)

Because the values of $M_{N,y,Rd}$ and $M_{N,z,Rd}$ are only valid for Class 1 and Class 2 sections, no values are shown when N_{Ed} / $N_{pl,Rd}$ exceeds the limit for a Class 2 section (shown as the symbol' – ' in the tables).

Reduced design moment resistances for parallel flange channels are not presented in the tables. This is because BS EN 1993-1-1, 6.2.9 does not specifically cover the requirements for parallel flange channels.

10.1.2 Member buckling check

Interaction equations (6.61) and (6.62) from BS EN 1993-1-1, 6.3.3(4) must be satisfied for members subject to combined axial compression and bending. To check these interaction equations the following parameters given in (a), (b) and (c) are needed:

(a) $\chi_y \dfrac{N_{Rk}}{\gamma_{M1}}$ and $\chi_z \dfrac{N_{Rk}}{\gamma_{M1}}$

These are given in the tables as $N_{b,y,Rd}$ and $N_{b,z,Rd}$. They are the compression resistances for buckling about the *y-y* and the *z-z* axis respectively. The adjacent N_{Ed} / $N_{pl,Rd}$ limit ensures that the section is not Class 4 and has been calculated as in Section 6.1.

(b) $\chi_{LT} \dfrac{M_{y,Rk}}{\gamma_{M1}}$

This term is given in the tables as $M_{b,Rd}$. Values are given for two N_{Ed} / $N_{pl,Rd}$ limits. The higher limit indicates when the section is Class 3 and the lower limit (in bold) indicates when the section is Class 2. $M_{b,Rd}$ is calculated using the appropriate modulus. In both cases it is conservatively assumed that $C_1 = 1.0$.

(c) $\dfrac{M_{z,Rk}}{\gamma_{M1}}$

$M_{z,Rk}$ may be based on the elastic or plastic modulus, depending on the section classification, as shown in Table 6.7 of BS EN 1993-1-1. Values of $f_y W_{el,z}$ are given. Values of $f_y W_{pl,z}$ are given as $M_{c,z,Rd}$ in the tables for cross-section resistance check. Values are quoted with $\gamma_{M1} = 1.0$, as given in the National Annex.

In addition, values of $f_y W_{el,y}$ and $N_{pl,Rd}$ are given in the tables for completeness.

According to the National Annex, either Annex A or Annex B of BS EN 1993-1-1 should be used to calculate the interaction factors *k* for UB, UC and joists. Annex B of BS EN 1993-1-1 should be used to calculate the interaction factors *k* for parallel flange channels

The symbol * denotes that the cross-section is Class 4 under axial compression only (due to the web becoming Class 4). None of the sections listed are Class 4 due to the flanges being Class 4. Under combined axial compression and bending, the class of the cross-section depends on the axial force, expressed in terms of n (= $N_{Ed}/N_{pl,Rd}$). Values of n are given, up to which the cross-section would be Class 2 or Class 3.

The limits in normal and bold type are the maximum values up to which the section is either Class 3 or Class 2, respectively. The tabulated resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

11 BOLTS AND WELDS

11.1 Bolt resistances

The types of bolts covered are:

- Classes 4.6, 8.8 and 10.9, as specified in BS EN ISO 4014[67], BS EN ISO 4016[69], BS EN ISO 4017[68] and BS EN ISO 4018[70], assembled with a nut conforming to BS EN ISO 4032[71] or BS EN ISO 4034[72]. Such bolts should be specified as also complying with BS EN 15048[62].
- Countersunk non-preloaded bolts as specified in BS 4933[66], assembled with a nut conforming to BS EN ISO 4032[71] or BS EN ISO 4034[72]. Such bolts should be specified as also complying with BS EN 15048[62] and, for grade 8.8 and grade 10.9, with the mechanical property requirements of BS EN ISO 898-1[73].
- Preloaded bolts as specified in BS EN 14399[61]. In the UK, either system HR bolts to BS EN 14399-3 or HRC bolts to EN 14399-10 should be used, with appropriate nuts and washers (including direct tension indicators to BS EN 14399-9, where required). Countersunk bolts to BS EN 14399-7 may alternatively be used. Bolts should be tightened in accordance with BS EN 1090-2[60].

(a) Non-Preloaded Hexagon Head bolts and Countersunk bolts

For each grade:

- The first table gives the tensile stress area, the design tension resistance, the design shear resistance and the minimum thickness of ply passed through in order to avoid failure due to punching shear.
- The second table (and where applicable the third table) gives the design bearing resistance for the given bolt configurations.

(i) The values of the tensile stress area A_s are those given in the relevant product standard.

(ii) The design tension resistance of a bolt is given by: Table 3.4

$$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}}$$

where:

k_2 = 0.63 for countersunk bolts
= 0.9 for other bolts

f_{ub} is the ultimate tensile strength of the bolt from the relevant product standard

A_s is the tensile stress area of the bolt

γ_{M2} is the partial factor for bolts (γ_{M2} = 1.25, as given in the National Annex).

(iii) The shear resistance of the bolt is given by:

$$F_{v,Rd} = \frac{\alpha_v f_{ub} A_s}{\gamma_{M2}}$$ Table 3.4

where:

α_v = 0.6 for Classes 4.6 and 8.8

= 0.5 for Class 10.9

f_{ub} is the ultimate tensile strength of the bolt

A_s is the tensile stress area of the bolt.

(iv) The punching shear resistance is expressed in terms of the minimum thickness of the ply for which the design punching shear resistance would be equal to the design tension resistance. The value has been derived from the expression for the punching shear resistance given in BS EN 1993-1-8, table 3.4. The minimum thickness is given by: Table 3.4

$$t_{min} = \frac{B_{p,Rd}\, \gamma_{M2}}{0.6 \pi\, d_m\, f_u}$$

where:

$B_{p,Rd} = F_{t,Rd}$

$F_{t,Rd}$ is the design tension resistance per bolt

d_m has been taken as:

Bolt	d_m (mm)
M 12	18.5
M 16	23.2
M 20	29.2
M 24	35.0
M 30	45.0

f_u is the ultimate tensile strength of the ply under the bolt head or nut

A_s is the tensile stress area of the bolt.

(v) The bearing resistance of a bolt is given by:

$$F_{b,Rd} = \frac{k_1\, \alpha_b\, f_u\, d\, t}{\gamma_{M2}}$$ Table 3.4

where:

k_1 $\min\left(2.8\frac{e_2}{d_0} - 1.7;\quad 1.4\frac{p_2}{d_0} - 1.7;\quad 2.5\right)$

e_2 is the edge distance measured perpendicular to the direction of load transfer

p_2 is the gauge measured perpendicular to the direction of load transfer

d_0 is the hole diameter

α_b $\min\left(\frac{e_1}{3d_0};\quad \frac{p_1}{3d_0} - \frac{1}{4};\quad \frac{f_{ub}}{f_u};\quad 1.0\right)$

f_{ub} is the ultimate tensile strength of the bolt

f_u is the ultimate tensile strength of the ply passed through

e_1 is the end distance measured in the direction of load transfer

p_1 is the pitch measured in the direction of load transfer

For countersunk bolts, the bearing resistance has been based on the thickness of the plate, minus half the depth of the countersinking. The depth of countersinking has been taken as half the bolt diameter, meaning the reduction in plate thickness is one quarter of the bolt diameter.

Bearing resistances have been calculated for end distances of $e_1 = 2d$ in the second table and $e_1 = 3d$ in the third table.

The values of e_2 in the second table are based on typical connections used in the UK and values of e_2 in the third for Class 8.8 and 10.9 bolts table have been chosen to give increased resistances.

The values of pitch, p_1 and p_2, have been chosen such that resistance values based on them are not more critical than those based on e_1 and e_2.

Clause 3.6.1(3) of BS EN 1993-1-8 states that where the threads do not comply with EN 1090 the relevant bolt resistances should be multiplied by a factor of 0.85.

Note 1 in Table 3.4 of BS EN 1993-1-8 gives the reduction factors that should to be applied to the bearing resistance for oversize holes and slotted holes.

(b) Preloaded hexagon head bolts and countersunk bolts at serviceability and ultimate limit states

(i) The tensile stress area, A_s, tension resistance, shear resistance, punching shear resistance and bearing resistance are calculated as given above.

When calculating the punching shear resistance for preloaded bolts, the following values of d_m have been taken:

Bolt	d_m (mm)
M 12	21.2
M 16	27.0
M 20	32.0
M 24	41.0
M 30	50.0

(ii) The tension resistance has been calculated as for non-preloaded bolts.

(iii) The bearing resistance has been calculated as for non-preloaded bolts.

(iv) The slip resistance of the bolt is given by: BS EN 1993-1-8, 3.9.1(1)

$$F_{s,Rd} = \frac{k_s n \mu}{\gamma_{M3,ser}} F_{p,C} \quad \text{at SLS}$$

$$F_{s,Rd} = \frac{k_s n \mu}{\gamma_{M3}} F_{p,C} \quad \text{at ULS}$$

where: Table 3.6

k_s is taken as 1.0

n is the number of friction surfaces Table 3.7

μ is the slip factor

Slip resistances for a range of slip factors, μ are provided. Designers should ensure the value selected is appropriate for the surfaces to be fastened, or should calculate revised resistances.

$F_{p,C}$ $= 0.7 f_{ub} A_s$ is the preloading force

γ_{M3} is the partial factor for slip resistance (According to the National Annex, $\gamma_{M3} = 1.25$ at ultimate limit state, and $\gamma_{M3,ser} = 1.1$ at serviceability limit state).

Tables are provided for connections which are non-slip at the serviceability state and those that are non-slip at the ultimate limit state. In both cases, according to BS EN 1993-1-8, 3.4.1, bearing resistance must be checked, and resistance values are provided for this purpose.

Note that for connections which are non-slip at the serviceability limit state, the slip resistance must be equal to or greater than the design force due to the SLS values of actions (i.e. not the design force due to ULS actions).

11.2 Welds

BS EN 1993-1-8
3.9.1(1)

Design resistances of fillet welds per unit length are tabulated. The design resistance of fillet welds will be sufficient if the following criteria are both satisfied: 4.5.3.3

$$\sqrt{\sigma_\perp^2 + 3\left(\tau_\perp^2 + \tau_{//}^2\right)} \leq \frac{f_u}{\beta_w \gamma_{M2}} \quad \text{and} \quad \sigma_\perp \leq 0.9 f_u / \gamma_{M2} \qquad \text{Eq (4.1)}$$

Each of these components of the stress in the weld can be expressed in terms of the longitudinal and transverse resistance of the weld per unit length as follows:

$$\sigma_\perp = \frac{F_{w,T,Ed} \sin\theta}{a}$$

$$\tau_\perp = \frac{F_{w,T,Ed} \cos\theta}{a}$$

$$\tau_{//} = \frac{F_{w,L,Ed}}{a}$$

Therefore:

$$\sqrt{\left(\frac{F_{\mathrm{w,T,Ed}}\ \sin\theta}{a}\right)^2 + 3\left[\left(\frac{F_{\mathrm{w,T,Ed}}\ \cos\theta}{a}\right)^2 + \left(\frac{F_{\mathrm{w,L,Ed}}}{a}\right)^2\right]} \le \frac{f_{\mathrm{u}}}{\beta_{\mathrm{w}}\gamma_{\mathrm{M2}}}$$

$$\frac{1}{a}\sqrt{F_{\mathrm{w,T,Ed}}{}^2\left(\sin^2\theta + 3\cos^2\theta\right) + 3F_{\mathrm{w,L,Ed}}{}^2} \le \frac{f_{\mathrm{u}}}{\beta_{\mathrm{w}}\gamma_{\mathrm{M2}}}$$

$$\frac{1}{a}\sqrt{F_{\mathrm{w,T,Ed}}{}^2\left(1 + 2\cos^2\theta\right) + 3F_{\mathrm{w,L,Ed}}{}^2} \le \frac{f_{\mathrm{u}}}{\beta_{\mathrm{w}}\gamma_{\mathrm{M2}}}$$

$$\frac{1}{a}\sqrt{\frac{F_{\mathrm{w,T,Ed}}{}^2}{K^2} + F_{\mathrm{w,L,Ed}}{}^2} \le \frac{f_{\mathrm{u}}}{\sqrt{3}\beta_{\mathrm{w}}\gamma_{\mathrm{M2}}} \qquad \text{with} \quad K = \sqrt{\frac{3}{\left(1 + 2\cos^2\theta\right)}}$$

From this equation, taking each of the components in turn as zero, the following expressions can be derived for the longitudinal and the transverse resistances of welds: BS EN 1993-1-8 4.5.3.3(2)

Design weld resistance, longitudinal: $F_{\mathrm{w,L,Rd}} = f_{\mathrm{vw,d}}\,a$

Design weld resistance, transverse: $F_{\mathrm{w,T,Rd}} = KF_{\mathrm{w,L,Rd}}$

where:

$f_{\mathrm{vw,d}}$ is the design shear strength of the weld $= \dfrac{f_{\mathrm{u}}}{\sqrt{3}\,\beta_{\mathrm{w}}\,\gamma_{\mathrm{M2}}}$ BS EN 1993-1-8 4.5.3.3(3)

f_{u} = 410 N/mm^2 for S275

= 470 N/mm^2 for S355

These values are valid for thicknesses up to 100mm

β_{w} = 0.85 for S275 BS EN 1993-1-8 Table 4.1

= 0.9 for S355

γ_{M2} is the partial factor for the resistance of welds (γ_{M2} = 1.25 according to the National Annex)

a is the throat thickness of the fillet weld

$$K = \sqrt{\frac{3}{\left(1 + 2\cos^2\theta\right)}}$$

The above expression for transverse weld resistance is valid where the plates are at 90° and therefore θ = 45° and K = 1.225.

12 SECTION DESIGNATIONS AND STEEL GRADES

12.1 Open Sections

The dimension and member resistance tables given in this publication are dual titled. The tables give the name of the section type, as given in the relevant British Standard (e.g. universal beams and universal columns, for I sections to BS 4-1 and equal leg angles and unequal leg angles to BS EN 10056-1), followed by the Tata Steel designation in their Advance® range of sections. An example of this dual titling is given below:

UNIVERSAL BEAMS

Advance® UKB

The Advance® range of sections encompasses all the UB, UC, Tee and PFC sections in BS 4-1 and most of the angle sections in BS EN 10056-1. The dimensions and properties of the Advance® sections are the same as those of the corresponding British Standard sections and the same standards for dimensional tolerance apply. The Advance® range also includes additional beam and column sections that are not in BS 4-1 and angle sections not in BS EN 10056-1; these are designated by '+' in the tables. These sections are manufactured to the same tolerances as those in the British Standards and the nominal dimensions may be taken as characteristic values and used in design.

The difference between Advance® sections and BS sections is that the Advance® sections are always CE Marked.

The table below shows the relationship between the BS 4-1 section designation and the section designation for the Advance® sections.

Comparison of section designation systems

BS designation		Tata Steel Advance® designation	
Universal beam	UB*	UK Beam	UKB
Universal column	UC*	UK Column	UKC
Parallel flange channel	PFC*	UK Parallel flange channel	UKPFC
Tee		UK Tee	UKT
Equal leg angle Unequal leg angle	L	UK Angle	UKA
* These abbreviations are commonly used but are not a BS designation			

Tables are also included for Asymmetric *Slimflor* Beams. These sections are manufactured by Tata Steel; they are part of the Advance® range and they are CE Marked. These beams are manufactured to the same tolerances as those in the British Standards and the nominal dimensions may be used for design.

Tables are included for joist sections to BS 4-1. These are not part of the Advance® range.

Where resistance tables cover Advance® sections, the steel grade is also dual titled. The strength grade designation in BS EN 10025-2: 2004 is given first, followed by the grade designation for the Advance® sections. An example of this dual titling of the steel grade is given below:

S275 / Advance® 275

The Advance® designation is a simplified designation that encompasses the specification to BS EN 10025 and the additional quality control procedures to ensure CE Marking. It also enables a shorter form of designating the grade when ordering. The table below shows the corresponding designations in the two systems.

Steel grade designations

BS Designation	Advance® Sections designation
BS EN 10025-2:2004 S275JR	Advance® 275JR
BS EN 10025-2:2004 S275J0	Advance® 275J0
BS EN 10025-2:2004 S275J2	Advance® 275J2
BS EN 10025-2:2004 S355JR	Advance® 355JR
BS EN 10025-2:2004 S355J0	Advance® 355J0
BS EN 10025-2:2004 S355J2	Advance® 355J2
BS EN 10025-2:2004 S355K2	Advance® 355K2

12.2 Hollow Sections

The dimension and section property tables given in this publication are dual titled. The tables give the name of the section type, as given in the relevant British Standard (e.g. Hot finished circular hollow section, for a circular section to BS EN 10210-2, and Cold formed square hollow section, for a square section to BS EN 10219-2), followed by the Tata Steel designation from the Celsius® range of hot finished sections or from the Hybox® range of high strength cold formed sections. An example of this dual titling for hot finished circular hollow sections is as follows:

HOT FINISHED CIRCULAR HOLLOW SECTIONS

Celsius® CHS

The tables include circular, square, rectangular and elliptical hollow sections available in the Celsius® and Hybox® ranges and the dimensional and sectional properties are either as tabulated in the Standards or are calculated in accordance with the Standards. The only difference between a section to BS EN 10210-2 or to BS EN 10219-2 and its equivalent Celsius® or Hybox® sections is that the Tata Steel section will always be CE Marked.

The table below shows the relationship between section designations in BS EN 10210: 2006 and BS EN 10219: 2006, and those for Celsius® and Hybox® sections produced by Tata Steel.

Comparison of designation systems for hollow sections

BS EN 10210: 2006	Tata Steel designation
Hot finished circular hollow section	Celsius® CHS
Hot finished square hollow section	Celsius® SHS
Hot finished rectangular hollow section	Celsius® RHS
Hot finished elliptical hollow section	Celsius® OHS
BS EN 10219: 2006	
Cold formed circular hollow section	Hybox® CHS
Cold formed square hollow section	Hybox® SHS
Cold formed rectangular hollow section	Hybox® RHS

In the resistance tables the steel grade is also dual titled. The strength grade designation given in BS EN 10210-1 or BS EN 10219-1 is given first, followed by the grade designation for the Celsius® or Hybox® sections. An example of this dual titling of the steel grade is given below:

S355 / Celsius® 355

In all cases, the mechanical properties of Celsius® or Hybox® hollow sections meet all the requirements given in BS EN 10210-1:2006 or BS EN 10219-1:2006, as appropriate. The table below shows the relationship between the steel grades given in the standards and those for Celsius® and Hybox® sections from Tata Steel.

Comparison of designations for hollow sections

BS Designation	Tata Steel designation
BS EN 10210-1:2006 S355J2H	Celsius® 355
BS EN 10219-1:2006 S355J2H	Hybox® 355

Note that a limited range of sections is also available in grade S355K2H – consult Tata Steel for availability.

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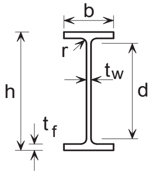
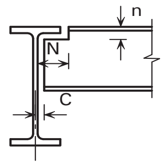
TABLES OF DIMENSIONS AND GROSS SECTION PROPERTIES

UNIVERSAL BEAMS

Advance® UKB





Dimensions

Section Designation	Mass per Metre kg/m	Depth of Section h mm	Width of Section b mm	Thickness Web t_w mm	Thickness Flange t_f mm	Root Radius r mm	Depth between Fillets d mm	Ratios for Local Buckling Flange c_f / t_f	Ratios for Local Buckling Web c_w / t_w	Dimensions for Detailing End Clearance C mm	Dimensions for Detailing Notch N mm	Dimensions for Detailing Notch n mm	Surface Area Per Metre m^2	Surface Area Per Tonne m^2
1016x305x487 +	486.7	1036.3	308.5	30.0	54.1	30.0	868.1	2.02	28.9	17	150	86	3.20	6.58
1016x305x437 +	437.0	1026.1	305.4	26.9	49.0	30.0	868.1	2.23	32.3	15	150	80	3.17	7.25
1016x305x393 +	392.7	1015.9	303.0	24.4	43.9	30.0	868.1	2.49	35.6	14	150	74	3.14	8.00
1016x305x349 +	349.4	1008.1	302.0	21.1	40.0	30.0	868.1	2.76	41.1	13	152	70	3.13	8.96
1016x305x314 +	314.3	999.9	300.0	19.1	35.9	30.0	868.1	3.08	45.5	12	152	66	3.11	9.89
1016x305x272 +	272.3	990.1	300.0	16.5	31.0	30.0	868.1	3.60	52.6	10	152	62	3.10	11.4
1016x305x249 +	248.7	980.1	300.0	16.5	26.0	30.0	868.1	4.30	52.6	10	152	56	3.08	12.4
1016x305x222 +	222.0	970.3	300.0	16.0	21.1	30.0	868.1	5.31	54.3	10	152	52	3.06	13.8
914x419x388	388.0	921.0	420.5	21.4	36.6	24.1	799.6	4.79	37.4	13	210	62	3.44	8.87
914x419x343	343.3	911.8	418.5	19.4	32.0	24.1	799.6	5.48	41.2	12	210	58	3.42	9.96
914x305x289	289.1	926.6	307.7	19.5	32.0	19.1	824.4	3.91	42.3	12	156	52	3.01	10.4
914x305x253	253.4	918.4	305.5	17.3	27.9	19.1	824.4	4.48	47.7	11	156	48	2.99	11.8
914x305x224	224.2	910.4	304.1	15.9	23.9	19.1	824.4	5.23	51.8	10	156	44	2.97	13.2
914x305x201	200.9	903.0	303.3	15.1	20.2	19.1	824.4	6.19	54.6	10	156	40	2.96	14.7
838x292x226	226.5	850.9	293.8	16.1	26.8	17.8	761.7	4.52	47.3	10	150	46	2.81	12.4
838x292x194	193.8	840.7	292.4	14.7	21.7	17.8	761.7	5.58	51.8	9	150	40	2.79	14.4
838x292x176	175.9	834.9	291.7	14.0	18.8	17.8	761.7	6.44	54.4	9	150	38	2.78	15.8
762x267x197	196.8	769.8	268.0	15.6	25.4	16.5	686.0	4.32	44.0	10	138	42	2.55	13.0
762x267x173	173.0	762.2	266.7	14.3	21.6	16.5	686.0	5.08	48.0	9	138	40	2.53	14.6
762x267x147	146.9	754.0	265.2	12.8	17.5	16.5	686.0	6.27	53.6	8	138	34	2.51	17.1
762x267x134	133.9	750.0	264.4	12.0	15.5	16.5	686.0	7.08	57.2	8	138	32	2.51	18.7
686x254x170	170.2	692.9	255.8	14.5	23.7	15.2	615.1	4.45	42.4	9	132	40	2.35	13.8
686x254x152	152.4	687.5	254.5	13.2	21.0	15.2	615.1	5.02	46.6	9	132	38	2.34	15.4
686x254x140	140.1	683.5	253.7	12.4	19.0	15.2	615.1	5.55	49.6	8	132	36	2.33	16.6
686x254x125	125.2	677.9	253.0	11.7	16.2	15.2	615.1	6.51	52.6	8	132	32	2.32	18.5
610x305x238	238.1	635.8	311.4	18.4	31.4	16.5	540.0	4.14	29.3	11	158	48	2.45	10.3
610x305x179	179.0	620.2	307.1	14.1	23.6	16.5	540.0	5.51	38.3	9	158	42	2.41	13.5
610x305x149	149.2	612.4	304.8	11.8	19.7	16.5	540.0	6.60	45.8	8	158	38	2.39	16.0
610x229x140	139.9	617.2	230.2	13.1	22.1	12.7	547.6	4.34	41.8	9	120	36	2.11	15.1
610x229x125	125.1	612.2	229.0	11.9	19.6	12.7	547.6	4.89	46.0	8	120	34	2.09	16.7
610x229x113	113.0	607.6	228.2	11.1	17.3	12.7	547.6	5.54	49.3	8	120	30	2.08	18.4
610x229x101	101.2	602.6	227.6	10.5	14.8	12.7	547.6	6.48	52.2	7	120	28	2.07	20.5
610x178x100 +	100.3	607.4	179.2	11.3	17.2	12.7	547.6	4.14	48.5	8	94	30	1.89	18.8
610x178x92 +	92.2	603.0	178.8	10.9	15.0	12.7	547.6	4.75	50.2	7	94	28	1.88	20.4
610x178x82 +	81.8	598.6	177.9	10.0	12.8	12.7	547.6	5.57	54.8	7	94	26	1.87	22.9
533x312x273 +	273.3	577.1	320.2	21.1	37.6	12.7	476.5	3.64	22.6	13	160	52	2.37	8.67
533x312x219 +	218.8	560.3	317.4	18.3	29.2	12.7	476.5	4.69	26.0	11	160	42	2.33	10.7
533x312x182 +	181.5	550.7	314.5	15.2	24.4	12.7	476.5	5.61	31.3	10	160	38	2.31	12.7
533x312x151 +	150.6	542.5	312.0	12.7	20.3	12.7	476.5	6.75	37.5	8	160	34	2.29	15.2

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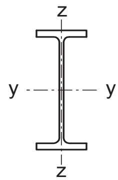
+ These sections are in addition to the range of BS 4 sections.

FOR EXPLANATION OF TABLES SEE NOTE 2

UNIVERSAL BEAMS

Advance® UKB



Properties

Section Designation	Second Moment of Area Axis y-y cm^4	Second Moment of Area Axis z-z cm^4	Radius of Gyration Axis y-y cm	Radius of Gyration Axis z-z cm	Elastic Modulus Axis y-y cm^3	Elastic Modulus Axis z-z cm^3	Plastic Modulus Axis y-y cm^3	Plastic Modulus Axis z-z cm^3	Buckling Parameter U	Torsional Index X	Warping Constant I_w dm^6	Torsional Constant I_T cm^4	Area of Section A cm^2
1016x305x487 +	1022000	26700	40.6	6.57	19700	1730	23200	2800	0.867	21.1	64.4	4300	620
1016x305x437 +	910000	23400	40.4	6.49	17700	1540	20800	2470	0.868	23.1	56.0	3190	557
1016x305x393 +	808000	20500	40.2	6.40	15900	1350	18500	2170	0.868	25.5	48.4	2330	500
1016x305x349 +	723000	18500	40.3	6.44	14300	1220	16600	1940	0.872	27.9	43.3	1720	445
1016x305x314 +	644000	16200	40.1	6.37	12900	1080	14800	1710	0.872	30.7	37.7	1260	400
1016x305x272 +	554000	14000	40.0	6.35	11200	934	12800	1470	0.872	35.0	32.2	835	347
1016x305x249 +	481000	11800	39.0	6.09	9820	784	11300	1240	0.861	39.9	26.8	582	317
1016x305x222 +	408000	9550	38.0	5.81	8410	636	9810	1020	0.850	45.7	21.5	390	283
914x419x388	720000	45400	38.2	9.59	15600	2160	17700	3340	0.885	26.7	88.9	1730	494
914x419x343	626000	39200	37.8	9.46	13700	1870	15500	2890	0.883	30.1	75.8	1190	437
914x305x289	504000	15600	37.0	6.51	10900	1010	12600	1600	0.867	31.9	31.2	926	368
914x305x253	436000	13300	36.8	6.42	9500	871	10900	1370	0.865	36.2	26.4	626	323
914x305x224	376000	11200	36.3	6.27	8270	739	9530	1160	0.860	41.3	22.1	422	286
914x305x201	325000	9420	35.7	6.07	7200	621	8350	982	0.853	46.9	18.4	291	256
838x292x226	340000	11400	34.3	6.27	7980	773	9160	1210	0.869	35.0	19.3	514	289
838x292x194	279000	9070	33.6	6.06	6640	620	7640	974	0.862	41.6	15.2	306	247
838x292x176	246000	7800	33.1	5.90	5890	535	6810	842	0.856	46.5	13.0	221	224
762x267x197	240000	8170	30.9	5.71	6230	610	7170	958	0.869	33.1	11.3	404	251
762x267x173	205000	6850	30.5	5.58	5390	514	6200	807	0.865	38.0	9.39	267	220
762x267x147	169000	5460	30.0	5.40	4470	411	5160	647	0.858	45.2	7.40	159	187
762x267x134	151000	4790	29.7	5.30	4020	362	4640	570	0.853	49.8	6.46	119	171
686x254x170	170000	6630	28.0	5.53	4920	518	5630	811	0.872	31.8	7.42	308	217
686x254x152	150000	5780	27.8	5.46	4370	455	5000	710	0.871	35.4	6.42	220	194
686x254x140	136000	5180	27.6	5.39	3990	409	4560	638	0.870	38.6	5.72	169	178
686x254x125	118000	4380	27.2	5.24	3480	346	3990	542	0.863	43.8	4.80	116	159
610x305x238	209000	15800	26.3	7.23	6590	1020	7490	1570	0.886	21.3	14.5	785	303
610x305x179	153000	11400	25.9	7.07	4930	743	5550	1140	0.885	27.7	10.2	340	228
610x305x149	126000	9310	25.7	7.00	4110	611	4590	937	0.886	32.7	8.17	200	190
610x229x140	112000	4510	25.0	5.03	3620	391	4140	611	0.875	30.6	3.99	216	178
610x229x125	98600	3930	24.9	4.97	3220	343	3680	535	0.875	34.0	3.45	154	159
610x229x113	87300	3430	24.6	4.88	2870	301	3280	469	0.870	38.0	2.99	111	144
610x229x101	75800	2910	24.2	4.75	2520	256	2880	400	0.863	43.0	2.52	77.0	129
610x178x100 +	72500	1660	23.8	3.60	2390	185	2790	296	0.854	38.7	1.44	95.0	128
610x178x92 +	64600	1440	23.4	3.50	2140	161	2510	258	0.850	42.7	1.24	71.0	117
610x178x82 +	55900	1210	23.2	3.40	1870	136	2190	218	0.843	48.5	1.04	48.8	104
533x312x273 +	199000	20600	23.9	7.69	6890	1290	7870	1990	0.891	15.9	15.0	1290	348
533x312x219 +	151000	15600	23.3	7.48	5400	982	6120	1510	0.884	19.8	11.0	642	279
533x312x182 +	123000	12700	23.1	7.40	4480	806	5040	1240	0.886	23.4	8.77	373	231
533x312x151 +	101000	10300	22.9	7.32	3710	659	4150	1010	0.885	27.8	7.01	216	192

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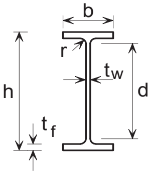
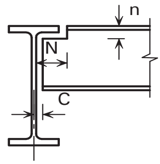
+ These sections are in addition to the range of BS 4 sections.

FOR EXPLANATION OF TABLES SEE NOTE 3

UNIVERSAL BEAMS

Advance® UKB





Dimensions

Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
533x210x138 +	138.3	549.1	213.9	14.7	23.6	12.7	476.5	3.68	32.4	9	110	38	1.90	13.7
533x210x122	122.0	544.5	211.9	12.7	21.3	12.7	476.5	4.08	37.5	8	110	34	1.89	15.5
533x210x109	109.0	539.5	210.8	11.6	18.8	12.7	476.5	4.62	41.1	8	110	32	1.88	17.2
533x210x101	101.0	536.7	210.0	10.8	17.4	12.7	476.5	4.99	44.1	7	110	32	1.87	18.5
533x210x92	92.1	533.1	209.3	10.1	15.6	12.7	476.5	5.57	47.2	7	110	30	1.86	20.2
533x210x82	82.2	528.3	208.8	9.6	13.2	12.7	476.5	6.58	49.6	7	110	26	1.85	22.5
533x165x85 +	84.8	534.9	166.5	10.3	16.5	12.7	476.5	3.96	46.3	7	90	30	1.69	19.9
533x165x75 +	74.7	529.1	165.9	9.7	13.6	12.7	476.5	4.81	49.1	7	90	28	1.68	22.5
533x165x66 +	65.7	524.7	165.1	8.9	11.4	12.7	476.5	5.74	53.5	6	90	26	1.67	25.4
457x191x161 +	161.4	492.0	199.4	18.0	32.0	10.2	407.6	2.52	22.6	11	102	44	1.73	10.7
457x191x133 +	133.3	480.6	196.7	15.3	26.3	10.2	407.6	3.06	26.6	10	102	38	1.70	12.8
457x191x106 +	105.8	469.2	194.0	12.6	20.6	10.2	407.6	3.91	32.3	8	102	32	1.67	15.8
457x191x98	98.3	467.2	192.8	11.4	19.6	10.2	407.6	4.11	35.8	8	102	30	1.67	17.0
457x191x89	89.3	463.4	191.9	10.5	17.7	10.2	407.6	4.55	38.8	7	102	28	1.66	18.6
457x191x82	82.0	460.0	191.3	9.9	16.0	10.2	407.6	5.03	41.2	7	102	28	1.65	20.1
457x191x74	74.3	457.0	190.4	9.0	14.5	10.2	407.6	5.55	45.3	7	102	26	1.64	22.1
457x191x67	67.1	453.4	189.9	8.5	12.7	10.2	407.6	6.34	48.0	6	102	24	1.63	24.3
457x152x82	82.1	465.8	155.3	10.5	18.9	10.2	407.6	3.29	38.8	7	84	30	1.51	18.4
457x152x74	74.2	462.0	154.4	9.6	17.0	10.2	407.6	3.66	42.5	7	84	28	1.50	20.2
457x152x67	67.2	458.0	153.8	9.0	15.0	10.2	407.6	4.15	45.3	7	84	26	1.50	22.3
457x152x60	59.8	454.6	152.9	8.1	13.3	10.2	407.6	4.68	50.3	6	84	24	1.49	24.9
457x152x52	52.3	449.8	152.4	7.6	10.9	10.2	407.6	5.71	53.6	6	84	22	1.48	28.3
406x178x85 +	85.3	417.2	181.9	10.9	18.2	10.2	360.4	4.14	33.1	7	96	30	1.52	17.8
406x178x74	74.2	412.8	179.5	9.5	16.0	10.2	360.4	4.68	37.9	7	96	28	1.51	20.4
406x178x67	67.1	409.4	178.8	8.8	14.3	10.2	360.4	5.23	41.0	6	96	26	1.50	22.3
406x178x60	60.1	406.4	177.9	7.9	12.8	10.2	360.4	5.84	45.6	6	96	24	1.49	24.8
406x178x54	54.1	402.6	177.7	7.7	10.9	10.2	360.4	6.86	46.8	6	96	22	1.48	27.3
406x140x53 +	53.3	406.6	143.3	7.9	12.9	10.2	360.4	4.46	45.6	6	78	24	1.35	25.3
406x140x46	46.0	403.2	142.2	6.8	11.2	10.2	360.4	5.13	53.0	5	78	22	1.34	29.1
406x140x39	39.0	398.0	141.8	6.4	8.6	10.2	360.4	6.69	56.3	5	78	20	1.33	34.1
356x171x67	67.1	363.4	173.2	9.1	15.7	10.2	311.6	4.58	34.2	7	94	26	1.38	20.6
356x171x57	57.0	358.0	172.2	8.1	13.0	10.2	311.6	5.53	38.5	6	94	24	1.37	24.1
356x171x51	51.0	355.0	171.5	7.4	11.5	10.2	311.6	6.25	42.1	6	94	22	1.36	26.7
356x171x45	45.0	351.4	171.1	7.0	9.7	10.2	311.6	7.41	44.5	6	94	20	1.36	30.2
356x127x39	39.1	353.4	126.0	6.6	10.7	10.2	311.6	4.63	47.2	5	70	22	1.18	30.2
356x127x33	33.1	349.0	125.4	6.0	8.5	10.2	311.6	5.82	51.9	5	70	20	1.17	35.4
305x165x54	54.0	310.4	166.9	7.9	13.7	8.9	265.2	5.15	33.6	6	90	24	1.26	23.3
305x165x46	46.1	306.6	165.7	6.7	11.8	8.9	265.2	5.98	39.6	5	90	22	1.25	27.1
305x165x40	40.3	303.4	165.0	6.0	10.2	8.9	265.2	6.92	44.2	5	90	20	1.24	30.8

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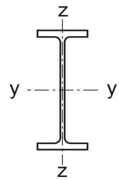
BS EN 1993-1-1:2005
BS 4-1:2005

UNIVERSAL BEAMS

Advance® UKB



Properties

Section Designation	Second Moment of Area Axis y-y cm^4	Second Moment of Area Axis z-z cm^4	Radius of Gyration Axis y-y cm	Radius of Gyration Axis z-z cm	Elastic Modulus Axis y-y cm^3	Elastic Modulus Axis z-z cm^3	Plastic Modulus Axis y-y cm^3	Plastic Modulus Axis z-z cm^3	Buckling Parameter U	Torsional Index X	Warping Constant I_w dm^6	Torsional Constant I_T cm^4	Area of Section A cm^2
533x210x138 +	86100	3860	22.1	4.68	3140	361	3610	568	0.874	24.9	2.67	250	176
533x210x122	76000	3390	22.1	4.67	2790	320	3200	500	0.878	27.6	2.32	178	155
533x210x109	66800	2940	21.9	4.60	2480	279	2830	436	0.875	30.9	1.99	126	139
533x210x101	61500	2690	21.9	4.57	2290	256	2610	399	0.874	33.1	1.81	101	129
533x210x92	55200	2390	21.7	4.51	2070	228	2360	355	0.873	36.4	1.60	75.7	117
533x210x82	47500	2010	21.3	4.38	1800	192	2060	300	0.863	41.6	1.33	51.5	105
533x165x85 +	48500	1270	21.2	3.44	1820	153	2100	243	0.861	35.5	0.857	73.8	108
533x165x75 +	41100	1040	20.8	3.30	1550	125	1810	200	0.853	41.1	0.691	47.9	95.2
533x165x66 +	35000	859	20.5	3.20	1340	104	1560	166	0.847	47.0	0.566	32.0	83.7
457x191x161 +	79800	4250	19.7	4.55	3240	426	3780	672	0.881	16.5	2.25	515	206
457x191x133 +	63800	3350	19.4	4.44	2660	341	3070	535	0.879	19.6	1.73	292	170
457x191x106 +	48900	2510	19.0	4.32	2080	259	2390	405	0.876	24.4	1.27	146	135
457x191x98	45700	2350	19.1	4.33	1960	243	2230	379	0.881	25.8	1.18	121	125
457x191x89	41000	2090	19.0	4.29	1770	218	2010	338	0.878	28.3	1.04	90.7	114
457x191x82	37100	1870	18.8	4.23	1610	196	1830	304	0.879	30.8	0.922	69.2	104
457x191x74	33300	1670	18.8	4.20	1460	176	1650	272	0.877	33.8	0.818	51.8	94.6
457x191x67	29400	1450	18.5	4.12	1300	153	1470	237	0.873	37.8	0.705	37.1	85.5
457x152x82	36600	1180	18.7	3.37	1570	153	1810	240	0.872	27.4	0.591	89.2	105
457x152x74	32700	1050	18.6	3.33	1410	136	1630	213	0.872	30.1	0.518	65.9	94.5
457x152x67	28900	913	18.4	3.27	1260	119	1450	187	0.868	33.6	0.448	47.7	85.6
457x152x60	25500	795	18.3	3.23	1120	104	1290	163	0.868	37.5	0.387	33.8	76.2
457x152x52	21400	645	17.9	3.11	950	84.6	1100	133	0.859	43.8	0.311	21.4	66.6
406x178x85 +	31700	1830	17.1	4.11	1520	201	1730	313	0.880	24.4	0.728	93.0	109
406x178x74	27300	1550	17.0	4.04	1320	172	1500	267	0.882	27.5	0.608	62.8	94.5
406x178x67	24300	1360	16.9	3.99	1190	153	1350	237	0.880	30.4	0.533	46.1	85.5
406x178x60	21600	1200	16.8	3.97	1060	135	1200	209	0.880	33.7	0.466	33.3	76.5
406x178x54	18700	1020	16.5	3.85	930	115	1050	178	0.871	38.3	0.392	23.1	69.0
406x140x53 +	18300	635	16.4	3.06	899	88.6	1030	139	0.870	34.1	0.246	29.0	67.9
406x140x46	15700	538	16.4	3.03	778	75.7	888	118	0.871	39.0	0.207	19.0	58.6
406x140x39	12500	410	15.9	2.87	629	57.8	724	90.8	0.858	47.4	0.155	10.7	49.7
356x171x67	19500	1360	15.1	3.99	1070	157	1210	243	0.886	24.4	0.412	55.7	85.5
356x171x57	16000	1110	14.9	3.91	896	129	1010	199	0.882	28.8	0.330	33.4	72.6
356x171x51	14100	968	14.8	3.86	796	113	896	174	0.881	32.1	0.286	23.8	64.9
356x171x45	12100	811	14.5	3.76	687	94.8	775	147	0.874	36.8	0.237	15.8	57.3
356x127x39	10200	358	14.3	2.68	576	56.8	659	89.0	0.871	35.2	0.105	15.1	49.8
356x127x33	8250	280	14.0	2.58	473	44.7	543	70.2	0.863	42.1	0.081	8.79	42.1
305x165x54	11700	1060	13.0	3.93	754	127	846	196	0.889	23.6	0.234	34.8	68.8
305x165x46	9900	896	13.0	3.90	646	108	720	166	0.890	27.1	0.195	22.2	58.7
305x165x40	8500	764	12.9	3.86	560	92.6	623	142	0.889	31.0	0.164	14.7	51.3

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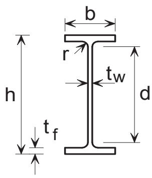
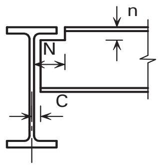
BS 4-1:2005

UNIVERSAL BEAMS

Advance® UKB





Dimensions

Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
305x127x48	48.1	311.0	125.3	9.0	14.0	8.9	265.2	3.52	29.5	7	70	24	1.09	22.7
305x127x42	41.9	307.2	124.3	8.0	12.1	8.9	265.2	4.07	33.2	6	70	22	1.08	25.8
305x127x37	37.0	304.4	123.4	7.1	10.7	8.9	265.2	4.60	37.4	6	70	20	1.07	28.9
305x102x33	32.8	312.7	102.4	6.6	10.8	7.6	275.9	3.73	41.8	5	58	20	1.01	30.8
305x102x28	28.2	308.7	101.8	6.0	8.8	7.6	275.9	4.58	46.0	5	58	18	1.00	35.5
305x102x25	24.8	305.1	101.6	5.8	7.0	7.6	275.9	5.76	47.6	5	58	16	0.992	40.0
254x146x43	43.0	259.6	147.3	7.2	12.7	7.6	219.0	4.92	30.4	6	82	22	1.08	25.1
254x146x37	37.0	256.0	146.4	6.3	10.9	7.6	219.0	5.73	34.8	5	82	20	1.07	28.9
254x146x31	31.1	251.4	146.1	6.0	8.6	7.6	219.0	7.26	36.5	5	82	18	1.06	34.0
254x102x28	28.3	260.4	102.2	6.3	10.0	7.6	225.2	4.04	35.7	5	58	18	0.904	31.9
254x102x25	25.2	257.2	101.9	6.0	8.4	7.6	225.2	4.80	37.5	5	58	16	0.897	35.7
254x102x22	22.0	254.0	101.6	5.7	6.8	7.6	225.2	5.93	39.5	5	58	16	0.890	40.5
203x133x30	30.0	206.8	133.9	6.4	9.6	7.6	172.4	5.85	26.9	5	74	18	0.923	30.8
203x133x25	25.1	203.2	133.2	5.7	7.8	7.6	172.4	7.20	30.2	5	74	16	0.915	36.5
203x102x23	23.1	203.2	101.8	5.4	9.3	7.6	169.4	4.37	31.4	5	60	18	0.790	34.2
178x102x19	19.0	177.8	101.2	4.8	7.9	7.6	146.8	5.14	30.6	4	60	16	0.738	38.7
152x89x16	16.0	152.4	88.7	4.5	7.7	7.6	121.8	4.48	27.1	4	54	16	0.638	40.0
127x76x13	13.0	127.0	76.0	4.0	7.6	7.6	96.6	3.74	24.2	4	46	16	0.537	41.4

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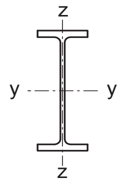
FOR EXPLANATION OF TABLES SEE NOTE 2

UNIVERSAL BEAMS

Advance® UKB



Properties

Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	U	X	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3			dm^6	cm^4	cm^2
305x127x48	9570	461	12.5	2.74	616	73.6	711	116	0.873	23.3	0.102	31.8	61.2
305x127x42	8200	389	12.4	2.70	534	62.6	614	98.4	0.872	26.5	0.0846	21.1	53.4
305x127x37	7170	336	12.3	2.67	471	54.5	539	85.4	0.872	29.7	0.0725	14.8	47.2
305x102x33	6500	194	12.5	2.15	416	37.9	481	60.0	0.867	31.6	0.0442	12.2	41.8
305x102x28	5370	155	12.2	2.08	348	30.5	403	48.4	0.859	37.3	0.0349	7.40	35.9
305x102x25	4460	123	11.9	1.97	292	24.2	342	38.8	0.846	43.4	0.027	4.77	31.6
254x146x43	6540	677	10.9	3.52	504	92.0	566	141	0.891	21.1	0.103	23.9	54.8
254x146x37	5540	571	10.8	3.48	433	78.0	483	119	0.890	24.3	0.0857	15.3	47.2
254x146x31	4410	448	10.5	3.36	351	61.3	393	94.1	0.879	29.6	0.0660	8.55	39.7
254x102x28	4000	179	10.5	2.22	308	34.9	353	54.8	0.873	27.5	0.0280	9.57	36.1
254x102x25	3410	149	10.3	2.15	266	29.2	306	46.0	0.866	31.4	0.0230	6.42	32.0
254x102x22	2840	119	10.1	2.06	224	23.5	259	37.3	0.856	36.3	0.0182	4.15	28.0
203x133x30	2900	385	8.71	3.17	280	57.5	314	88.2	0.882	21.5	0.0374	10.3	38.2
203x133x25	2340	308	8.56	3.10	230	46.2	258	70.9	0.876	25.6	0.0294	5.96	32.0
203x102x23	2100	164	8.46	2.36	207	32.2	234	49.7	0.888	22.4	0.0154	7.02	29.4
178x102x19	1360	137	7.48	2.37	153	27.0	171	41.6	0.886	22.6	0.0099	4.41	24.3
152x89x16	834	89.8	6.41	2.10	109	20.2	123	31.2	0.890	19.5	0.00470	3.56	20.3
127x76x13	473	55.7	5.35	1.84	74.6	14.7	84.2	22.6	0.894	16.3	0.00200	2.85	16.5

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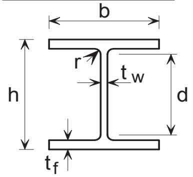
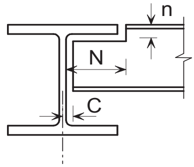
FOR EXPLANATION OF TABLES SEE NOTE 3

BS EN 1993-1-1:2005
BS 4-1:2005

UNIVERSAL COLUMNS

Advance® UKC





Dimensions

Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
356x406x634	633.9	474.6	424.0	47.6	77.0	15.2	290.2	2.25	6.10	26	200	94	2.52	3.98
356x406x551	551.0	455.6	418.5	42.1	67.5	15.2	290.2	2.56	6.89	23	200	84	2.47	4.48
356x406x467	467.0	436.6	412.2	35.8	58.0	15.2	290.2	2.98	8.11	20	200	74	2.42	5.18
356x406x393	393.0	419.0	407.0	30.6	49.2	15.2	290.2	3.52	9.48	17	200	66	2.38	6.06
356x406x340	339.9	406.4	403.0	26.6	42.9	15.2	290.2	4.03	10.9	15	200	60	2.35	6.91
356x406x287	287.1	393.6	399.0	22.6	36.5	15.2	290.2	4.74	12.8	13	200	52	2.31	8.05
356x406x235	235.1	381.0	394.8	18.4	30.2	15.2	290.2	5.73	15.8	11	200	46	2.28	9.70
356x368x202	201.9	374.6	374.7	16.5	27.0	15.2	290.2	6.07	17.6	10	190	44	2.19	10.8
356x368x177	177.0	368.2	372.6	14.4	23.8	15.2	290.2	6.89	20.2	9	190	40	2.17	12.3
356x368x153	152.9	362.0	370.5	12.3	20.7	15.2	290.2	7.92	23.6	8	190	36	2.16	14.1
356x368x129	129.0	355.6	368.6	10.4	17.5	15.2	290.2	9.4	27.9	7	190	34	2.14	16.6
305x305x283	282.9	365.3	322.2	26.8	44.1	15.2	246.7	3.00	9.21	15	158	60	1.94	6.86
305x305x240	240.0	352.5	318.4	23.0	37.7	15.2	246.7	3.51	10.7	14	158	54	1.91	7.96
305x305x198	198.1	339.9	314.5	19.1	31.4	15.2	246.7	4.22	12.9	12	158	48	1.87	9.44
305x305x158	158.1	327.1	311.2	15.8	25.0	15.2	246.7	5.30	15.6	10	158	42	1.84	11.6
305x305x137	136.9	320.5	309.2	13.8	21.7	15.2	246.7	6.11	17.90	9	158	38	1.82	13.3
305x305x118	117.9	314.5	307.4	12.0	18.7	15.2	246.7	7.09	20.6	8	158	34	1.81	15.4
305x305x97	96.9	307.9	305.3	9.9	15.4	15.2	246.7	8.60	24.9	7	158	32	1.79	18.5
254x254x167	167.1	289.1	265.2	19.2	31.7	12.7	200.3	3.48	10.4	12	134	46	1.58	9.46
254x254x132	132.0	276.3	261.3	15.3	25.3	12.7	200.3	4.36	13.1	10	134	38	1.55	11.7
254x254x107	107.1	266.7	258.8	12.8	20.5	12.7	200.3	5.38	15.6	8	134	34	1.52	14.2
254x254x89	88.9	260.3	256.3	10.3	17.3	12.7	200.3	6.38	19.4	7	134	30	1.50	16.9
254x254x73	73.1	254.1	254.6	8.6	14.2	12.7	200.3	7.77	23.3	6	134	28	1.49	20.4
203x203x127 +	127.5	241.4	213.9	18.1	30.1	10.2	160.8	2.91	8.88	11	108	42	1.28	10.0
203x203x113 +	113.5	235.0	212.1	16.3	26.9	10.2	160.8	3.26	9.87	10	108	38	1.27	11.2
203x203x100 +	99.6	228.6	210.3	14.5	23.7	10.2	160.8	3.70	11.1	9	108	34	1.25	12.6
203x203x86	86.1	222.2	209.1	12.7	20.5	10.2	160.8	4.29	12.7	8	110	32	1.24	14.4
203x203x71	71.0	215.8	206.4	10.0	17.3	10.2	160.8	5.09	16.1	7	110	28	1.22	17.2
203x203x60	60.0	209.6	205.8	9.4	14.2	10.2	160.8	6.20	17.1	7	110	26	1.21	20.2
203x203x52	52.0	206.2	204.3	7.9	12.5	10.2	160.8	7.04	20.4	6	110	24	1.20	23.1
203x203x46	46.1	203.2	203.6	7.2	11.0	10.2	160.8	8.00	22.3	6	110	22	1.19	25.8
152x152x51 +	51.2	170.2	157.4	11.0	15.7	7.6	123.6	4.18	11.2	8	84	24	0.935	18.3
152x152x44 +	44.0	166.0	155.9	9.5	13.6	7.6	123.6	4.82	13.0	7	84	22	0.924	21.0
152x152x37	37.0	161.8	154.4	8.0	11.5	7.6	123.6	5.70	15.5	6	84	20	0.912	24.7
152x152x30	30.0	157.6	152.9	6.5	9.4	7.6	123.6	6.98	19.0	5	84	18	0.901	30.0
152x152x23	23.0	152.4	152.2	5.8	6.8	7.6	123.6	9.65	21.3	5	84	16	0.889	38.7

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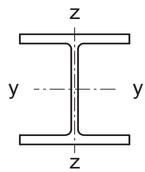
+ These sections are in addition to the range of BS 4 sections.

FOR EXPLANATION OF TABLES SEE NOTE 2

BS EN 1993-1-1:2005
BS 4-1:2005

UNIVERSAL COLUMNS

Advance® UKC



Properties

Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	U	X	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3			dm^6	cm^4	cm^2
356x406x634	275000	98100	18.4	11.0	11600	4630	14200	7110	0.843	5.46	38.8	13700	808
356x406x551	227000	82700	18.0	10.9	9960	3950	12100	6060	0.841	6.05	31.1	9240	702
356x406x467	183000	67800	17.5	10.7	8380	3290	10000	5030	0.839	6.85	24.3	5810	595
356x406x393	147000	55400	17.1	10.5	7000	2720	8220	4150	0.837	7.86	18.9	3550	501
356x406x340	123000	46900	16.8	10.4	6030	2330	7000	3540	0.836	8.84	15.5	2340	433
356x406x287	99900	38700	16.5	10.3	5070	1940	5810	2950	0.835	10.17	12.3	1440	366
356x406x235	79100	31000	16.3	10.2	4150	1570	4690	2380	0.834	12.04	9.54	812	299
356x368x202	66300	23700	16.1	9.60	3540	1260	3970	1920	0.844	13.35	7.16	558	257
356x368x177	57100	20500	15.9	9.54	3100	1100	3460	1670	0.844	15.00	6.09	381	226
356x368x153	48600	17600	15.8	9.49	2680	948	2960	1430	0.844	17.01	5.11	251	195
356x368x129	40200	14600	15.6	9.43	2260	793	2480	1200	0.844	19.81	4.18	153	164
305x305x283	78900	24600	14.8	8.27	4320	1530	5110	2340	0.855	7.64	6.35	2030	360
305x305x240	64200	20300	14.5	8.15	3640	1280	4250	1950	0.854	8.73	5.03	1270	306
305x305x198	50900	16300	14.2	8.04	3000	1040	3440	1580	0.854	10.23	3.88	734	252
305x305x158	38700	12600	13.9	7.90	2370	808	2680	1230	0.851	12.46	2.87	378	201
305x305x137	32800	10700	13.7	7.83	2050	692	2300	1050	0.851	14.13	2.39	249	174
305x305x118	27700	9060	13.6	7.77	1760	589	1960	895	0.850	16.14	1.98	161	150
305x305x97	22200	7310	13.4	7.69	1450	479	1590	726	0.850	19.19	1.56	91.2	123
254x254x167	30000	9870	11.9	6.81	2080	744	2420	1140	0.851	8.48	1.63	626	213
254x254x132	22500	7530	11.6	6.69	1630	576	1870	878	0.850	10.32	1.19	319	168
254x254x107	17500	5930	11.3	6.59	1310	458	1480	697	0.848	12.38	0.898	172	136
254x254x89	14300	4860	11.2	6.55	1100	379	1220	575	0.850	14.46	0.717	102	113
254x254x73	11400	3910	11.1	6.48	898	307	992	465	0.849	17.24	0.562	57.6	93.1
203x203x127 +	15400	4920	9.75	5.50	1280	460	1520	704	0.854	7.38	0.549	427	162
203x203x113 +	13300	4290	9.59	5.45	1130	404	1330	618	0.853	8.11	0.464	305	145
203x203x100 +	11300	3680	9.44	5.39	988	350	1150	534	0.852	9.02	0.386	210	127
203x203x86	9450	3130	9.28	5.34	850	299	977	456	0.850	10.20	0.318	137	110
203x203x71	7620	2540	9.18	5.30	706	246	799	374	0.853	11.90	0.250	80.2	90.4
203x203x60	6120	2060	8.96	5.20	584	201	656	305	0.846	14.10	0.197	47.2	76.4
203x203x52	5260	1780	8.91	5.18	510	174	567	264	0.848	15.80	0.167	31.8	66.3
203x203x46	4570	1550	8.82	5.13	450	152	497	231	0.847	17.70	0.143	22.2	58.7
152x152x51 +	3230	1020	7.04	3.96	379	130	438	199	0.848	10.10	0.061	48.8	65.2
152x152x44 +	2700	860	6.94	3.92	326	110	372	169	0.848	11.50	0.050	31.7	56.1
152x152x37	2210	706	6.85	3.87	273	91.5	309	140	0.848	13.30	0.040	19.2	47.1
152x152x30	1750	560	6.76	3.83	222	73.3	248	112	0.849	16.00	0.031	10.5	38.3
152x152x23	1250	400	6.54	3.70	164	52.6	182	80.1	0.840	20.70	0.021	4.63	29.2

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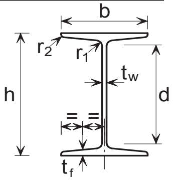
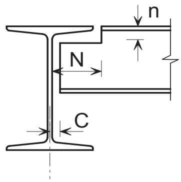
+ These sections are in addition to the range of BS 4 sections.

FOR EXPLANATION OF TABLES SEE NOTE 3

BS EN 1993-1-1:2005
BS 4-1:2005

JOISTS



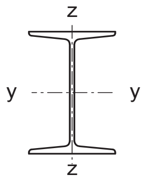


Dimensions

Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Radii		Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange	Root	Toe		Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r_1	r_2	d	c_f / t_f	c_w / t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
254x203x82	82.0	254.0	203.2	10.2	19.9	19.6	9.7	166.6	3.86	16.3	7	104	44	1.21	14.8
254x114x37	37.2	254.0	114.3	7.6	12.8	12.4	6.1	199.3	3.20	26.2	6	60	28	0.899	24.2
203x152x52	52.3	203.2	152.4	8.9	16.5	15.5	7.6	133.2	3.41	15.0	6	78	36	0.932	17.8
152x127x37	37.3	152.4	127.0	10.4	13.2	13.5	6.6	94.3	3.39	9.07	7	66	30	0.737	19.8
127x114x29	29.3	127.0	114.3	10.2	11.5	9.9	4.8	79.5	3.67	7.79	7	60	24	0.646	22.0
127x114x27	26.9	127.0	114.3	7.4	11.4	9.9	5.0	79.5	3.82	10.7	6	60	24	0.650	24.2
127x76x16	16.5	127.0	76.2	5.6	9.6	9.4	4.6	86.5	2.70	15.4	5	42	22	0.512	31.0
114x114x27	27.1	114.3	114.3	9.5	10.7	14.2	3.2	60.8	3.57	6.40	7	60	28	0.618	22.8
102x102x23	23.0	101.6	101.6	9.5	10.3	11.1	3.2	55.2	3.39	5.81	7	54	24	0.549	23.9
102x44x7	7.5	101.6	44.5	4.3	6.1	6.9	3.3	74.6	2.16	17.3	4	28	14	0.350	46.6
89x89x19	19.5	88.9	88.9	9.5	9.9	11.1	3.2	44.2	2.89	4.65	7	46	24	0.476	24.4
76x76x15	15.0	76.2	80.0	8.9	8.4	9.4	4.6	38.1	3.11	4.28	6	42	20	0.419	27.9
76x76x13	12.8	76.2	76.2	5.1	8.4	9.4	4.6	38.1	3.11	7.47	5	42	20	0.411	32.1

FOR EXPLANATION OF TABLES SEE NOTE 2

JOISTS



Properties

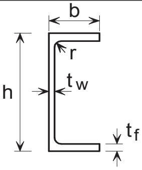
Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	U	X	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3			dm^6	cm^4	cm^2
254x203x82	12000	2280	10.7	4.67	947	224	1080	371	0.888	11.0	0.312	152	105
254x114x37	5080	269	10.4	2.39	400	47.1	459	79.1	0.884	18.7	0.0392	25.2	47.3
203x152x52	4800	816	8.49	3.50	472	107	541	176	0.890	10.7	0.0711	64.8	66.6
152x127x37	1820	378	6.19	2.82	239	59.6	279	99.8	0.867	9.3	0.0183	33.9	47.5
127x114x29	979	242	5.12	2.54	154	42.3	181	70.8	0.853	8.8	0.00807	20.8	37.4
127x114x27	946	236	5.26	2.63	149	41.3	172	68.2	0.868	9.3	0.00788	16.9	34.2
127x76x16	571	60.8	5.21	1.70	90.0	16.0	104	26.4	0.890	11.8	0.00210	6.72	21.1
114x114x27	736	224	4.62	2.55	129	39.2	151	65.8	0.839	7.9	0.00601	18.9	34.5
102x102x23	486	154	4.07	2.29	95.6	30.3	113	50.6	0.836	7.4	0.00321	14.2	29.3
102x44x7	153	7.82	4.01	0.907	30.1	3.51	35.4	6.03	0.872	14.9	0.000178	1.25	9.50
89x89x19	307	101	3.51	2.02	69.0	22.8	82.7	38.0	0.829	6.6	0.00158	11.5	24.9
76x76x15	172	60.9	3.00	1.78	45.2	15.2	54.2	25.8	0.820	6.4	0.000700	6.83	19.1
76x76x13	158	51.8	3.12	1.79	41.5	13.6	48.7	22.4	0.853	7.2	0.000595	4.59	16.2

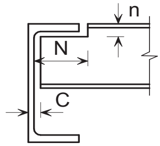
FOR EXPLANATION OF TABLES SEE NOTE 3

BS EN 1993-1-1:2005
BS 4-1:2005

PARALLEL FLANGE CHANNELS

Advance® UKPFC





Dimensions

Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Distance	Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web		End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	e_o	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			cm	mm	mm	mm	m^2	m^2
430x100x64	64.4	430	100	11.0	19.0	15	362	3.89	32.9	3.27	13	96	36	1.23	19.0
380x100x54	54.0	380	100	9.5	17.5	15	315	4.31	33.2	3.48	12	98	34	1.13	20.9
300x100x46	45.5	300	100	9.0	16.5	15	237	4.61	26.3	3.68	11	98	32	0.969	21.3
300x90x41	41.4	300	90	9.0	15.5	12	245	4.45	27.2	3.18	11	88	28	0.932	22.5
260x90x35	34.8	260	90	8.0	14.0	12	208	5.00	26.0	3.32	10	88	28	0.854	24.5
260x75x28	27.6	260	75	7.0	12.0	12	212	4.67	30.3	2.62	9	74	26	0.796	28.8
230x90x32	32.2	230	90	7.5	14.0	12	178	5.04	23.7	3.46	10	90	28	0.795	24.7
230x75x26	25.7	230	75	6.5	12.5	12	181	4.52	27.8	2.78	9	76	26	0.737	28.7
200x90x30	29.7	200	90	7.0	14.0	12	148	5.07	21.1	3.60	9	90	28	0.736	24.8
200x75x23	23.4	200	75	6.0	12.5	12	151	4.56	25.2	2.91	8	76	26	0.678	28.9
180x90x26	26.1	180	90	6.5	12.5	12	131	5.72	20.2	3.64	9	90	26	0.697	26.7
180x75x20	20.3	180	75	6.0	10.5	12	135	5.43	22.5	2.87	8	76	24	0.638	31.4
150x90x24	23.9	150	90	6.5	12.0	12	102	5.96	15.7	3.71	9	90	26	0.637	26.7
150x75x18	17.9	150	75	5.5	10.0	12	106	5.75	19.3	2.99	8	76	24	0.579	32.4
125x65x15	14.8	125	65	5.5	9.5	12	82.0	5.00	14.9	2.56	8	66	22	0.489	33.1
100x50x10	10.2	100	50	5.0	8.5	9	65.0	4.24	13.0	1.94	7	52	18	0.382	37.5

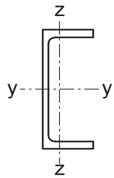
Advance® and UKPFC are trademarks of Tata Steel. A fuller description of the relationship between Parallel Flange Channels (PFC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

e_0 is the distance from the centre of the web to the shear centre

FOR EXPLANATION OF TABLES SEE NOTE 2

PARALLEL FLANGE CHANNELS

Advance® UKPFC



Properties

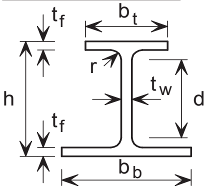
Section Designation	Second Moment of Area Axis y-y cm⁴	Second Moment of Area Axis z-z cm⁴	Radius of Gyration Axis y-y cm	Radius of Gyration Axis z-z cm	Elastic Modulus Axis y-y cm³	Elastic Modulus Axis z-z cm³	Plastic Modulus Axis y-y cm³	Plastic Modulus Axis z-z cm³	Buckling Parameter U	Torsional Index X	Warping Constant I_w dm^6	Torsional Constant I_T cm^4	Area of Section A cm^2
430x100x64	21900	722	16.3	2.97	1020	97.9	1220	176	0.917	22.5	0.219	63.0	82.1
380x100x54	15000	643	14.8	3.06	791	89.2	933	161	0.933	21.2	0.150	45.7	68.7
300x100x46	8230	568	11.9	3.13	549	81.7	641	148	0.944	17.0	0.0813	36.8	58.0
300x90x41	7220	404	11.7	2.77	481	63.1	568	114	0.934	18.3	0.0581	28.8	52.7
260x90x35	4730	353	10.3	2.82	364	56.3	425	102	0.943	17.2	0.0379	20.6	44.4
260x75x28	3620	185	10.1	2.30	278	34.4	328	62.0	0.932	20.5	0.0203	11.7	35.1
230x90x32	3520	334	9.27	2.86	306	55.0	355	98.9	0.949	15.1	0.0279	19.3	41.0
230x75x26	2750	181	9.17	2.35	239	34.8	278	63.2	0.945	17.3	0.0153	11.8	32.7
200x90x30	2520	314	8.16	2.88	252	53.4	291	94.5	0.952	12.9	0.0197	18.3	37.9
200x75x23	1960	170	8.11	2.39	196	33.8	227	60.6	0.956	14.7	0.0107	11.1	29.9
180x90x26	1820	277	7.40	2.89	202	47.4	232	83.5	0.950	12.8	0.0141	13.3	33.2
180x75x20	1370	146	7.27	2.38	152	28.8	176	51.8	0.945	15.3	0.00754	7.34	25.9
150x90x24	1160	253	6.18	2.89	155	44.4	179	76.9	0.937	10.8	0.00890	11.8	30.4
150x75x18	861	131	6.15	2.40	115	26.6	132	47.2	0.945	13.1	0.00467	6.10	22.8
125x65x15	483	80.0	5.07	2.06	77.3	18.8	89.9	33.2	0.942	11.1	0.00194	4.72	18.8
100x50x10	208	32.3	4.00	1.58	41.5	9.89	48.9	17.5	0.942	10.0	0.000491	2.53	13.0

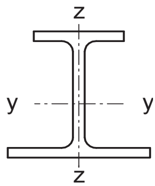
Advance® and UKPFC are trademarks of Tata Steel. A fuller description of the relationship between Parallel Flange Channels (PFC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

FOR EXPLANATION OF TABLES SEE NOTE 3

BS EN 1993-1-1:2005
Corus ASB

ASB (ASYMMETRIC BEAMS)





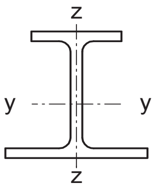
Dimensions and properties

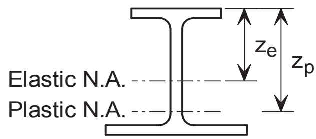
Section Designation	Mass per Metre	Depth of Section	Width of Flange		Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling			Second Moment of Area		Surface Area	
			Top	Bottom	Web	Flange			Flanges		Web	Axis y-y	Axis z-z	Per Metre	Per Tonne
		h	b_t	b_b	t_w	t_f	r	d	c_{ft}/t_f	c_{fb}/t_f	c_w/t_w				
	kg/m	mm	mm	mm	mm	mm	mm	mm				cm^4	cm^4	m^2	m^2
300 ASB 249 ^	249	342	203	313	40.0	40.0	27.0	208	1.36	2.74	5.20	52900	13200	1.59	6.38
300 ASB 196	196	342	183	293	20.0	40.0	27.0	208	1.36	2.74	10.4	45900	10500	1.55	7.93
300 ASB 185 ^	185	320	195	305	32.0	29.0	27.0	208	1.88	3.78	6.50	35700	8750	1.53	8.29
300 ASB 155	155	326	179	289	16.0	32.0	27.0	208	1.70	3.42	13.0	34500	7990	1.51	9.71
300 ASB 153 ^	153	310	190	300	27.0	24.0	27.0	208	2.27	4.56	7.70	28400	6840	1.50	9.81
280 ASB 136 ^	136	288	190	300	25.0	22.0	24.0	196	2.66	5.16	7.84	22200	6260	1.46	10.7
280 ASB 124	124	296	178	288	13.0	26.0	24.0	196	2.25	4.37	15.1	23500	6410	1.46	11.8
280 ASB 105	105	288	176	286	11.0	22.0	24.0	196	2.66	5.16	17.8	19200	5300	1.44	13.7
280 ASB 100 ^	100	276	184	294	19.0	16.0	24.0	196	3.66	7.09	10.3	15500	4250	1.43	14.2
280 ASB 74	73.6	272	175	285	10.0	14.0	24.0	196	4.18	8.11	19.6	12200	3330	1.40	19.1

^ Sections are fire engineered with thick webs.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

ASB (ASYMMETRIC BEAMS)





Properties (Continued)

Section Designation	Radius of Gyration		Elastic Modulus			Neutral Axis Position		Plastic Modulus		Buckling Parameter	Torsional Index	Mono-symmetry index*	Warping Constant	Torsional Constant	Area of Section
	Axis y-y cm	Axis z-z cm	Axis y-y Top cm^3	Axis y-y Bottom cm^3	Axis z-z cm^3	Elastic z_e cm	Plastic z_p cm	Axis y-y cm^3	Axis z-z cm^3	U	X	ψ	I_w dm^6	I_T cm^4	A cm^2
300 ASB 249 ^	12.9	6.40	2760	3530	843	19.2	22.6	3760	1510	0.820	6.80	0.663	2.00	2000	318
300 ASB 196	13.6	6.48	2320	3180	714	19.8	28.1	3060	1230	0.840	7.86	0.895	1.50	1180	249
300 ASB 185 ^	12.3	6.10	1980	2540	574	18.0	21.0	2660	1030	0.820	8.56	0.662	1.20	871	235
300 ASB 155	13.2	6.35	1830	2520	553	18.9	27.3	2360	950	0.840	9.40	0.868	1.07	620	198
300 ASB 153 ^	12.1	5.93	1630	2090	456	17.4	20.4	2160	817	0.820	9.97	0.643	0.895	513	195
280 ASB 136 ^	11.3	6.00	1370	1770	417	16.3	19.2	1810	741	0.810	10.2	0.628	0.710	379	174
280 ASB 124	12.2	6.37	1360	1900	445	17.3	25.7	1730	761	0.830	10.5	0.807	0.721	332	158
280 ASB 105	12.0	6.30	1150	1610	370	16.8	25.3	1440	633	0.830	12.1	0.777	0.574	207	133
280 ASB 100 ^	11.0	5.76	995	1290	289	15.6	18.4	1290	511	0.810	13.2	0.616	0.451	160	128
280 ASB 74	11.4	5.96	776	1060	234	15.7	21.3	978	403	0.830	16.7	0.699	0.338	72.0	93.7

^ Sections are fire engineered with thick webs.

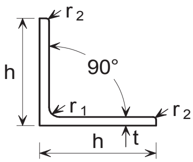
* Monosymmetry index is positive when the wide flange is in compression and negative when the narrow flange is in compression

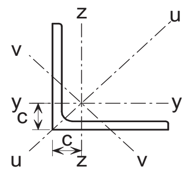
FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10056-1:1999

EQUAL ANGLES

Advance® UKA - Equal Angles





Dimensions and properties

Section Designation		Mass per Metre	Radius		Area of Section	Distance to centroid	Second Moment of Area			Radius of Gyration			Elastic Modulus	Torsional Constant	Equivalent Slenderness Coefficient
Size	Thickness		Root	Toe			Axis y-y, z-z	Axis u-u	Axis v-v	Axis y-y, z-z	Axis u-u	Axis v-v	Axis y-y, z-z		
h x h	t		r_1	r_2		c								I_T	ϕ_a
mm	mm	kg/m	mm	mm	cm^2	cm	cm^4	cm^4	cm^4	cm	cm	cm	cm^3	cm^4	
200x200	24	71.1	18.0	9.00	90.6	5.84	3330	5280	1380	6.06	7.64	3.90	235	182	2.50
	20	59.9	18.0	9.00	76.3	5.68	2850	4530	1170	6.11	7.70	3.92	199	107	3.05
	18	54.3	18.0	9.00	69.1	5.60	2600	4150	1050	6.13	7.75	3.90	181	78.9	3.43
	16	48.5	18.0	9.00	61.8	5.52	2340	3720	960	6.16	7.76	3.94	162	56.1	3.85
150x150	18 +	40.1	16.0	8.00	51.2	4.38	1060	1680	440	4.55	5.73	2.93	99.8	58.6	2.48
	15	33.8	16.0	8.00	43.0	4.25	898	1430	370	4.57	5.76	2.93	83.5	34.6	3.01
	12	27.3	16.0	8.00	34.8	4.12	737	1170	303	4.60	5.80	2.95	67.7	18.2	3.77
	10	23.0	16.0	8.00	29.3	4.03	624	990	258	4.62	5.82	2.97	56.9	10.8	4.51
120x120	15 +	26.6	13.0	6.50	34.0	3.52	448	710	186	3.63	4.57	2.34	52.8	27.0	2.37
	12	21.6	13.0	6.50	27.5	3.40	368	584	152	3.65	4.60	2.35	42.7	14.2	2.99
	10	18.2	13.0	6.50	23.2	3.31	313	497	129	3.67	4.63	2.36	36.0	8.41	3.61
	8 +	14.7	13.0	6.50	18.8	3.24	259	411	107	3.71	4.67	2.38	29.5	4.44	4.56
100x100	15 +	21.9	12.0	6.00	28.0	3.02	250	395	105	2.99	3.76	1.94	35.8	22.3	1.92
	12	17.8	12.0	6.00	22.7	2.90	207	328	85.7	3.02	3.80	1.94	29.1	11.8	2.44
	10	15.0	12.0	6.00	19.2	2.82	177	280	73.0	3.04	3.83	1.95	24.6	6.97	2.94
	8	12.2	12.0	6.00	15.5	2.74	145	230	59.9	3.06	3.85	1.96	19.9	3.68	3.70
90x90	12 +	15.9	11.0	5.50	20.3	2.66	149	235	62.0	2.71	3.40	1.75	23.5	10.5	2.17
	10	13.4	11.0	5.50	17.1	2.58	127	201	52.6	2.72	3.42	1.75	19.8	6.20	2.64
	8	10.9	11.0	5.50	13.9	2.50	104	166	43.1	2.74	3.45	1.76	16.1	3.28	3.33
	7	9.61	11.0	5.50	12.2	2.45	92.6	147	38.3	2.75	3.46	1.77	14.1	2.24	3.80
80x80	10	11.9	10.0	5.00	15.1	2.34	87.5	139	36.4	2.41	3.03	1.55	15.4	5.45	2.33
	8	9.63	10.0	5.00	12.3	2.26	72.2	115	29.9	2.43	3.06	1.56	12.6	2.88	2.94
75x75	8	8.99	9.00	4.50	11.4	2.14	59.1	93.8	24.5	2.27	2.86	1.46	11.0	2.65	2.76
	6	6.85	9.00	4.50	8.73	2.05	45.8	72.7	18.9	2.29	2.89	1.47	8.41	1.17	3.70
70x70	7	7.38	9.00	4.50	9.40	1.97	42.3	67.1	17.5	2.12	2.67	1.36	8.41	1.69	2.92
	6	6.38	9.00	4.50	8.13	1.93	36.9	58.5	15.3	2.13	2.68	1.37	7.27	1.09	3.41
65x65	7	6.83	9.00	4.50	8.73	2.05	33.4	53.0	13.8	1.96	2.47	1.26	7.18	1.58	2.67
60x60	8	7.09	8.00	4.00	9.03	1.77	29.2	46.1	12.2	1.80	2.26	1.16	6.89	2.09	2.14
	6	5.42	8.00	4.00	6.91	1.69	22.8	36.1	9.44	1.82	2.29	1.17	5.29	0.922	2.90
	5	4.57	8.00	4.00	5.82	1.64	19.4	30.7	8.03	1.82	2.30	1.17	4.45	0.550	3.48
50x50	6	4.47	7.00	3.50	5.69	1.45	12.8	20.3	5.34	1.50	1.89	0.968	3.61	0.755	2.38
	5	3.77	7.00	3.50	4.80	1.40	11.0	17.4	4.55	1.51	1.90	0.973	3.05	0.450	2.88
	4	3.06	7.00	3.50	3.89	1.36	8.97	14.2	3.73	1.52	1.91	0.979	2.46	0.240	3.57
45x45	5	3.06	7.00	3.50	3.90	1.25	7.14	11.4	2.94	1.35	1.71	0.870	2.20	0.304	2.84
40x40	5	2.97	6.00	3.00	3.79	1.16	5.43	8.60	2.26	1.20	1.51	0.773	1.91	0.352	2.26
	4	2.42	6.00	3.00	3.08	1.12	4.47	7.09	1.86	1.21	1.52	0.777	1.55	0.188	2.83
35x35	4	2.09	5.00	2.50	2.67	1.00	2.95	4.68	1.23	1.05	1.32	0.678	1.18	0.158	2.50
30x30	4	1.78	5.00	2.50	2.27	0.878	1.80	2.85	0.754	0.892	1.12	0.577	0.850	0.137	2.07
	3	1.36	5.00	2.50	1.74	0.835	1.40	2.22	0.585	0.899	1.13	0.581	0.649	0.0613	2.75
25x25	4	1.45	3.50	1.75	1.85	0.762	1.02	1.61	0.430	0.741	0.931	0.482	0.586	0.1070	1.75
	3	1.12	3.50	1.75	1.42	0.723	0.803	1.27	0.334	0.751	0.945	0.484	0.452	0.0472	2.38
20x20	3	0.882	3.50	1.75	1.12	0.598	0.392	0.618	0.165	0.590	0.742	0.383	0.279	0.0382	1.81

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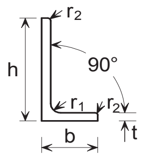
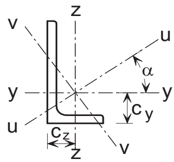
+ These sections are in addition to the range of BS EN 10056-1 sections.
c is the distance from the back of the leg to the centre of gravity.
FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10056-1:1999

UNEQUAL ANGLES

Advance® UKA - Unequal Angles





Dimensions and properties

Section Designation		Mass per	Radius		Dimension		Second Moment of Area				Radius of Gyration			
Size	Thickness	Metre	Root	Toe			Axis y-y	Axis z-z	Axis u-u	Axis v-v	Axis y-y	Axis z-z	Axis u-u	Axis v-v
h x b	t		r_1	r_2	c_y	c_z								
mm	mm	kg/m	mm	mm	cm	cm	cm^4	cm^4	cm^4	cm^4	cm	cm	cm	cm
200x150	18 +	47.1	15.0	7.50	6.33	3.85	2380	1150	2920	623	6.29	4.37	6.97	3.22
	15	39.6	15.0	7.50	6.21	3.73	2020	979	2480	526	6.33	4.40	7.00	3.23
	12	32.0	15.0	7.50	6.08	3.61	1650	803	2030	430	6.36	4.44	7.04	3.25
200x100	15	33.8	15.0	7.50	7.16	2.22	1760	299	1860	193	6.40	2.64	6.59	2.12
	12	27.3	15.0	7.50	7.03	2.10	1440	247	1530	159	6.43	2.67	6.63	2.14
	10	23.0	15.0	7.50	6.93	2.01	1220	210	1290	135	6.46	2.68	6.65	2.15
150x90	15	26.6	12.0	6.00	5.21	2.23	761	205	841	126	4.74	2.46	4.98	1.93
	12	21.6	12.0	6.00	5.08	2.12	627	171	694	104	4.77	2.49	5.02	1.94
	10	18.2	12.0	6.00	5.00	2.04	533	146	591	88.3	4.80	2.51	5.05	1.95
150x75	15	24.8	12.0	6.00	5.52	1.81	713	119	753	78.6	4.75	1.94	4.88	1.58
	12	20.2	12.0	6.00	5.40	1.69	588	99.6	623	64.7	4.78	1.97	4.92	1.59
	10	17.0	12.0	6.00	5.31	1.61	501	85.6	531	55.1	4.81	1.99	4.95	1.60
125x75	12	17.8	11.0	5.50	4.31	1.84	354	95.5	391	58.5	3.95	2.05	4.15	1.61
	10	15.0	11.0	5.50	4.23	1.76	302	82.1	334	49.9	3.97	2.07	4.18	1.61
	8	12.2	11.0	5.50	4.14	1.68	247	67.6	274	40.9	4.00	2.09	4.21	1.63
100x75	12	15.4	10.0	5.00	3.27	2.03	189	90.2	230	49.5	3.10	2.14	3.42	1.59
	10	13.0	10.0	5.00	3.19	1.95	162	77.6	197	42.2	3.12	2.16	3.45	1.59
	8	10.6	10.0	5.00	3.10	1.87	133	64.1	162	34.6	3.14	2.18	3.47	1.60
100x65	10 +	12.3	10.0	5.00	3.36	1.63	154	51.0	175	30.1	3.14	1.81	3.35	1.39
	8 +	9.94	10.0	5.00	3.27	1.55	127	42.2	144	24.8	3.16	1.83	3.37	1.40
	7 +	8.77	10.0	5.00	3.23	1.51	113	37.6	128	22.0	3.17	1.83	3.39	1.40
100x50	8	8.97	8.00	4.00	3.60	1.13	116	19.7	123	12.8	3.19	1.31	3.28	1.06
	6	6.84	8.00	4.00	3.51	1.05	89.9	15.4	95.4	9.92	3.21	1.33	3.31	1.07
80x60	7	7.36	8.00	4.00	2.51	1.52	59.0	28.4	72.0	15.4	2.51	1.74	2.77	1.28
80x40	8	7.07	7.00	3.50	2.94	0.963	57.6	9.61	60.9	6.34	2.53	1.03	2.60	0.838
	6	5.41	7.00	3.50	2.85	0.884	44.9	7.59	47.6	4.93	2.55	1.05	2.63	0.845
75x50	8	7.39	7.00	3.50	2.52	1.29	52.0	18.4	59.6	10.8	2.35	1.40	2.52	1.07
	6	5.65	7.00	3.50	2.44	1.21	40.5	14.4	46.6	8.36	2.37	1.42	2.55	1.08
70x50	6	5.41	7.00	3.50	2.23	1.25	33.4	14.2	39.7	7.92	2.20	1.43	2.40	1.07
65x50	5	4.35	6.00	3.00	1.99	1.25	23.2	11.9	28.8	6.32	2.05	1.47	2.28	1.07
60x40	6	4.46	6.00	3.00	2.00	1.01	20.1	7.12	23.1	4.16	1.88	1.12	2.02	0.855
	5	3.76	6.00	3.00	1.96	0.972	17.2	6.11	19.7	3.54	1.89	1.13	2.03	0.860
60x30	5	3.36	5.00	2.50	2.17	0.684	15.6	2.63	16.5	1.71	1.91	0.784	1.97	0.633
50x30	5	2.96	5.00	2.50	1.73	0.741	9.36	2.51	10.3	1.54	1.57	0.816	1.65	0.639
45x30	4	2.25	4.50	2.25	1.48	0.740	5.78	2.05	6.65	1.18	1.42	0.850	1.52	0.640
40x25	4	1.93	4.00	2.00	1.36	0.623	3.89	1.16	4.35	0.700	1.26	0.687	1.33	0.534
40x20	4	1.77	4.00	2.00	1.47	0.480	3.59	0.600	3.80	0.393	1.26	0.514	1.30	0.417
30x20	4	1.46	4.00	2.00	1.03	0.541	1.59	0.553	1.81	0.330	0.925	0.546	0.988	0.421
	3	1.12	4.00	2.00	0.990	0.502	1.25	0.437	1.43	0.256	0.935	0.553	1.00	0.424

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+ These sections are in addition to the range of BS EN 10056-1 sections.

c_y is the distance from the back of the short leg to the centre of gravity.

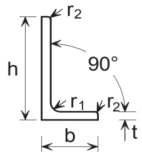
c_z is the distance from the back of the long leg to the centre of gravity.

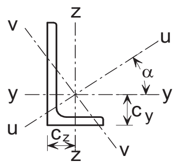
FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10056-1:1999

UNEQUAL ANGLES

Advance® UKA - Unequal Angles





Dimensions and properties (continued)

Section Designation		Elastic Modulus		Angle Axis y-y to Axis u-u	Torsional Constant	Equivalent Slenderness Coefficient		Mono-symmetry Index	Area of Section
Size $h \times b$ mm	Thickness t mm	Axis y-y cm^3	Axis z-z cm^3	Tan α	I_T cm^4	Min ϕ_a	Max ϕ_a	ψ_a	cm^2
200x150	18 +	174	103	0.549	67.9	2.93	3.72	4.60	60.0
	15	147	86.9	0.551	39.9	3.53	4.50	5.55	50.5
	12	119	70.5	0.552	20.9	4.43	5.70	6.97	40.8
200x100	15	137	38.5	0.260	34.3	3.54	5.17	9.19	43.0
	12	111	31.3	0.262	18.0	4.42	6.57	11.5	34.8
	10	93.2	26.3	0.263	10.66	5.26	7.92	13.9	29.2
150x90	15	77.7	30.4	0.354	26.8	2.58	3.59	5.96	33.9
	12	63.3	24.8	0.358	14.1	3.24	4.58	7.50	27.5
	10	53.3	21.0	0.360	8.30	3.89	5.56	9.03	23.2
150x75	15	75.2	21.0	0.253	25.1	2.62	3.74	6.84	31.7
	12	61.3	17.1	0.258	13.2	3.30	4.79	8.60	25.7
	10	51.6	14.5	0.261	7.80	3.95	5.83	10.4	21.7
125x75	12	43.2	16.9	0.354	11.6	2.66	3.73	6.23	22.7
	10	36.5	14.3	0.357	6.87	3.21	4.55	7.50	19.1
	8	29.6	11.6	0.360	3.62	4.00	5.75	9.43	15.5
100x75	12	28.0	16.5	0.540	10.05	2.10	2.64	3.46	19.7
	10	23.8	14.0	0.544	5.95	2.54	3.22	4.17	16.6
	8	19.3	11.4	0.547	3.13	3.18	4.08	5.24	13.5
100x65	10 +	23.2	10.5	0.410	5.61	2.52	3.43	5.45	15.6
	8 +	18.9	8.54	0.413	2.96	3.14	4.35	6.86	12.7
	7 +	16.6	7.53	0.415	2.02	3.58	5.00	7.85	11.2
100x50	8	18.2	5.08	0.258	2.61	3.30	4.80	8.61	11.4
	6	13.8	3.89	0.262	1.14	4.38	6.52	11.6	8.71
80x60	7	10.7	6.34	0.546	1.66	2.92	3.72	4.78	9.38
80x40	8	11.4	3.16	0.253	2.05	2.61	3.73	6.85	9.01
	6	8.73	2.44	0.258	0.899	3.48	5.12	9.22	6.89
75x50	8	10.4	4.95	0.430	2.14	2.36	3.18	4.92	9.41
	6	8.01	3.81	0.435	0.935	3.18	4.34	6.60	7.19
70x50	6	7.01	3.78	0.500	0.899	2.96	3.89	5.44	6.89
65x50	5	5.14	3.19	0.577	0.498	3.38	4.26	5.08	5.54
60x40	6	5.03	2.38	0.431	0.735	2.51	3.39	5.26	5.68
	5	4.25	2.02	0.434	0.435	3.02	4.11	6.34	4.79
60x30	5	4.07	1.14	0.257	0.382	3.15	4.56	8.26	4.28
50x30	5	2.86	1.11	0.352	0.340	2.51	3.52	5.99	3.78
45x30	4	1.91	0.910	0.436	0.166	2.85	3.87	5.92	2.87
40x25	4	1.47	0.619	0.380	0.142	2.51	3.48	5.75	2.46
40x20	4	1.42	0.393	0.252	0.131	2.57	3.68	6.86	2.26
30x20	4	0.807	0.379	0.421	0.1096	1.79	2.39	3.95	1.86
	3	0.621	0.292	0.427	0.0486	2.40	3.28	5.31	1.43

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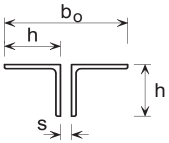
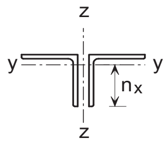
+ These sections are in addition to the range of BS EN 10056-1 sections.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

EQUAL ANGLES BACK TO BACK



Advance® UKA - Equal Angles BACK TO BACK



Dimensions and properties

Composed of Two Angles		Total Mass per Metre	Distance	Total Area	Properties about Axis y-y			Radius of Gyration i_z about Axis z-z (cm)				
h x h	t		n_y		I_y	i_y	$W_{el,y}$	Space between angles, s, (mm)				
mm	mm	kg/m	cm	cm^2	cm^4	cm	cm^3	0	8	10	12	15
200x200	24	142	14.2	181	6660	6.06	470	8.42	8.70	8.77	8.84	8.95
	20	120	14.3	153	5700	6.11	398	8.34	8.62	8.69	8.76	8.87
	18	109	14.4	138	5200	6.13	362	8.31	8.58	8.65	8.72	8.83
	16	97.0	14.5	124	4680	6.16	324	8.27	8.54	8.61	8.68	8.79
150x150	18 +	80.2	10.6	102	2120	4.55	200	6.32	6.60	6.67	6.75	6.86
	15	67.6	10.8	86.0	1800	4.57	167	6.24	6.52	6.59	6.66	6.77
	12	54.6	10.9	69.6	1470	4.60	135	6.18	6.45	6.52	6.59	6.70
	10	46.0	11.0	58.6	1250	4.62	114	6.13	6.40	6.47	6.54	6.64
120x120	15 +	53.2	8.48	68.0	896	3.63	106	5.06	5.34	5.42	5.49	5.60
	12	43.2	8.60	55.0	736	3.65	85.4	4.99	5.27	5.35	5.42	5.53
	10	36.4	8.69	46.4	626	3.67	72.0	4.94	5.22	5.29	5.36	5.47
	8 +	29.4	8.76	37.6	518	3.71	59.0	4.93	5.20	5.27	5.34	5.45
100x100	15 +	43.8	6.98	56.0	500	2.99	71.6	4.25	4.54	4.62	4.69	4.81
	12	35.6	7.10	45.4	414	3.02	58.2	4.19	4.47	4.55	4.62	4.74
	10	30.0	7.18	38.4	354	3.04	49.2	4.14	4.43	4.50	4.57	4.69
	8	24.4	7.26	31.0	290	3.06	39.8	4.11	4.38	4.46	4.53	4.64
90x90	12 +	31.8	6.34	40.6	298	2.71	47.0	3.80	4.09	4.16	4.24	4.36
	10	26.8	6.42	34.2	254	2.72	39.6	3.75	4.04	4.11	4.19	4.30
	8	21.8	6.50	27.8	208	2.74	32.2	3.71	3.99	4.06	4.13	4.25
	7	19.2	6.55	24.4	185	2.75	28.2	3.69	3.96	4.04	4.11	4.22
80x80	10	23.8	5.66	30.2	175	2.41	30.8	3.36	3.65	3.72	3.80	3.92
	8	19.3	5.74	24.6	144	2.43	25.2	3.31	3.60	3.67	3.75	3.86
75x75	8	18.0	5.36	22.8	118	2.27	22.0	3.12	3.41	3.49	3.56	3.68
	6	13.7	5.45	17.5	91.6	2.29	16.8	3.07	3.35	3.43	3.50	3.62
70x70	7	14.8	5.03	18.8	84.6	2.12	16.8	2.89	3.18	3.26	3.33	3.45
	6	12.8	5.07	16.3	73.8	2.13	14.5	2.87	3.16	3.23	3.31	3.42
65x65	7	13.7	4.45	17.5	66.8	1.96	14.4	2.83	3.14	3.21	3.29	3.42
60x60	8	14.2	4.23	18.1	58.4	1.80	13.8	2.52	2.82	2.90	2.97	3.10
	6	10.8	4.31	13.8	45.6	1.82	10.6	2.48	2.77	2.85	2.92	3.04
	5	9.14	4.36	11.6	38.8	1.82	8.90	2.45	2.74	2.81	2.89	3.01
50x50	6	8.94	3.55	11.4	25.6	1.50	7.22	2.09	2.38	2.46	2.54	2.66
	5	7.54	3.60	9.60	22.0	1.51	6.10	2.06	2.35	2.43	2.51	2.63
	4	6.12	3.64	7.78	17.9	1.52	4.92	2.04	2.32	2.40	2.48	2.60

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+ These sections are in addition to the range of BS EN 10056-1 sections.

Properties about z-z axis:

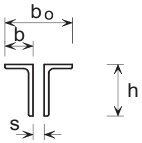
I_z = (Total Area).$(i_z)^2$

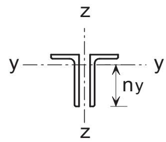
$W_{el,z} = I_z / (0.5b_o)$

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

UNEQUAL ANGLES BACK TO BACK

Advance® UKA - Unequal Angles BACK TO BACK





Dimensions and properties

Composed of Two Angles		Total Mass per Metre	Distance	Total Area	Properties about Axis y-y			Radius of Gyration i_z about Axis z-z (cm)				
								Space between angles, s, (mm)				
h x b	t		n_y		I_y	i_y	$W_{el,y}$					
mm	mm	kg/m	cm	cm^2	cm^4	cm	cm^3	0	8	10	12	15
200x150	18 +	94.2	13.7	120	4750	6.29	348	5.84	6.11	6.18	6.25	6.36
	15	79.2	13.8	101	4040	6.33	294	5.77	6.04	6.11	6.18	6.28
	12	64.0	13.9	81.6	3300	6.36	238	5.72	5.98	6.05	6.12	6.22
200x100	15	67.5	12.8	86.0	3520	6.40	274	3.45	3.72	3.79	3.86	3.97
	12	54.6	13.0	69.6	2880	6.43	222	3.39	3.65	3.72	3.79	3.90
	10	46.0	13.1	58.4	2440	6.46	186	3.35	3.61	3.67	3.74	3.85
150x90	15	53.2	9.79	67.8	1522	4.74	155	3.32	3.60	3.67	3.75	3.86
	12	43.2	9.92	55.0	1250	4.77	127	3.27	3.55	3.62	3.69	3.80
	10	36.4	10.0	46.4	1070	4.80	107	3.23	3.50	3.57	3.64	3.75
150x75	15	49.6	9.48	63.4	1430	4.75	150	2.65	2.94	3.01	3.09	3.21
	12	40.4	9.60	51.4	1180	4.78	123	2.59	2.87	2.94	3.02	3.14
	10	34.0	9.69	43.4	1000	4.81	103	2.56	2.83	2.90	2.97	3.08
125x75	12	35.6	8.19	45.4	708	3.95	86.4	2.76	3.04	3.11	3.19	3.30
	10	30.0	8.27	38.2	604	3.97	73.0	2.72	2.99	3.07	3.14	3.26
	8	24.4	8.36	31.0	494	4.00	59.2	2.68	2.95	3.02	3.09	3.20
100x75	12	30.8	6.73	39.4	378	3.10	56.0	2.95	3.24	3.31	3.39	3.51
	10	26.0	6.81	33.2	324	3.12	47.6	2.91	3.19	3.27	3.34	3.46
	8	21.2	6.90	27.0	266	3.14	38.6	2.87	3.15	3.22	3.29	3.41
100x65	10 +	24.6	6.64	31.2	308	3.14	46.4	2.43	2.72	2.79	2.87	2.99
	8 +	19.9	6.73	25.4	254	3.16	37.8	2.39	2.67	2.74	2.82	2.93
	7 +	17.5	6.77	22.4	226	3.17	33.2	2.37	2.65	2.72	2.79	2.91
100x50	8	17.9	6.40	22.8	232	3.19	36.4	1.73	2.02	2.09	2.17	2.29
	6	13.7	6.49	17.4	180	3.21	27.6	1.69	1.97	2.04	2.12	2.24
80x60	7	14.7	5.49	18.8	118	2.51	21.4	2.31	2.59	2.67	2.74	2.86
80x40	8	14.1	5.06	18.0	115	2.53	22.8	1.41	1.71	1.79	1.87	2.00
	6	10.8	5.15	13.8	89.8	2.55	17.5	1.37	1.66	1.74	1.82	1.94
75x50	8	14.8	4.98	18.8	104	2.35	20.8	1.90	2.19	2.27	2.35	2.47
	6	11.3	5.06	14.4	81.0	2.37	16.0	1.86	2.14	2.22	2.30	2.42
70x50	6	10.8	4.77	13.8	66.8	2.20	14.0	1.90	2.19	2.26	2.34	2.46
65x50	5	8.70	4.51	11.1	46.4	2.05	10.3	1.93	2.21	2.28	2.36	2.48
60x40	6	8.92	4.00	11.4	40.2	1.88	10.1	1.51	1.80	1.88	1.96	2.09
	5	7.52	4.04	9.58	34.4	1.89	8.50	1.49	1.78	1.86	1.94	2.06

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS EN 10056-1 sections.

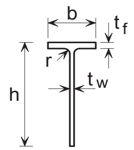
Properties about z-z axis:

I_z = (Total Area).$(i_z)^2$

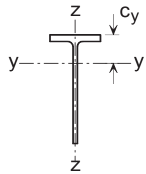
$W_{el,z} = I_z / (0.5b_o)$

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

STRUCTURAL TEES CUT FROM UNIVERSAL BEAMS



Advance® UKT split from Advance® UKB



Dimensions and properties

Section Designation	Cut from Universal Beam Section Designation	Mass per Metre kg/m	Width of Section b mm	Depth of Section h mm	Thickness Web t_w mm	Thickness Flange t_f mm	Root Radius r mm	Ratios for Local Buckling Flange c_f/t_f	Ratios for Local Buckling Web c_w/t_w	Dimension c_y cm	Second Moment of Area Axis y-y cm^4	Second Moment of Area Axis z-z cm^4
254x343x63	686x254x125	62.6	253.0	338.9	11.7	16.2	15.2	6.51	29.0	8.85	8980	2190
305x305x119	610x305x238	119.0	311.4	317.9	18.4	31.4	16.5	4.14	17.3	7.11	12400	7920
305x305x90	610x305x179	89.5	307.1	310.0	14.1	23.6	16.5	5.51	22.0	6.69	9040	5700
305x305x75	610x305x149	74.6	304.8	306.1	11.8	19.7	16.5	6.60	25.9	6.45	7410	4650
229x305x70	610x229x140	69.9	230.2	308.5	13.1	22.1	12.7	4.34	23.5	7.61	7740	2250
229x305x63	610x229x125	62.5	229.0	306.0	11.9	19.6	12.7	4.89	25.7	7.54	6900	1970
229x305x57	610x229x113	56.5	228.2	303.7	11.1	17.3	12.7	5.54	27.4	7.58	6270	1720
229x305x51	610x229x101	50.6	227.6	301.2	10.5	14.8	12.7	6.48	28.7	7.78	5690	1460
178x305x50 +	610x178x100	50.1	179.2	303.7	11.3	17.2	12.7	4.14	26.9	8.57	5890	829
178x305x46 +	610x178x92	46.1	178.8	301.5	10.9	15.0	12.7	4.75	27.7	8.78	5450	718
178x305x41 +	610x178x82	40.9	177.9	299.3	10.0	12.8	12.7	5.57	29.9	8.88	4840	603
312x267x136 +	533x312x272	136.6	320.2	288.8	21.1	37.6	12.7	3.64	13.7	6.28	10600	10300
312x267x110 +	533x312x219	109.4	317.4	280.4	18.3	29.2	12.7	4.69	15.3	6.09	8530	7790
312x267x91 +	533x312x182	90.7	314.5	275.6	15.2	24.4	12.7	5.61	18.1	5.78	6890	6330
312x267x75 +	533x312x151	75.3	312.0	271.5	12.7	20.3	12.7	6.75	21.4	5.54	5620	5140
210x267x69 +	533x210x138	69.1	213.9	274.5	14.7	23.6	12.7	3.68	18.7	6.94	5990	1930
210x267x61	533x210x122	61.0	211.9	272.2	12.7	21.3	12.7	4.08	21.4	6.66	5160	1690
210x267x55	533x210x109	54.5	210.8	269.7	11.6	18.8	12.7	4.62	23.3	6.61	4600	1470
210x267x51	533x210x101	50.5	210.0	268.3	10.8	17.4	12.7	4.99	24.8	6.53	4250	1350
210x267x46	533x210x92	46.0	209.3	266.5	10.1	15.6	12.7	5.57	26.4	6.55	3880	1190
210x267x41	533x210x82	41.1	208.8	264.1	9.6	13.2	12.7	6.58	27.5	6.75	3530	1000
165x267x43 +	533x165x85	42.3	166.5	267.1	10.3	16.5	12.7	3.96	25.9	7.23	3750	637
165x267x37 +	533x165x75	37.3	165.9	264.5	9.7	13.6	12.7	4.81	27.3	7.46	3350	520
165x267x33 +	533x165x66	32.8	165.1	262.4	8.9	11.4	12.7	5.74	29.5	7.59	2960	429
191x229x81 +	457x191x161	80.7	199.4	246.0	18.0	32.0	10.2	2.52	13.7	6.22	5160	2130
191x229x67 +	457x191x133	66.6	196.7	240.3	15.3	26.3	10.2	3.06	15.7	5.96	4180	1670
191x229x53 +	457x191x106	52.9	194.0	234.6	12.6	20.6	10.2	3.91	18.6	5.73	3260	1260
191x229x49	457x191x98	49.1	192.8	233.5	11.4	19.6	10.2	4.11	20.5	5.53	2970	1170
191x229x45	457x191x89	44.6	191.9	231.6	10.5	17.7	10.2	4.55	22.1	5.47	2680	1040
191x229x41	457x191x82	41.0	191.3	229.9	9.9	16.0	10.2	5.03	23.2	5.47	2470	935
191x229x37	457x191x74	37.1	190.4	228.4	9.0	14.5	10.2	5.55	25.4	5.38	2220	836
191x229x34	457x191x67	33.5	189.9	226.6	8.5	12.7	10.2	6.34	26.7	5.46	2030	726
152x229x41	457x152x82	41.0	155.3	232.8	10.5	18.9	10.2	3.29	22.2	5.96	2600	592
152x229x37	457x152x74	37.1	154.4	230.9	9.6	17.0	10.2	3.66	24.1	5.88	2330	523
152x229x34	457x152x67	33.6	153.8	228.9	9.0	15.0	10.2	4.15	25.4	5.91	2120	456
152x229x30	457x152x60	29.9	152.9	227.2	8.1	13.3	10.2	4.68	28.0	5.84	1880	397
152x229x26	457x152x52	26.1	152.4	224.8	7.6	10.9	10.2	5.71	29.6	6.04	1670	322

Advance®, UKT and UKB are trademarks of Tata Steel. A fuller description of the relationship between Structural Tees and the Advance® range of sections manufactured by Tata Steel is given in note 12.

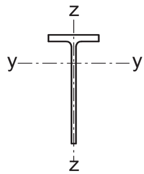
+ These sections are in addition to the range of BS 4 sections

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS 4-1:2005

STRUCTURAL TEES CUT FROM UNIVERSAL BEAMS

Advance® UKT split from Advance® UKB



Properties (continued)

Section Designation	Radius of Gyration		Elastic Modulus			Plastic Modulus		Buckling Parameter	Torsional Index	Mono-symmetry Index	Warping Constant (*)	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y Flange	Axis y-y Toe	Axis z-z	Axis y-y	Axis z-z	U	X	ψ	I_w	I_t	A
	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^3				cm^6	cm^4	cm^2
254x343x63	10.6	5.24	1010	358	173	643	271	0.651	21.9	0.740	2090	57.9	79.7
305x305x119	9.03	7.23	1740	501	509	894	787	0.483	10.6	0.662	11300	391	152
305x305x90	8.91	7.07	1350	372	371	656	572	0.484	13.8	0.664	4710	170	114
305x305x75	8.83	7.00	1150	307	305	538	469	0.483	16.4	0.666	2690	99.8	95.0
229x305x70	9.32	5.03	1020	333	196	592	306	0.613	15.3	0.727	2560	108	89.1
229x305x63	9.31	4.97	915	299	172	531	268	0.617	17.1	0.728	1840	76.9	79.7
229x305x57	9.33	4.88	826	275	150	489	235	0.626	19.0	0.731	1400	55.5	72.0
229x305x51	9.40	4.76	732	255	128	456	200	0.644	21.6	0.736	1080	38.3	64.4
178x305x50 +	9.60	3.60	688	270	92.5	490	148	0.694	19.4	0.768	1230	47.3	63.9
178x305x46 +	9.64	3.50	621	255	80.3	468	129	0.710	21.5	0.774	1050	35.3	58.7
178x305x41 +	9.64	3.40	545	230	67.8	425	109	0.722	24.3	0.778	780	24.3	52.1
312x267x136 +	7.81	7.69	1690	469	644	857	993	0.247	7.96	0.613	17300	642	174
312x267x110 +	7.82	7.48	1400	389	491	696	757	0.332	9.93	0.617	8730	320	139
312x267x91 +	7.72	7.40	1190	317	403	562	619	0.324	11.7	0.618	4920	186	116
312x267x75 +	7.65	7.32	1010	260	330	458	505	0.326	14.0	0.619	2780	108	95.9
210x267x69 +	8.24	4.68	862	292	181	520	284	0.609	12.5	0.719	2490	125	88.1
210x267x61	8.15	4.67	775	251	160	446	250	0.600	13.8	0.719	1660	88.9	77.7
210x267x55	8.14	4.60	697	226	140	401	218	0.605	15.5	0.721	1200	63.0	69.4
210x267x51	8.12	4.57	650	209	128	371	200	0.606	16.6	0.722	951	50.3	64.3
210x267x46	8.14	4.51	593	193	114	343	178	0.613	18.3	0.724	737	37.7	58.7
210x267x41	8.21	4.38	523	179	96.1	320	150	0.634	20.8	0.730	565	25.7	52.3
165x267x43 +	8.34	3.44	519	192	76.6	346	122	0.672	17.7	0.758	670	36.8	54.0
165x267x37 +	8.39	3.30	449	176	62.7	321	100	0.693	20.6	0.765	514	23.9	47.6
165x267x33 +	8.41	3.20	390	159	52.0	291	83.1	0.708	23.6	0.771	378	15.9	41.9
191x229x81 +	7.09	4.55	830	281	213	507	336	0.573	8.24	0.699	3780	256	103
191x229x67 +	7.01	4.44	702	231	170	414	267	0.576	9.82	0.702	2130	146	84.9
191x229x53 +	6.96	4.32	569	184	130	328	203	0.583	12.2	0.706	1070	72.6	67.4
191x229x49	6.88	4.33	536	167	122	296	189	0.573	12.9	0.705	835	60.5	62.6
191x229x45	6.87	4.29	491	152	109	269	169	0.576	14.1	0.706	628	45.2	56.9
191x229x41	6.88	4.23	452	141	97.8	250	152	0.583	15.5	0.709	494	34.5	52.2
191x229x37	6.86	4.20	413	127	87.8	225	136	0.583	16.9	0.709	365	25.8	47.3
191x229x34	6.90	4.12	372	118	76.5	209	119	0.597	18.9	0.713	280	18.5	42.7
152x229x41	7.05	3.37	436	150	76.3	267	120	0.634	13.7	0.740	534	44.5	52.3
152x229x37	7.03	3.33	397	135	67.8	242	107	0.636	15.1	0.742	396	32.9	47.2
152x229x34	7.04	3.27	359	125	59.3	223	93.3	0.646	16.8	0.745	305	23.8	42.8
152x229x30	7.02	3.23	322	111	52.0	199	81.5	0.648	18.8	0.746	217	16.9	38.1
152x229x26	7.08	3.11	276	102	42.3	183	66.6	0.671	22.0	0.753	161	10.7	33.3

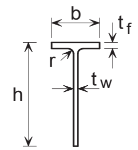
Advance®, UKT and UKB are trademarks of Tata Steel. A fuller description of the relationship between Structural Tees and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

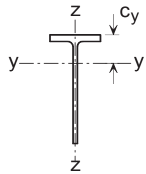
(*) Note units are cm^6 and not dm^6.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

STRUCTURAL TEES CUT FROM UNIVERSAL BEAMS



Advance® UKT split from Advance® UKB



Dimensions and properties

Section Designation	Cut from Universal Beam	Mass per Metre	Width of Section	Depth of Section	Thickness		Root Radius	Ratios for Local Buckling		Dimension	Second Moment of Area	
					Web	Flange		Flange	Web		Axis y-y	Axis z-z
	Section Designation		b	h	t_w	t_f	r	c_f/t_f	c_w/t_w	c_y		
		kg/m	mm	mm	mm	mm	mm			cm	cm^4	cm^4
178x203x43 +	406x178x85	42.6	181.9	208.6	10.9	18.2	10.2	4.14	19.1	4.91	2030	915
178x203x37	406x178x74	37.1	179.5	206.3	9.5	16.0	10.2	4.68	21.7	4.76	1740	773
178x203x34	406x178x67	33.5	178.8	204.6	8.8	14.3	10.2	5.23	23.3	4.73	1570	682
178x203x30	406x178x60	30.0	177.9	203.1	7.9	12.8	10.2	5.84	25.7	4.64	1400	602
178x203x27	406x178x54	27.0	177.7	201.2	7.7	10.9	10.2	6.86	26.1	4.83	1290	511
140x203x27 +	406x140x53	26.6	143.3	203.3	7.9	12.9	10.2	4.46	25.7	5.16	1320	317
140x203x23	406x140x46	23.0	142.2	201.5	6.8	11.2	10.2	5.13	29.6	5.02	1120	269
140x203x20	406x140x39	19.5	141.8	198.9	6.4	8.6	10.2	6.69	31.1	5.32	979	205
171x178x34	356x171x67	33.5	173.2	181.6	9.1	15.7	10.2	4.58	20.0	4.00	1150	681
171x178x29	356x171x57	28.5	172.2	178.9	8.1	13.0	10.2	5.53	22.1	3.97	986	554
171x178x26	356x171x51	25.5	171.5	177.4	7.4	11.5	10.2	6.25	24.0	3.94	882	484
171x178x23	356x171x45	22.5	171.1	175.6	7.0	9.7	10.2	7.41	25.1	4.05	798	406
127x178x20	356x127x39	19.5	126.0	176.6	6.6	10.7	10.2	4.63	26.8	4.43	728	179
127x178x17	356x127x33	16.5	125.4	174.4	6.0	8.5	10.2	5.82	29.1	4.56	626	140
165x152x27	305x165x54	27.0	166.9	155.1	7.9	13.7	8.9	5.15	19.6	3.21	642	531
165x152x23	305x165x46	23.0	165.7	153.2	6.7	11.8	8.9	5.98	22.9	3.07	536	448
165x152x20	305x165x40	20.1	165.0	151.6	6.0	10.2	8.9	6.92	25.3	3.03	468	382
127x152x24	305x127x48	24.0	125.3	155.4	9.0	14.0	8.9	3.52	17.3	3.94	662	231
127x152x21	305x127x42	20.9	124.3	153.5	8.0	12.1	8.9	4.07	19.2	3.87	573	194
127x152x19	305x127x37	18.5	123.4	152.1	7.1	10.7	8.9	4.60	21.4	3.78	501	168
102x152x17	305x102x33	16.4	102.4	156.3	6.6	10.8	7.6	3.73	23.7	4.14	487	97.1
102x152x14	305x102x28	14.1	101.8	154.3	6.0	8.8	7.6	4.58	25.7	4.20	420	77.7
102x152x13	305x102x25	12.4	101.6	152.5	5.8	7.0	7.6	5.76	26.3	4.43	377	61.5
146x127x22	254x146x43	21.5	147.3	129.7	7.2	12.7	7.6	4.92	18.0	2.64	343	339
146x127x19	254x146x37	18.5	146.4	127.9	6.3	10.9	7.6	5.73	20.3	2.55	292	285
146x127x16	254x146x31	15.5	146.1	125.6	6.0	8.6	7.6	7.26	20.9	2.66	259	224
102x127x14	254x102x28	14.1	102.2	130.1	6.3	10.0	7.6	4.04	20.7	3.24	277	89.3
102x127x13	254x102x25	12.6	101.9	128.5	6.0	8.4	7.6	4.80	21.4	3.32	250	74.3
102x127x11	254x102x22	11.0	101.6	126.9	5.7	6.8	7.6	5.93	22.3	3.45	223	59.7
133x102x15	203x133x30	15.0	133.9	103.3	6.4	9.6	7.6	5.85	16.1	2.11	154	192
133x102x13	203x133x25	12.5	133.2	101.5	5.7	7.8	7.6	7.20	17.8	2.10	131	154

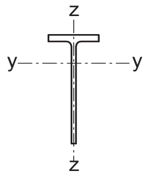
Advance®, UKT and UKB are trademarks of Tata Steel. A fuller description of the relationship between Structural Tees and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

STRUCTURAL TEES CUT FROM UNIVERSAL BEAMS

Advance® UKT split from Advance® UKB



Properties (continued)

Section Designation	Radius of Gyration		Elastic Modulus			Plastic Modulus		Buckling Parameter	Torsional Index	Mono-symmetry Index	Warping Constant (*)	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y Flange	Axis y-y Toe	Axis z-z	Axis y-y	Axis z-z	U	X	ψ	I_w	I_t	A
	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^3				cm^6	cm^4	cm^2
178x203x43 +	6.11	4.11	413	127	101	226	157	0.556	12.2	0.694	538	46.3	54.3
178x203x37	6.06	4.04	365	109	86.1	194	133	0.555	13.8	0.696	350	31.3	47.2
178x203x34	6.07	3.99	332	100	76.3	177	118	0.561	15.2	0.698	262	23.0	42.8
178x203x30	6.04	3.97	301	89.0	67.6	157	104	0.561	16.9	0.699	186	16.6	38.3
178x203x27	6.13	3.85	268	84.6	57.5	150	89.1	0.588	19.2	0.705	146	11.5	34.5
140x203x27 +	6.23	3.06	256	87.0	44.3	155	69.5	0.636	17.1	0.739	148	14.4	34.0
140x203x23	6.19	3.03	224	74.2	37.8	132	59.0	0.633	19.5	0.740	93.7	9.49	29.3
140x203x20	6.28	2.87	184	67.2	28.9	121	45.4	0.668	23.8	0.750	66.3	5.33	24.8
171x178x34	5.20	3.99	288	81.5	78.6	145	121	0.500	12.2	0.672	249	27.8	42.7
171x178x29	5.21	3.91	248	70.9	64.4	125	99.4	0.514	14.4	0.676	154	16.6	36.3
171x178x26	5.21	3.86	224	63.9	56.5	113	87.1	0.521	16.1	0.677	110	11.9	32.4
171x178x23	5.28	3.76	197	59.1	47.4	104	73.3	0.546	18.4	0.683	79.2	7.90	28.7
127x178x20	5.41	2.68	164	55.0	28.4	98.0	44.5	0.632	17.6	0.739	57.1	7.53	24.9
127x178x17	5.45	2.58	137	48.6	22.3	87.2	35.1	0.655	21.1	0.746	38.0	4.38	21.1
165x152x27	4.32	3.93	200	52.2	63.7	92.8	97.8	0.389	11.8	0.636	128	17.3	34.4
165x152x23	4.27	3.91	174	43.7	54.1	77.1	82.8	0.380	13.6	0.636	78.6	11.1	29.4
165x152x20	4.27	3.86	155	38.6	46.3	67.6	70.9	0.393	15.5	0.638	52.0	7.35	25.7
127x152x24	4.65	2.74	168	57.1	36.8	102	58.0	0.602	11.7	0.714	104	15.8	30.6
127x152x21	4.63	2.70	148	49.9	31.3	88.9	49.2	0.606	13.3	0.716	69.2	10.5	26.7
127x152x19	4.61	2.67	132	43.8	27.2	77.9	42.7	0.606	14.9	0.718	47.4	7.36	23.6
102x152x17	4.82	2.15	118	42.3	19.0	75.8	30.0	0.656	15.8	0.749	36.8	6.08	20.9
102x152x14	4.84	2.08	100.0	37.4	15.3	67.5	24.2	0.673	18.7	0.756	25.2	3.69	17.9
102x152x13	4.88	1.97	85.0	34.8	12.1	63.9	19.4	0.705	21.8	0.766	20.4	2.37	15.8
146x127x22	3.54	3.52	130	33.2	46.0	59.5	70.5	0.202	10.6	0.613	64.9	11.9	27.4
146x127x19	3.52	3.48	115	28.5	39.0	50.7	59.7	0.233	12.2	0.616	41.0	7.65	23.6
146x127x16	3.61	3.36	97.4	26.2	30.6	46.0	47.1	0.376	14.8	0.623	24.5	4.26	19.8
102x127x14	3.92	2.22	85.5	28.3	17.5	50.4	27.4	0.607	13.8	0.720	21.0	4.77	18.0
102x127x13	3.95	2.15	75.3	26.2	14.6	46.9	23.0	0.628	15.8	0.727	15.9	3.20	16.0
102x127x11	3.99	2.06	64.5	24.1	11.7	43.5	18.6	0.656	18.2	0.736	12.0	2.06	14.0
133x102x15	2.84	3.17	73.1	18.8	28.7	33.5	44.1	-	-	0.569	21.7	5.13	19.1
133x102x13	2.86	3.10	62.4	16.2	23.1	28.7	35.5	-	-	0.572	12.6	2.97	16.0

Advance®, UKT and UKB are trademarks of Tata Steel. A fuller description of the relationship between Structural Tees and the Advance® range of sections manufactured by Tata Steel is given in note 12.

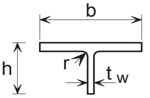
+ These sections are in addition to the range of BS 4 sections

(*) Note units are cm^6 and not dm^6.

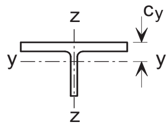
FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS 4-1:2005

STRUCTURAL TEES CUT FROM UNIVERSAL COLUMNS



Advance® UKT split from Advance® UKC



Dimensions

Section Designation	Cut from Universal Beam Section Designation	Mass per Metre	Width of Section	Depth of Section	Thickness		Root Radius	Ratios for Local Buckling		Dimension
					Web	Flange		Flange	Web	
			b	h	t_w	t_f	r	c_f/t_f	c_w/t_w	c_y
		kg/m	mm	mm	mm	mm	mm			cm
305x152x79	305x305x158	79.0	311.2	163.5	15.8	25.0	15.2	5.30	10.3	3.04
305x152x69	305x305x137	68.4	309.2	160.2	13.8	21.7	15.2	6.11	11.6	2.86
305x152x59	305x305x118	58.9	307.4	157.2	12.0	18.7	15.2	7.09	13.1	2.69
305x152x49	305x305x97	48.4	305.3	153.9	9.9	15.4	15.2	8.60	15.5	2.50
254x127x84	254x254x167	83.5	265.2	144.5	19.2	31.7	12.7	3.48	7.53	3.07
254x127x66	254x254x132	66.0	261.3	138.1	15.3	25.3	12.7	4.36	9.03	2.70
254x127x54	254x254x107	53.5	258.8	133.3	12.8	20.5	12.7	5.38	10.4	2.45
254x127x45	254x254x89	44.4	256.3	130.1	10.3	17.3	12.7	6.38	12.6	2.21
254x127x37	254x254x73	36.5	254.6	127.0	8.6	14.2	12.7	7.77	14.8	2.05
203x102x64 +	203x203x127	63.7	213.9	120.7	18.1	30.1	10.2	2.91	6.67	2.73
203x102x57 +	203x203x113	56.7	212.1	117.5	16.3	26.9	10.2	3.26	7.21	2.56
203x102x50 +	203x203x100	49.8	210.3	114.3	14.5	23.7	10.2	3.70	7.88	2.38
203x102x43	203x203x86	43.0	209.1	111.0	12.7	20.5	10.2	4.29	8.74	2.20
203x102x36	203x203x71	35.5	206.4	107.8	10.0	17.3	10.2	5.09	10.8	1.95
203x102x30	203x203x60	30.0	205.8	104.7	9.4	14.2	10.2	6.20	11.1	1.89
203x102x26	203x203x52	26.0	204.3	103.0	7.9	12.5	10.2	7.04	13.0	1.75
203x102x23	203x203x46	23.0	203.6	101.5	7.2	11.0	10.2	8.00	14.1	1.69
152x76x26 +	152x152x51	25.6	157.4	85.1	11.0	15.7	7.6	4.18	7.74	1.79
152x76x22 +	152x152x44	22.0	155.9	83.0	9.5	13.6	7.6	4.82	8.74	1.66
152x76x19	152x152x37	18.5	154.4	80.8	8.0	11.5	7.6	5.70	10.1	1.53
152x76x15	152x152x30	15.0	152.9	78.7	6.5	9.4	7.6	6.98	12.1	1.41
152x76x12	152x152x23	11.5	152.2	76.1	5.8	6.8	7.6	9.65	13.1	1.39

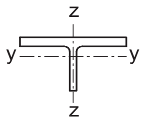
Advance®, UKT and UKC are trademarks of Tata Steel. A fuller description of the relationship between Structural Tees and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

STRUCTURAL TEES CUT FROM UNIVERSAL COLUMNS

Advance® UKT split from Advance® UKC



Properties

Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus			Plastic Modulus		Mono-symmetry Index	Warping Constant (*)	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y Flange	Axis y-y Toe	Axis z-z	Axis y-y	Axis z-z	ψ	I_w	I_t	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^3		cm^6	cm^4	cm^2
305x152x79	1530	6280	3.90	7.90	503	115	404	225	615	0.268	3650	188	101
305x152x69	1290	5350	3.84	7.83	450	97.7	346	188	526	0.263	2340	124	87.2
305x152x59	1080	4530	3.79	7.77	401	82.8	295	156	448	0.262	1470	80.3	75.1
305x152x49	858	3650	3.73	7.69	343	66.5	239	123	363	0.258	806	45.5	61.7
254x127x84	1200	4930	3.36	6.81	391	105	372	220	569	0.261	4540	312	106
254x127x66	871	3770	3.22	6.69	323	78.3	288	159	439	0.250	2200	159	84.1
254x127x54	676	2960	3.15	6.59	276	62.1	229	122	348	0.245	1150	85.9	68.2
254x127x45	524	2430	3.04	6.55	237	48.5	190	94.0	288	0.242	660	51.1	56.7
254x127x37	417	1950	2.99	6.48	204	39.2	153	74.0	233	0.236	359	28.8	46.5
203x102x64 +	637	2460	2.80	5.50	233	68.2	230	145	352	0.279	2050	212	81.2
203x102x57 +	540	2140	2.73	5.45	211	58.8	202	123	309	0.270	1430	152	72.3
203x102x50 +	453	1840	2.67	5.39	190	50.0	175	103	267	0.266	951	104	63.4
203x102x43	373	1560	2.61	5.34	169	41.9	150	84.6	228	0.257	605	68.1	54.8
203x102x36	280	1270	2.49	5.30	143	31.8	123	63.6	187	0.254	343	40.0	45.2
203x102x30	244	1030	2.53	5.20	129	28.4	100	54.3	153	0.245	195	23.5	38.2
203x102x26	200	889	2.46	5.18	115	23.4	87.0	44.5	132	0.243	128	15.8	33.1
203x102x23	177	774	2.45	5.13	105	20.9	76.0	39.0	115	0.242	87.2	11.0	29.4
152x76x26 +	141	511	2.08	3.96	79.0	21.0	64.9	41.4	99.5	0.281	122	24.3	32.6
152x76x22 +	116	430	2.04	3.92	70.0	17.5	55.2	34.0	84.4	0.281	76.7	15.8	28.0
152x76x19	93.1	353	1.99	3.87	60.7	14.2	45.7	27.1	69.8	0.277	44.9	9.54	23.5
152x76x15	72.2	280	1.94	3.83	51.4	11.2	36.7	20.9	55.8	0.269	23.7	5.24	19.1
152x76x12	58.5	200	2.00	3.70	41.9	9.41	26.3	16.9	40.1	0.278	9.78	2.30	14.6

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+ These sections are in addition to the range of BS 4 sections

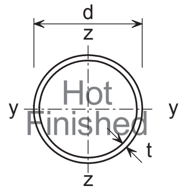
(*) Note units are cm^6 and not dm^6.

Values of U and X are not given, as lateral torsional buckling due to bending about the y-y axis is not possible, because the second moment of area about the z-z axis exceeds the second moment of area about the y-y axis.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

HOT-FINISHED
CIRCULAR HOLLOW SECTIONS

Celsius® CHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Outside Diameter d mm	Thickness t mm	kg/m	A cm^2	d/t	I cm^4	i cm	W_{el} cm^3	W_{pl} cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
21.3	2.6 #	1.20	1.53	8.19	0.681	0.668	0.639	0.915	1.36	1.28	0.067	55.9
	2.9 #	1.32	1.68	7.34	0.727	0.659	0.683	0.990	1.45	1.37	0.067	50.9
	3.2	1.43	1.82	6.66	0.768	0.650	0.722	1.06	1.54	1.44	0.067	46.9
26.9	2.6 #	1.56	1.98	10.3	1.48	0.864	1.10	1.54	2.96	2.20	0.085	54.6
	2.9 #	1.72	2.19	9.28	1.60	0.855	1.19	1.68	3.19	2.38	0.085	49.6
	3.2	1.87	2.38	8.41	1.70	0.846	1.27	1.81	3.41	2.53	0.085	45.5
	3.6 #	2.07	2.64	7.47	1.83	0.834	1.36	1.97	3.66	2.72	0.085	41.1
33.7	2.6 #	1.99	2.54	13.0	3.09	1.10	1.84	2.52	6.19	3.67	0.106	53.1
	2.9 #	2.20	2.81	11.6	3.36	1.09	1.99	2.76	6.71	3.98	0.106	48.1
	3.2	2.41	3.07	10.5	3.60	1.08	2.14	2.99	7.21	4.28	0.106	44.0
	3.6 #	2.67	3.40	9.36	3.91	1.07	2.32	3.28	7.82	4.64	0.106	39.6
	4.0	2.93	3.73	8.43	4.19	1.06	2.49	3.55	8.38	4.97	0.106	36.1
	4.5 #	3.24	4.13	7.49	4.50	1.04	2.67	3.87	9.01	5.35	0.106	32.8
	5.0 #	3.54	4.51	6.74	4.78	1.03	2.84	4.16	9.57	5.68	0.106	30.0
42.4	2.6 #	2.55	3.25	16.3	6.46	1.41	3.05	4.12	12.9	6.10	0.133	52.1
	2.9 #	2.82	3.60	14.6	7.06	1.40	3.33	4.53	14.1	6.66	0.133	47.1
	3.2	3.09	3.94	13.3	7.62	1.39	3.59	4.93	15.2	7.19	0.133	43.0
	3.6 #	3.44	4.39	11.8	8.33	1.38	3.93	5.44	16.7	7.86	0.133	38.6
	4.0	3.79	4.83	10.6	8.99	1.36	4.24	5.92	18.0	8.48	0.133	35.1
	4.5 #	4.21	5.36	9.42	9.76	1.35	4.60	6.49	19.5	9.20	0.133	31.7
	5.0 #	4.61	5.87	8.48	10.5	1.33	4.93	7.04	20.9	9.86	0.133	28.9
48.3	2.6 #	2.93	3.73	18.6	9.78	1.62	4.05	5.44	19.6	8.10	0.152	51.8
	2.9 #	3.25	4.14	16.7	10.7	1.61	4.43	5.99	21.4	8.86	0.152	46.8
	3.2	3.56	4.53	15.1	11.6	1.60	4.80	6.52	23.2	9.59	0.152	42.7
	3.6 #	3.97	5.06	13.4	12.7	1.59	5.26	7.21	25.4	10.5	0.152	38.3
	4.0	4.37	5.57	12.1	13.8	1.57	5.70	7.87	27.5	11.4	0.152	34.8
	4.5 #	4.86	6.19	10.7	15.0	1.56	6.21	8.66	30.0	12.4	0.152	31.3
	5.0	5.34	6.80	9.66	16.2	1.54	6.69	9.42	32.3	13.4	0.152	28.4
	5.6 #	5.90	7.51	8.63	17.4	1.52	7.21	10.3	34.8	14.4	0.152	25.8
	6.3	6.53	8.31	7.67	18.7	1.50	7.76	11.2	37.5	15.5	0.152	23.3
60.3	2.6 #	3.70	4.71	23.2	19.7	2.04	6.52	8.66	39.3	13.0	0.189	51.0
	2.9 #	4.11	5.23	20.8	21.6	2.03	7.16	9.56	43.2	14.3	0.189	46.1
	3.2	4.51	5.74	18.8	23.5	2.02	7.78	10.4	46.9	15.6	0.189	42.0
	3.6 #	5.03	6.41	16.8	25.9	2.01	8.58	11.6	51.7	17.2	0.189	37.6
	4.0	5.55	7.07	15.1	28.2	2.00	9.34	12.7	56.3	18.7	0.189	34.0
	4.5 #	6.19	7.89	13.4	30.9	1.98	10.2	14.0	61.8	20.5	0.189	30.4
	5.0	6.82	8.69	12.1	33.5	1.96	11.1	15.3	67.0	22.2	0.189	27.8
	5.6 #	7.55	9.62	10.8	36.4	1.94	12.1	16.8	72.7	24.1	0.189	24.9
	6.3	8.39	10.7	9.57	39.5	1.92	13.1	18.5	79.0	26.2	0.189	22.5
	8.0 #	10.3	13.1	7.54	46.0	1.87	15.3	22.1	92.0	30.5	0.189	18.3

Celsius® is a trademark of Tata Steel. A fuller description of the relationship between Hot Finished Circular Hollow Sections (HFCHS) and the Celsius® range of sections manufactured by Tata Steel is given in note 12.

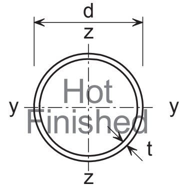
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED
CIRCULAR HOLLOW SECTIONS

Celsius® CHS



Dimensions and properties

Section Designation		Mass per	Area of	Ratio for	Second Moment	Radius of	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Outside Diameter d mm	Thickness t mm	Metre kg/m	Section A cm^2	Local Buckling d/t	of Area I cm^4	Gyration i cm	W_{el} cm^3	W_{pl} cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
76.1	2.9	5.24	6.67	26.2	44.7	2.59	11.8	15.5	89.5	23.5	0.239	45.6
	3.2	5.75	7.33	23.8	48.8	2.58	12.8	17.0	97.6	25.6	0.239	41.6
	3.6 #	6.44	8.20	21.1	54.0	2.57	14.2	18.9	108	28.4	0.239	37.0
	4.0	7.11	9.06	19.0	59.1	2.55	15.5	20.8	118	31.0	0.239	33.7
	4.5 #	7.95	10.1	16.9	65.1	2.54	17.1	23.1	130	34.2	0.239	30.1
	5.0	8.77	11.2	15.2	70.9	2.52	18.6	25.3	142	37.3	0.239	27.2
	5.6 #	9.74	12.4	13.6	77.5	2.50	20.4	27.9	155	40.8	0.239	24.6
	6.3	10.8	13.8	12.1	84.8	2.48	22.3	30.8	170	44.6	0.239	22.0
	8.0	13.4	17.1	9.51	101	2.42	26.4	37.3	201	52.9	0.239	17.8
88.9	2.9 #	6.15	7.84	30.7	72.5	3.04	16.3	21.5	145	32.6	0.279	45.5
	3.2 #	6.76	8.62	27.8	79.2	3.03	17.8	23.5	158	35.6	0.279	41.3
	3.6 #	7.57	9.65	24.7	87.9	3.02	19.8	26.2	176	39.5	0.279	36.8
	4.0	8.38	10.7	22.2	96.3	3.00	21.7	28.9	193	43.3	0.279	33.2
	4.5 #	9.37	11.9	19.8	107	2.99	24.0	32.1	213	47.9	0.279	29.9
	5.0	10.3	13.2	17.8	116	2.97	26.2	35.2	233	52.4	0.279	27.0
	5.6 #	11.5	14.7	15.9	128	2.95	28.7	38.9	255	57.5	0.279	24.2
	6.3	12.8	16.3	14.1	140	2.93	31.5	43.1	280	63.1	0.279	21.7
	8.0	16.0	20.3	11.1	168	2.87	37.8	52.5	336	75.6	0.279	17.5
	10.0 #	19.5	24.8	8.89	196	2.81	44.1	62.6	392	88.2	0.279	14.3
101.6	3.2 #	7.77	9.89	31.8	120	3.48	23.6	31.0	240	47.2	0.319	41.2
	3.6 #	8.70	11.1	28.2	133	3.47	26.2	34.6	266	52.5	0.319	36.7
	4.0 #	9.63	12.3	25.4	146	3.45	28.8	38.1	293	57.6	0.319	33.2
	4.5 #	10.8	13.7	22.6	162	3.44	31.9	42.5	324	63.8	0.319	29.6
	5.0 #	11.9	15.2	20.3	177	3.42	34.9	46.7	355	69.9	0.319	26.8
	5.6 #	13.3	16.9	18.1	195	3.40	38.4	51.7	390	76.9	0.319	24.1
	6.3 #	14.8	18.9	16.1	215	3.38	42.3	57.3	430	84.7	0.319	21.5
	8.0 #	18.5	23.5	12.7	260	3.32	51.1	70.3	519	102	0.319	17.3
	10.0 #	22.6	28.8	10.2	305	3.26	60.1	84.2	611	120	0.319	14.1
114.3	3.2 #	8.77	11.2	35.7	172	3.93	30.2	39.5	345	60.4	0.359	40.9
	3.6	9.83	12.5	31.8	192	3.92	33.6	44.1	384	67.2	0.359	36.6
	4.0	10.9	13.9	28.6	211	3.90	36.9	48.7	422	73.9	0.359	33.0
	4.5 #	12.2	15.5	25.4	234	3.89	41.0	54.3	469	82.0	0.359	29.5
	5.0	13.5	17.2	22.9	257	3.87	45.0	59.8	514	89.9	0.359	26.6
	5.6 #	15.0	19.1	20.4	283	3.85	49.6	66.2	566	99.1	0.359	23.9
	6.3	16.8	21.4	18.1	313	3.82	54.7	73.6	625	109	0.359	21.4
	8.0	21.0	26.7	14.3	379	3.77	66.4	90.6	759	133	0.359	17.1
	10.0 #	25.7	32.8	11.4	450	3.70	78.7	109	899	157	0.359	14.0

Celsius® is a trademark of Tata Steel. A fuller description of the relationship between Hot Finished Circular Hollow Sections (HFCHS) and the Celsius® range of sections manufactured by Tata Steel is given in note 12.

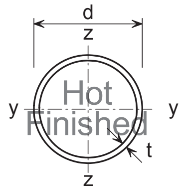
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED
CIRCULAR HOLLOW SECTIONS

Celsius® CHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Outside Diameter d mm	Thickness t mm	kg/m	A cm^2	d/t	I cm^4	i cm	W_{el} cm^3	W_{pl} cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
139.7	3.2 #	10.8	13.7	43.7	320	4.83	45.8	59.6	640	91.6	0.439	40.7
	3.6 #	12.1	15.4	38.8	357	4.81	51.1	66.7	713	102	0.439	36.3
	4.0 #	13.4	17.1	34.9	393	4.80	56.2	73.7	786	112	0.439	32.8
	4.5 #	15.0	19.1	31.0	437	4.78	62.6	82.3	874	125	0.439	29.2
	5.0	16.6	21.2	27.9	481	4.77	68.8	90.8	961	138	0.439	26.4
	5.6 #	18.5	23.6	24.9	531	4.75	76.1	101	1060	152	0.439	23.7
	6.3	20.7	26.4	22.2	589	4.72	84.3	112	1180	169	0.439	21.2
	8.0	26.0	33.1	17.5	720	4.66	103	139	1440	206	0.439	16.9
	10.0	32.0	40.7	14.0	862	4.60	123	169	1720	247	0.439	13.7
	12.5 #	39.2	50.0	11.2	1020	4.52	146	203	2040	292	0.439	11.2
168.3	5.0	20.1	25.7	33.7	856	5.78	102	133	1710	203	0.529	26.3
	5.6 #	22.5	28.6	30.1	948	5.76	113	148	1900	225	0.529	23.5
	6.3	25.2	32.1	26.7	1050	5.73	125	165	2110	250	0.529	21.0
	8.0	31.6	40.3	21.0	1300	5.67	154	206	2600	308	0.529	16.7
	10.0	39.0	49.7	16.8	1560	5.61	186	251	3130	372	0.529	13.5
	12.5	48.0	61.2	13.5	1870	5.53	222	304	3740	444	0.529	11.0
193.7	5.0	23.3	29.6	38.7	1320	6.67	136	178	2640	273	0.609	26.2
	5.6 #	26.0	33.1	34.6	1470	6.65	151	198	2930	303	0.609	23.4
	6.3	29.1	37.1	30.7	1630	6.63	168	221	3260	337	0.609	20.9
	8.0	36.6	46.7	24.2	2020	6.57	208	276	4030	416	0.609	16.6
	10.0	45.3	57.7	19.4	2440	6.50	252	338	4880	504	0.609	13.5
	12.5	55.9	71.2	15.5	2930	6.42	303	411	5870	606	0.609	10.9
	16.0 #	70.1	89.3	12.1	3550	6.31	367	507	7110	734	0.609	8.71
219.1	4.5 #	23.8	30.3	48.7	1750	7.59	159	207	3490	319	0.688	28.9
	5.0 #	26.4	33.6	43.8	1930	7.57	176	229	3860	352	0.688	26.1
	5.6 #	29.5	37.6	39.1	2140	7.55	195	255	4280	391	0.688	23.3
	6.3	33.1	42.1	34.8	2390	7.53	218	285	4770	436	0.688	20.8
	8.0	41.6	53.1	27.4	2960	7.47	270	357	5920	540	0.688	16.5
	10.0	51.6	65.7	21.9	3600	7.40	328	438	7200	657	0.688	13.3
	12.5	63.7	81.1	17.5	4350	7.32	397	534	8690	793	0.688	10.8
	14.2 #	71.8	91.4	15.4	4820	7.26	440	597	9640	880	0.688	9.56
	16.0	80.1	102	13.7	5300	7.20	483	661	10600	967	0.688	8.60
244.5	5.0 #	29.5	37.6	48.9	2700	8.47	221	287	5400	441	0.768	26.0
	5.6 #	33.0	42.0	43.7	3000	8.45	245	320	6000	491	0.768	23.3
	6.3 #	37.0	47.1	38.8	3350	8.42	274	358	6690	547	0.768	20.7
	8.0 #	46.7	59.4	30.6	4160	8.37	340	448	8320	681	0.768	16.4
	10.0 #	57.8	73.7	24.5	5070	8.30	415	550	10100	830	0.768	13.3
	12.5	71.5	91.1	19.6	6150	8.21	503	673	12300	1010	0.768	10.8
	14.2 #	80.6	103	17.2	6840	8.16	559	754	13700	1120	0.768	9.52
	16.0	90.2	115	15.3	7530	8.10	616	837	15100	1230	0.768	8.52

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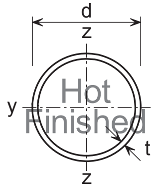
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED CIRCULAR HOLLOW SECTIONS

Celsius® CHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Outside Diameter	Thickness										Per Metre	Per Tonne
d	t		A	d/t	I	i	W_{el}	W_{pl}	I_T	W_t		
mm	mm	kg/m	cm^2		cm^4	cm	cm^3	cm^3	cm^4	cm^3	m^2	m^2
273.0	5.0 #	33.0	42.1	54.6	3780	9.48	277	359	7560	554	0.858	26.0
	5.6 #	36.9	47.0	48.8	4210	9.46	308	400	8410	616	0.858	23.3
	6.3 #	41.4	52.8	43.3	4700	9.43	344	448	9390	688	0.858	20.7
	8.0 #	52.3	66.6	34.1	5850	9.37	429	562	11700	857	0.858	16.4
	10.0	64.9	82.6	27.3	7150	9.31	524	692	14300	1050	0.858	13.2
	12.5	80.3	102	21.8	8700	9.22	637	849	17400	1270	0.858	10.7
	14.2 #	90.6	115	19.2	9700	9.16	710	952	19400	1420	0.858	9.44
	16.0	101	129	17.1	10700	9.10	784	1060	21400	1570	0.858	8.46
323.9	5.0 #	39.3	50.1	64.8	6370	11.3	393	509	12700	787	1.02	25.9
	5.6 #	44.0	56.0	57.8	7090	11.3	438	567	14200	876	1.02	23.2
	6.3 #	49.3	62.9	51.4	7930	11.2	490	636	15900	979	1.02	20.7
	8.0 #	62.3	79.4	40.5	9910	11.2	612	799	19800	1220	1.02	16.3
	10.0	77.4	98.6	32.4	12200	11.1	751	986	24300	1500	1.02	13.2
	12.5	96.0	122	25.9	14800	11.0	917	1210	29700	1830	1.02	10.6
	14.2 #	108	138	22.8	16600	11.0	1030	1360	33200	2050	1.02	9.40
	16.0	121	155	20.2	18400	10.9	1140	1520	36800	2270	1.02	8.39
355.6	6.3 #	54.3	69.1	56.4	10500	12.4	593	769	21100	1190	1.12	20.6
	8.0 #	68.6	87.4	44.5	13200	12.3	742	967	26400	1490	1.12	16.4
	10.0 #	85.2	109	35.6	16200	12.2	912	1200	32400	1830	1.12	13.1
	12.5 #	106	135	28.4	19900	12.1	1120	1470	39700	2230	1.12	10.6
	14.2 #	120	152	25.0	22200	12.1	1250	1660	44500	2500	1.12	9.36
	16.0	134	171	22.2	24700	12.0	1390	1850	49300	2770	1.12	8.36
406.4	6.3 #	62.2	79.2	64.5	15800	14.1	780	1010	31700	1560	1.28	20.6
	8.0 #	78.6	100	50.8	19900	14.1	978	1270	39700	1960	1.28	16.3
	10.0	97.8	125	40.6	24500	14.0	1210	1570	49000	2410	1.28	13.1
	12.5 #	121	155	32.5	30000	13.9	1480	1940	60100	2960	1.28	10.5
	14.2 #	137	175	28.6	33700	13.9	1660	2190	67400	3320	1.28	9.32
	16.0	154	196	25.4	37400	13.8	1840	2440	74900	3690	1.28	8.31
457.0	6.3 #	70.0	89.2	72.5	22700	15.9	991	1280	45300	1980	1.44	20.6
	8.0 #	88.6	113	57.1	28400	15.9	1250	1610	56900	2490	1.44	16.3
	10.0	110	140	45.7	35100	15.8	1540	2000	70200	3070	1.44	13.1
	12.5 #	137	175	36.6	43100	15.7	1890	2470	86300	3780	1.44	10.5
	14.2 #	155	198	32.2	48500	15.7	2120	2790	96900	4240	1.44	9.29
	16.0	174	222	28.6	54000	15.6	2360	3110	108000	4720	1.44	8.28
508.0	6.3 #	77.9	99.3	80.6	31200	17.7	1230	1590	62500	2460	1.60	20.5
	8.0 #	98.6	126	63.5	39300	17.7	1550	2000	78600	3090	1.60	16.2
	10.0 #	123	156	50.8	48500	17.6	1910	2480	97000	3820	1.60	13.0
	12.5	153	195	40.6	59800	17.5	2350	3070	120000	4710	1.60	10.5
	14.2 #	173	220	35.8	67200	17.5	2650	3460	134000	5290	1.60	9.25
	16.0	194	247	31.8	74900	17.4	2950	3870	150000	5900	1.60	8.24

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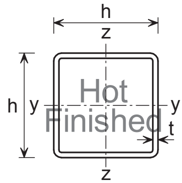
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED
SQUARE HOLLOW SECTIONS

Celsius® SHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Size	Thickness										Per Metre	Per Tonne
h x h	t		A	c/t (1)	I	i	W_{el}	W_{pl}	I_T	W_t		
mm	mm	kg/m	cm^2		cm^4	cm	cm^3	cm^3	cm^4	cm^3	m^2	m^2
40 x 40	3.0 #	3.41	4.34	10.3	9.78	1.50	4.89	5.97	15.7	7.10	0.152	44.5
	3.2	3.61	4.60	9.50	10.2	1.49	5.11	6.28	16.5	7.42	0.152	42.1
	3.6 #	4.01	5.10	8.11	11.1	1.47	5.54	6.88	18.1	8.01	0.151	37.8
	4.0	4.39	5.59	7.00	11.8	1.45	5.91	7.44	19.5	8.54	0.150	34.2
	5.0	5.28	6.73	5.00	13.4	1.41	6.68	8.66	22.5	9.60	0.147	27.8
50 x 50	3.0 #	4.35	5.54	13.7	20.2	1.91	8.08	9.70	32.1	11.8	0.192	44.2
	3.2	4.62	5.88	12.6	21.2	1.90	8.49	10.2	33.8	12.4	0.192	41.7
	3.6 #	5.14	6.54	10.9	23.2	1.88	9.27	11.3	37.2	13.5	0.191	37.2
	4.0	5.64	7.19	9.50	25.0	1.86	9.99	12.3	40.4	14.5	0.190	33.6
	5.0	6.85	8.73	7.00	28.9	1.82	11.6	14.5	47.6	16.7	0.187	27.3
	6.3	8.31	10.6	4.94	32.8	1.76	13.1	17.0	55.2	18.8	0.184	22.1
	7.1 #	9.14	11.6	4.04	34.5	1.72	13.8	18.3	58.9	19.8	0.182	19.8
	8.0 #	10.0	12.8	3.25	36.0	1.68	14.4	19.5	62.3	20.6	0.179	17.9
60 x 60	3.0 #	5.29	6.74	17.0	36.2	2.32	12.1	14.3	56.9	17.7	0.232	43.8
	3.2	5.62	7.16	15.8	38.2	2.31	12.7	15.2	60.2	18.6	0.232	41.3
	3.6 #	6.27	7.98	13.7	41.9	2.29	14.0	16.8	66.5	20.4	0.231	37.0
	4.0	6.90	8.79	12.0	45.4	2.27	15.1	18.3	72.5	22.0	0.230	33.4
	5.0	8.42	10.7	9.00	53.3	2.23	17.8	21.9	86.4	25.7	0.227	27.0
	6.3	10.3	13.1	6.52	61.6	2.17	20.5	26.0	102	29.6	0.224	21.8
	7.1 #	11.4	14.5	5.45	65.8	2.13	21.9	28.2	110	31.6	0.222	19.5
	8.0	12.5	16.0	4.50	69.7	2.09	23.2	30.4	118	33.4	0.219	17.5
70 x 70	3.0 #	6.24	7.94	20.3	59.0	2.73	16.9	19.9	92.2	24.8	0.272	43.5
	3.2	6.63	8.44	18.9	62.3	2.72	17.8	21.0	97.6	26.1	0.272	41.1
	3.6 #	7.40	9.42	16.4	68.6	2.70	19.6	23.3	108	28.7	0.271	36.6
	4.0	8.15	10.4	14.5	74.7	2.68	21.3	25.5	118	31.2	0.270	33.2
	5.0	9.99	12.7	11.0	88.5	2.64	25.3	30.8	142	36.8	0.267	26.7
	6.3	12.3	15.6	8.11	104	2.58	29.7	36.9	169	42.9	0.264	21.5
	7.1 #	13.6	17.3	6.86	112	2.54	32.0	40.3	185	46.1	0.262	19.3
	8.0	15.0	19.2	5.75	120	2.50	34.2	43.8	200	49.2	0.259	17.2
	8.8 #	16.3	20.7	4.95	126	2.46	35.9	46.6	212	51.6	0.257	15.8
80 x 80	3.0 #	7.18	9.14	23.7	89.8	3.13	22.5	26.3	140	33.0	0.312	43.4
	3.2	7.63	9.72	22.0	95.0	3.13	23.7	27.9	148	34.9	0.312	40.9
	3.6 #	8.53	10.9	19.2	105	3.11	26.2	31.0	164	38.5	0.311	36.4
	4.0	9.41	12.0	17.0	114	3.09	28.6	34.0	180	41.9	0.310	32.9
	5.0	11.6	14.7	13.0	137	3.05	34.2	41.1	217	49.8	0.307	26.6
	6.3	14.2	18.1	9.70	162	2.99	40.5	49.7	262	58.7	0.304	21.3
	7.1 #	15.8	20.2	8.27	176	2.95	43.9	54.5	286	63.5	0.302	19.1
	8.0	17.5	22.4	7.00	189	2.91	47.3	59.5	312	68.3	0.299	17.0
	8.8 #	19.0	24.2	6.09	200	2.87	50.0	63.7	332	72.0	0.297	15.6
	10.0 #	21.1	26.9	5.00	214	2.82	53.5	69.3	360	76.8	0.294	13.9
	12.5 #	25.2	32.1	3.40	234	2.70	58.6	78.9	404	83.8	0.288	11.4

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(1) For local buckling calculation c = h - 3t.

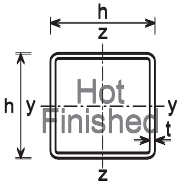
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED
SQUARE HOLLOW SECTIONS

Celsius® SHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Size	Thickness										Per Metre	Per Tonne
h x h	t		A	c/t (1)	I	i	W_{el}	W_{pl}	I_T	W_t		
mm	mm	kg/m	cm^2		cm^4	cm	cm^3	cm^3	cm^4	cm^3	m^2	m^2
90 x 90	3.6 #	9.66	12.3	22.0	152	3.52	33.8	39.7	237	49.7	0.351	36.5
	4.0	10.7	13.6	19.5	166	3.50	37.0	43.6	260	54.2	0.350	32.8
	5.0	13.1	16.7	15.0	200	3.45	44.4	53.0	316	64.8	0.347	26.4
	6.3	16.2	20.7	11.3	238	3.40	53.0	64.3	382	77.0	0.344	21.2
	7.1 #	18.1	23.0	9.68	260	3.36	57.7	70.8	419	83.7	0.342	18.9
	8.0	20.1	25.6	8.25	281	3.32	62.6	77.6	459	90.5	0.339	16.9
	8.8 #	21.8	27.8	7.23	299	3.28	66.5	83.4	492	96.0	0.337	15.5
	10.0 #	24.3	30.9	6.00	322	3.23	71.6	91.3	536	103	0.334	13.8
	12.5 #	29.1	37.1	4.20	359	3.11	79.8	105	612	114	0.328	11.3
100 x 100	3.6	10.8	13.7	24.8	212	3.92	42.3	49.5	328	62.3	0.391	36.2
	4.0	11.9	15.2	22.0	232	3.91	46.4	54.4	361	68.2	0.390	32.7
	5.0	14.7	18.7	17.0	279	3.86	55.9	66.4	439	81.8	0.387	26.3
	6.3	18.2	23.2	12.9	336	3.80	67.1	80.9	534	97.8	0.384	21.1
	7.1 #	20.3	25.8	11.1	367	3.77	73.4	89.2	589	107	0.382	18.8
	8.0	22.6	28.8	9.50	400	3.73	79.9	98.2	646	116	0.379	16.8
	8.8 #	24.5	31.3	8.36	426	3.69	85.2	106	694	123	0.377	15.3
	10.0	27.4	34.9	7.00	462	3.64	92.4	116	761	133	0.374	13.7
	12.5 #	33.0	42.1	5.00	522	3.52	104	135	879	150	0.368	11.2
120 x 120	4.0 #	14.4	18.4	27.0	410	4.72	68.4	79.7	635	101	0.470	32.6
	5.0	17.8	22.7	21.0	498	4.68	83.0	97.6	777	122	0.467	26.2
	6.3	22.2	28.2	16.0	603	4.62	100	120	950	147	0.464	20.9
	7.1 #	24.7	31.5	13.9	663	4.59	110	133	1050	161	0.462	18.7
	8.0	27.6	35.2	12.0	726	4.55	121	146	1160	176	0.459	16.6
	8.8 #	30.1	38.3	10.6	779	4.51	130	158	1250	189	0.457	15.2
	10.0	33.7	42.9	9.00	852	4.46	142	175	1380	206	0.454	13.5
	12.5	40.9	52.1	6.60	982	4.34	164	207	1620	236	0.448	11.0
140 x 140	5.0	21.0	26.7	25.0	807	5.50	115	135	1250	170	0.547	26.1
	6.3	26.1	33.3	19.2	984	5.44	141	166	1540	206	0.544	20.8
	7.1 #	29.2	37.2	16.7	1090	5.40	155	184	1710	227	0.542	18.5
	8.0	32.6	41.6	14.5	1200	5.36	171	204	1890	249	0.539	16.5
	8.8 #	35.6	45.4	12.9	1290	5.33	184	221	2050	268	0.537	15.1
	10.0	40.0	50.9	11.0	1420	5.27	202	246	2270	294	0.534	13.4
	12.5	48.7	62.1	8.20	1650	5.16	236	293	2700	342	0.528	10.8

Celsius® is a trademark of Tata Steel. A fuller description of the relationship between Hot Finished Square Hollow Sections (HFSHS) and the Celsius® range of sections manufactured by Tata Steel is given in note 12.

(1) For local buckling calculation c = h - 3t.

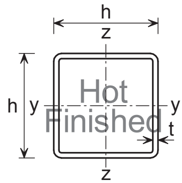
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED
SQUARE HOLLOW SECTIONS

Celsius® SHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Size	Thickness										Per Metre	Per Tonne
h x h	t		A	c/t [(1)]	I	i	W_{el}	W_{pl}	I_T	W_t		
mm	mm	kg/m	cm^2		cm^4	cm	cm^3	cm^3	cm^4	cm^3	m^2	m^2
150 x 150	5.0	22.6	28.7	27.0	1000	5.90	134	156	1550	197	0.587	26.0
	6.3	28.1	35.8	20.8	1220	5.85	163	192	1910	240	0.584	20.8
	7.1 #	31.4	40.0	18.1	1350	5.81	180	213	2120	264	0.582	18.5
	8.0	35.1	44.8	15.8	1490	5.77	199	237	2350	291	0.579	16.5
	8.8 #	38.4	48.9	14.0	1610	5.74	214	257	2550	313	0.577	15.1
	10.0	43.1	54.9	12.0	1770	5.68	236	286	2830	344	0.574	13.3
	12.5	52.7	67.1	9.00	2080	5.57	277	342	3380	402	0.568	10.8
	14.2 #	58.9	75.0	7.56	2260	5.49	302	377	3710	436	0.563	9.57
	16.0 # r	65.2	83.0	6.38	2430	5.41	324	411	4030	467	0.559	8.55
160 x 160	5.0 #	24.1	30.7	29.0	1230	6.31	153	178	1890	226	0.627	26.0
	6.3	30.1	38.3	22.4	1500	6.26	187	220	2330	275	0.624	20.8
	7.1 #	33.7	42.9	19.5	1660	6.22	207	245	2600	304	0.622	18.5
	8.0	37.6	48.0	17.0	1830	6.18	229	272	2880	335	0.619	16.5
	8.8 #	41.1	52.4	15.2	1980	6.14	247	295	3130	361	0.617	15.0
	10.0	46.3	58.9	13.0	2190	6.09	273	329	3480	398	0.614	13.3
	12.5	56.6	72.1	9.80	2580	5.98	322	395	4160	467	0.608	10.8
	14.2 #	63.3	80.7	8.27	2810	5.90	351	436	4580	508	0.603	9.53
	16.0 #	70.2	89.4	7.00	3030	5.82	379	476	4990	546	0.599	8.51
180 x 180	5.0 #	27.3	34.7	33.0	1770	7.13	196	227	2720	290	0.707	25.9
	6.3	34.0	43.3	25.6	2170	7.07	241	281	3360	355	0.704	20.7
	7.1 #	38.1	48.6	22.4	2400	7.04	267	314	3740	393	0.702	18.4
	8.0	42.7	54.4	19.5	2660	7.00	296	349	4160	434	0.699	16.4
	8.8 #	46.7	59.4	17.5	2880	6.96	320	379	4520	469	0.697	14.9
	10.0	52.5	66.9	15.0	3190	6.91	355	424	5050	518	0.694	13.2
	12.5	64.4	82.1	11.4	3790	6.80	421	511	6070	613	0.688	10.7
	14.2 #	72.2	92.0	9.68	4150	6.72	462	566	6710	670	0.683	9.43
	16.0	80.2	102	8.25	4500	6.64	500	621	7340	724	0.679	8.49
200 x 200	5.0	30.4	38.7	37.0	2450	7.95	245	283	3760	362	0.787	25.9
	6.3	38.0	48.4	28.7	3010	7.89	301	350	4650	444	0.784	20.6
	7.1 #	42.6	54.2	25.2	3350	7.85	335	391	5190	493	0.782	18.4
	8.0	47.7	60.8	22.0	3710	7.81	371	436	5780	545	0.779	16.4
	8.8 #	52.2	66.5	19.7	4020	7.78	402	474	6290	590	0.777	14.9
	10.0	58.8	74.9	17.0	4470	7.72	447	531	7030	655	0.774	13.2
	12.5	72.3	92.1	13.0	5340	7.61	534	643	8490	778	0.768	10.6
	14.2 #	81.1	103	11.1	5870	7.54	587	714	9420	854	0.763	9.38
	16.0	90.3	115	9.50	6390	7.46	639	785	10300	927	0.759	8.42

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(1) For local buckling calculation c = h - 3t.

r External corner radius >2T but ≤3T

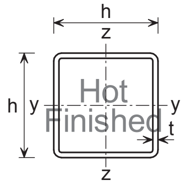
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED
SQUARE HOLLOW SECTIONS

Celsius® SHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Size	Thickness										Per Metre	Per Tonne
h x h	t		A	c/t (1)	I	i	W_{el}	W_{pl}	I_T	W_t		
mm	mm	kg/m	cm^2		cm^4	cm	cm^3	cm^3	cm^4	cm^3	m^2	m^2
250 x 250	5.0 #	38.3	48.7	47.0	4860	9.99	389	447	7430	577	0.987	25.8
	6.3	47.9	61.0	36.7	6010	9.93	481	556	9240	712	0.984	20.6
	7.1 #	53.7	68.4	32.2	6700	9.90	536	622	10300	792	0.982	18.3
	8.0	60.3	76.8	28.3	7460	9.86	596	694	11500	880	0.979	16.3
	8.8 #	66.0	84.1	25.4	8110	9.82	649	758	12600	955	0.977	14.9
	10.0	74.5	94.9	22.0	9060	9.77	724	851	14100	1070	0.974	13.1
	12.5	91.9	117	17.0	10900	9.66	873	1040	17200	1280	0.968	10.6
	14.2 #	103	132	14.6	12100	9.58	967	1160	19100	1410	0.963	9.31
	16.0	115	147	12.6	13300	9.50	1060	1280	21100	1550	0.959	8.31
260 x 260	6.3 #	49.9	63.5	38.3	6790	10.3	522	603	10400	773	1.02	20.5
	7.1 #	56.0	71.3	33.6	7570	10.3	582	674	11600	861	1.02	18.3
	8.0 #	62.8	80.0	29.5	8420	10.3	648	753	13000	956	1.02	16.2
	8.8 #	68.8	87.6	26.5	9160	10.2	705	822	14200	1040	1.02	14.8
	10.0 #	77.7	98.9	23.0	10200	10.2	788	924	15900	1160	1.01	13.0
	12.5 #	95.8	122	17.8	12400	10.1	951	1130	19400	1390	1.01	10.5
	14.2 #	108	137	15.3	13700	9.99	1060	1260	21700	1540	1.00	9.27
	16.0 #	120	153	13.3	15100	9.91	1160	1390	23900	1690	0.999	8.29
300 x 300	6.3 #	57.8	73.6	44.6	10500	12.0	703	809	16100	1040	1.18	20.4
	7.1 #	64.9	82.6	39.3	11800	11.9	785	906	18100	1160	1.18	18.2
	8.0	72.8	92.8	34.5	13100	11.9	875	1010	20200	1290	1.18	16.2
	8.8 #	79.8	102	31.1	14300	11.9	954	1110	22100	1410	1.18	14.8
	10.0	90.2	115	27.0	16000	11.8	1070	1250	24800	1580	1.17	13.0
	12.5	112	142	21.0	19400	11.7	1300	1530	30300	1900	1.17	10.5
	14.2 #	126	160	18.1	21600	11.6	1440	1710	33900	2110	1.16	9.22
	16.0	141	179	15.8	23900	11.5	1590	1900	37600	2330	1.16	8.26
350 x 350	8.0	85.4	109	40.8	21100	13.9	1210	1390	32400	1790	1.38	16.1
	8.8 #	93.6	119	36.8	23100	13.9	1320	1520	35400	1950	1.38	14.8
	10.0	106	135	32.0	25900	13.9	1480	1720	39900	2190	1.37	12.9
	12.5	131	167	25.0	31500	13.7	1800	2110	48900	2650	1.37	10.4
	14.2 #	148	189	21.6	35200	13.7	2010	2360	54900	2960	1.36	9.19
	16.0	166	211	18.9	38900	13.6	2230	2630	61000	3260	1.36	8.21
400 x 400	8.0 #	97.9	125	47.0	31900	16.0	1590	1830	48700	2360	1.58	16.1
	8.8 #	107	137	42.5	34800	15.9	1740	2000	53300	2580	1.58	14.7
	10.0	122	155	37.0	39100	15.9	1960	2260	60100	2900	1.57	12.9
	12.5	151	192	29.0	47800	15.8	2390	2780	73900	3530	1.57	10.4
	14.2 #	170	217	25.2	53500	15.7	2680	3130	83000	3940	1.56	9.16
	16.0	191	243	22.0	59300	15.6	2970	3480	92400	4360	1.56	8.17
	20.0 ^	235	300	17.0	71500	15.4	3580	4250	112000	5240	1.55	6.59

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(1) For local buckling calculation c = h - 3t.

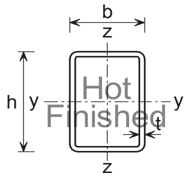
^ SAW process (single longitudinal seam weld, slightly proud)

Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

HOT-FINISHED RECTANGULAR HOLLOW SECTIONS

Celsius® RHS



Dimensions and properties

Section Designation: Size h x b	Section Designation: Thickness t	Mass per Metre	Area of Section A	Ratios for Local Buckling c_w/t (1)	Ratios for Local Buckling c_f/t (1)	Second Moment of Area: Axis y-y	Second Moment of Area: Axis z-z	Radius of Gyration: Axis y-y	Radius of Gyration: Axis z-z	Elastic Modulus: Axis y-y	Elastic Modulus: Axis z-z	Plastic Modulus: Axis y-y	Plastic Modulus: Axis z-z	Torsional Constants I_T	Torsional Constants W_t	Surface Area: Per Metre	Surface Area: Per Tonne
mm	mm	kg/m	cm^2			cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^4	cm^3	m^2	m^2
50x30	3.0 #	3.41	4.34	13.7	7.00	13.6	5.94	1.77	1.17	5.43	3.96	6.88	4.76	13.5	6.51	0.152	44.5
	3.2	3.61	4.60	12.6	6.38	14.2	6.20	1.76	1.16	5.68	4.13	7.25	5.00	14.2	6.80	0.152	42.1
	3.6 #	4.01	5.10	10.9	5.33	15.4	6.67	1.74	1.14	6.16	4.45	7.94	5.46	15.4	7.31	0.151	37.8
	4.0	4.39	5.59	9.50	4.50	16.5	7.08	1.72	1.13	6.60	4.72	8.59	5.88	16.6	7.77	0.150	34.2
	5.0	5.28	6.73	7.00	3.00	18.7	7.89	1.67	1.08	7.49	5.26	10.0	6.80	19.0	8.67	0.147	27.8
60x40	3.0 #	4.35	5.54	17.0	10.3	26.5	13.9	2.18	1.58	8.82	6.95	10.9	8.19	29.2	11.2	0.192	44.2
	3.2	4.62	5.88	15.8	9.50	27.8	14.6	2.18	1.57	9.27	7.29	11.5	8.64	30.8	11.7	0.192	41.7
	3.6 #	5.14	6.54	13.7	8.11	30.4	15.9	2.16	1.56	10.1	7.93	12.7	9.50	33.8	12.8	0.191	37.2
	4.0	5.64	7.19	12.0	7.00	32.8	17.0	2.14	1.54	10.9	8.52	13.8	10.3	36.7	13.7	0.190	33.6
	5.0	6.85	8.73	9.00	5.00	38.1	19.5	2.09	1.50	12.7	9.77	16.4	12.2	43.0	15.7	0.187	27.3
	6.3	8.31	10.6	6.52	3.35	43.4	21.9	2.02	1.44	14.5	11.0	19.2	14.2	49.5	17.6	0.184	22.1
80x40	3.0 #	5.29	6.74	23.7	10.3	54.2	18.0	2.84	1.63	13.6	9.00	17.1	10.4	43.8	15.3	0.232	43.8
	3.2	5.62	7.16	22.0	9.50	57.2	18.9	2.83	1.63	14.3	9.46	18.0	11.0	46.2	16.1	0.232	41.3
	3.6 #	6.27	7.98	19.2	8.11	62.8	20.6	2.81	1.61	15.7	10.3	20.0	12.1	50.8	17.5	0.231	37.0
	4.0	6.90	8.79	17.0	7.00	68.2	22.2	2.79	1.59	17.1	11.1	21.8	13.2	55.2	18.9	0.230	33.4
	5.0	8.42	10.7	13.0	5.00	80.3	25.7	2.74	1.55	20.1	12.9	26.1	15.7	65.1	21.9	0.227	27.0
	6.3	10.3	13.1	9.70	3.35	93.3	29.2	2.67	1.49	23.3	14.6	31.1	18.4	75.6	24.8	0.224	21.8
	7.1 #	11.4	14.5	8.27	2.63	99.8	30.7	2.63	1.46	25.0	15.4	33.8	19.8	80.9	26.2	0.222	19.5
	8.0	12.5	16.0	7.00	2.00	106	32.1	2.58	1.42	26.5	16.1	36.5	21.2	85.8	27.4	0.219	17.5
90x50	3.0 #	6.24	7.94	27.0	13.7	84.4	33.5	3.26	2.05	18.8	13.4	23.2	15.3	76.5	22.4	0.272	43.5
	3.2	6.63	8.44	25.1	12.6	89.1	35.3	3.25	2.04	19.8	14.1	24.6	16.2	80.9	23.6	0.272	41.1
	3.6 #	7.40	9.42	22.0	10.9	98.3	38.7	3.23	2.03	21.8	15.5	27.2	18.0	89.4	25.9	0.271	36.6
	4.0	8.15	10.4	19.5	9.50	107	41.9	3.21	2.01	23.8	16.8	29.8	19.6	97.5	28.0	0.270	33.2
	5.0	9.99	12.7	15.0	7.00	127	49.2	3.16	1.97	28.3	19.7	36.0	23.5	116	32.9	0.267	26.7
	6.3	12.3	15.6	11.3	4.94	150	57.0	3.10	1.91	33.3	22.8	43.2	28.0	138	38.1	0.264	21.5
	7.1 #	13.6	17.3	9.68	4.04	162	60.9	3.06	1.88	36.0	24.4	47.2	30.5	149	40.7	0.262	19.3
	8.0	15.0	19.2	8.25	3.25	174	64.6	3.01	1.84	38.6	25.8	51.4	32.9	160	43.2	0.259	17.2
100x50	3.0 #	6.71	8.54	30.3	13.7	110	36.8	3.58	2.08	21.9	14.7	27.3	16.8	88.4	25.0	0.292	43.5
	3.2	7.13	9.08	28.3	12.6	116	38.8	3.57	2.07	23.2	15.5	28.9	17.7	93.4	26.4	0.292	40.9
	3.6 #	7.96	10.1	24.8	10.9	128	42.6	3.55	2.05	25.6	17.0	32.1	19.6	103	29.0	0.291	36.7
	4.0	8.78	11.2	22.0	9.50	140	46.2	3.53	2.03	27.9	18.5	35.2	21.5	113	31.4	0.290	33.1
	5.0	10.8	13.7	17.0	7.00	167	54.3	3.48	1.99	33.3	21.7	42.6	25.8	135	36.9	0.287	26.6
	6.3	13.3	16.9	12.9	4.94	197	63.0	3.42	1.93	39.4	25.2	51.3	30.8	160	42.9	0.284	21.4
	7.1 #	14.7	18.7	11.1	4.04	214	67.5	3.38	1.90	42.7	27.0	56.3	33.5	173	46.0	0.282	19.2
	8.0	16.3	20.8	9.50	3.25	230	71.7	3.33	1.86	46.0	28.7	61.4	36.3	186	48.9	0.279	17.1
	8.8 #	17.6	22.5	8.36	2.68	243	74.8	3.29	1.82	48.5	29.9	65.6	38.5	197	51.1	0.277	15.7
	10.0 #	19.6	24.9	7.00	2.00	259	78.4	3.22	1.77	51.8	31.4	71.2	41.4	209	53.6	0.274	14.0

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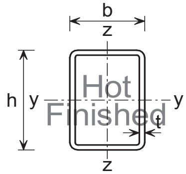
(1) For local buckling calculation $c_w = h - 3t$ and $c_f = b - 3t$.

Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

HOT-FINISHED
RECTANGULAR HOLLOW SECTIONS

Celsius® RHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size h x b mm	Thickness t mm	kg/m	A cm^2	c_w/t (1)	c_f/t (1)	Axis y-y cm^4	Axis z-z cm^4	Axis y-y cm	Axis z-z cm	Axis y-y cm^3	Axis z-z cm^3	Axis y-y cm^3	Axis z-z cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
100x60	3.0 #	7.18	9.14	30.3	17.0	124	55.7	3.68	2.47	24.7	18.6	30.2	21.2	121	30.7	0.312	43.4
	3.2	7.63	9.72	28.3	15.8	131	58.8	3.67	2.46	26.2	19.6	32.0	22.4	129	32.4	0.312	40.9
	3.6 #	8.53	10.9	24.8	13.7	145	64.8	3.65	2.44	28.9	21.6	35.6	24.9	142	35.6	0.311	36.4
	4.0	9.41	12.0	22.0	12.0	158	70.5	3.63	2.43	31.6	23.5	39.1	27.3	156	38.7	0.310	32.9
	5.0	11.6	14.7	17.0	9.00	189	83.6	3.58	2.38	37.8	27.9	47.4	32.9	188	45.9	0.307	26.6
	6.3	14.2	18.1	12.9	6.52	225	98.1	3.52	2.33	45.0	32.7	57.3	39.5	224	53.8	0.304	21.3
	7.1 #	15.8	20.2	11.1	5.45	244	106	3.48	2.29	48.8	35.3	62.9	43.2	245	58.0	0.302	19.1
	8.0	17.5	22.4	9.50	4.50	264	113	3.44	2.25	52.8	37.8	68.7	47.1	265	62.2	0.299	17.0
	8.8 #	19.0	24.2	8.36	3.82	279	119	3.40	2.22	55.9	39.7	73.6	50.2	282	65.4	0.297	15.6
	10.0 #	21.1	26.9	7.00	3.00	299	126	3.33	2.16	59.9	42.1	80.2	54.4	304	69.3	0.294	13.9
120x60	3.0 #	8.12	10.3	37.0	17.0	194	65.5	4.33	2.52	32.3	21.8	40.0	24.6	156	37.2	0.352	43.3
	3.2 #	8.64	11.0	34.5	15.8	205	69.2	4.32	2.51	34.2	23.1	42.4	26.1	165	39.2	0.352	40.8
	3.6 #	9.66	12.3	30.3	13.7	227	76.3	4.30	2.49	37.9	25.4	47.2	28.9	183	43.3	0.351	36.5
	4.0	10.7	13.6	27.0	12.0	249	83.1	4.28	2.47	41.5	27.7	51.9	31.7	201	47.1	0.350	32.8
	5.0	13.1	16.7	21.0	9.00	299	98.8	4.23	2.43	49.9	32.9	63.1	38.4	242	56.0	0.347	26.4
	6.3	16.2	20.7	16.0	6.52	358	116	4.16	2.37	59.7	38.8	76.7	46.3	290	65.9	0.344	21.2
	7.1 #	18.1	23.0	13.9	5.45	391	126	4.12	2.34	65.2	41.9	84.4	50.8	317	71.3	0.342	18.9
	8.0	20.1	25.6	12.0	4.50	425	135	4.08	2.30	70.8	45.0	92.7	55.4	344	76.6	0.339	16.9
	8.8 #	21.8	27.8	10.6	3.82	452	142	4.04	2.27	75.3	47.5	99.6	59.2	366	80.8	0.337	15.5
	10.0 #	24.3	30.9	9.00	3.00	488	152	3.97	2.21	81.4	50.5	109	64.4	396	86.1	0.334	13.8
	12.5 #	29.1	37.1	6.60	1.80	546	165	3.84	2.11	91.1	54.9	126	73.1	442	93.8	0.328	11.3
120x80	3.6 #	10.8	13.7	30.3	19.2	276	147	4.48	3.27	46.0	36.7	55.6	42.0	301	59.5	0.391	36.2
	4.0	11.9	15.2	27.0	17.0	303	161	4.46	3.25	50.4	40.2	61.2	46.1	330	65.0	0.390	32.7
	5.0	14.7	18.7	21.0	13.0	365	193	4.42	3.21	60.9	48.2	74.6	56.1	401	77.9	0.387	26.3
	6.3	18.2	23.2	16.0	9.70	440	230	4.36	3.15	73.3	57.6	91.0	68.2	487	92.9	0.384	21.1
	7.1 #	20.3	25.8	13.9	8.27	482	251	4.32	3.12	80.3	62.8	100	75.2	535	101	0.382	18.8
	8.0	22.6	28.8	12.0	7.00	525	273	4.27	3.08	87.5	68.1	111	82.6	587	110	0.379	16.8
	8.8 #	24.5	31.3	10.6	6.09	561	290	4.24	3.04	93.5	72.4	119	88.7	629	117	0.377	15.3
	10.0	27.4	34.9	9.00	5.00	609	313	4.18	2.99	102	78.1	131	97.3	688	126	0.374	13.7
	12.5 #	33.0	42.1	6.60	3.40	692	349	4.05	2.88	115	87.4	153	113	789	141	0.368	11.2
150x100	4.0 #	15.1	19.2	34.5	22.0	607	324	5.63	4.11	81.0	64.8	97.4	73.6	660	105	0.490	32.5
	5.0	18.6	23.7	27.0	17.0	739	392	5.58	4.07	98.5	78.5	119	90.1	807	127	0.487	26.2
	6.3	23.1	29.5	20.8	12.9	898	474	5.52	4.01	120	94.8	147	110	986	153	0.484	20.9
	7.1 #	25.9	32.9	18.1	11.1	990	520	5.48	3.97	132	104	163	122	1090	168	0.482	18.7
	8.0	28.9	36.8	15.8	9.50	1090	569	5.44	3.94	145	114	180	135	1200	183	0.479	16.6
	8.8 #	31.5	40.1	14.0	8.36	1170	610	5.40	3.90	156	122	195	146	1300	196	0.477	15.2
	10.0	35.3	44.9	12.0	7.00	1280	665	5.34	3.85	171	133	216	161	1430	214	0.474	13.5
	12.5	42.8	54.6	9.00	5.00	1490	763	5.22	3.74	198	153	256	190	1680	246	0.468	10.9

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(1) For local buckling calculation $c_w = h - 3t$ and $c_f = b - 3t$.

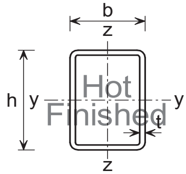
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED
RECTANGULAR HOLLOW SECTIONS

Celsius® RHS



Dimensions and properties

Section Designation		Mass per	Area of	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size	Thickness	Metre	Section			Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z			Per Metre	Per Tonne
h x b	t		A	c_w/t (1)	c_f/t (1)									I_T	W_t		
mm	mm	kg/m	cm^2			cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^4	cm^3	m^2	m^2
160x80	4.0 #	14.4	18.4	37.0	17.0	612	207	5.77	3.35	76.5	51.7	94.7	58.3	493	88.1	0.470	32.6
	5.0	17.8	22.7	29.0	13.0	744	249	5.72	3.31	93.0	62.3	116	71.1	600	106	0.467	26.2
	6.3	22.2	28.2	22.4	9.70	903	299	5.66	3.26	113	74.8	142	86.8	730	127	0.464	20.9
	7.1 #	24.7	31.5	19.5	8.27	994	327	5.62	3.22	124	81.7	158	95.9	804	139	0.462	18.7
	8.0	27.6	35.2	17.0	7.00	1090	356	5.57	3.18	136	89.0	175	106	883	151	0.459	16.6
	8.8 #	30.1	38.3	15.2	6.09	1170	379	5.53	3.15	147	94.9	189	114	949	161	0.457	15.2
	10.0	33.7	42.9	13.0	5.00	1280	411	5.47	3.10	161	103	209	125	1040	175	0.454	13.5
	12.5	40.9	52.1	9.80	3.40	1490	465	5.34	2.99	186	116	247	146	1200	198	0.448	11.0
180x60	4.0 #	14.4	18.4	42.0	12.0	697	121	6.16	2.56	77.4	40.3	99.8	45.2	341	72.2	0.470	32.6
	5.0 #	17.8	22.7	33.0	9.00	846	144	6.10	2.52	94.0	48.1	122	54.9	411	86.3	0.467	26.2
	6.3 #	22.2	28.2	25.6	6.52	1030	171	6.03	2.46	114	57.0	150	66.6	495	102	0.464	20.9
	7.1 #	24.7	31.5	22.4	5.45	1130	186	5.99	2.43	126	61.9	166	73.3	542	111	0.462	18.7
	8.0 #	27.6	35.2	19.5	4.50	1240	201	5.94	2.39	138	66.9	184	80.4	590	120	0.459	16.6
	8.8 #	30.1	38.3	17.5	3.82	1330	212	5.89	2.35	148	70.8	199	86.2	630	127	0.457	15.2
	10.0 #	33.7	42.9	15.0	3.00	1460	228	5.83	2.30	162	75.8	220	94.4	683	137	0.454	13.5
	12.5 #	40.9	52.1	11.4	1.80	1680	251	5.68	2.20	187	83.7	260	109	770	151	0.448	11.0
180x100	4.0 #	16.9	21.6	42.0	22.0	945	379	6.61	4.19	105	75.9	128	85.2	852	127	0.550	32.5
	5.0 #	21.0	26.7	33.0	17.0	1150	460	6.57	4.15	128	92.0	157	104	1040	154	0.547	26.1
	6.3 #	26.1	33.3	25.6	12.9	1410	557	6.50	4.09	156	111	194	128	1280	186	0.544	20.8
	7.1 #	29.2	37.2	22.4	11.1	1560	613	6.47	4.06	173	123	215	142	1410	205	0.542	18.5
	8.0 #	32.6	41.6	19.5	9.50	1710	671	6.42	4.02	190	134	239	157	1560	224	0.539	16.5
	8.8 #	35.6	45.4	17.5	8.36	1850	720	6.38	3.98	205	144	259	170	1690	240	0.537	15.1
	10.0 #	40.0	50.9	15.0	7.00	2040	787	6.32	3.93	226	157	288	188	1860	263	0.534	13.4
	12.5 #	48.7	62.1	11.4	5.00	2390	908	6.20	3.82	265	182	344	223	2190	303	0.528	10.8
200x100	4.0 #	18.2	23.2	47.0	22.0	1220	416	7.26	4.24	122	83.2	150	92.8	983	142	0.590	32.4
	5.0	22.6	28.7	37.0	17.0	1500	505	7.21	4.19	149	101	185	114	1200	172	0.587	26.0
	6.3	28.1	35.8	28.7	12.9	1830	613	7.15	4.14	183	123	228	140	1480	208	0.584	20.8
	7.1 #	31.4	40.0	25.2	11.1	2020	674	7.11	4.10	202	135	254	155	1630	229	0.582	18.5
	8.0	35.1	44.8	22.0	9.50	2230	739	7.06	4.06	223	148	282	172	1800	251	0.579	16.5
	8.8 #	38.4	48.9	19.7	8.36	2410	793	7.02	4.03	241	159	306	186	1950	270	0.577	15.1
	10.0	43.1	54.9	17.0	7.00	2660	869	6.96	3.98	266	174	341	206	2160	295	0.574	13.3
	12.5	52.7	67.1	13.0	5.00	3140	1000	6.84	3.87	314	201	408	245	2540	341	0.568	10.8
	14.2 #	58.9	75.0	11.1	4.04	3420	1080	6.75	3.80	342	216	450	268	2770	368	0.563	9.57
	16.0 # r	65.2	83.0	9.50	3.25	3680	1150	6.66	3.72	368	229	491	290	2980	391	0.559	8.55

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(1) For local buckling calculation $c_w = h - 3t$ and $c_f = b - 3t$.

r External corner radius >2T but ≤3T

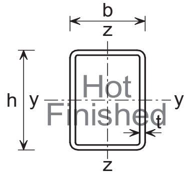
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED RECTANGULAR HOLLOW SECTIONS

Celsius® RHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size	Thickness					Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z			Per Metre	Per Tonne
h x b	t		A	c_w/t (1)	c_f/t (1)									I_T	W_t		
mm	mm	kg/m	cm^2			cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^4	cm^3	m^2	m^2
200x120	5.0 #	24.1	30.7	37.0	21.0	1690	762	7.40	4.98	168	127	205	144	1650	210	0.627	26.0
	6.3	30.1	38.3	28.7	16.0	2070	929	7.34	4.92	207	155	253	177	2030	255	0.624	20.8
	7.1 #	33.7	42.9	25.2	13.9	2290	1030	7.30	4.89	229	171	281	197	2250	282	0.622	18.5
	8.0	37.6	48.0	22.0	12.0	2530	1130	7.26	4.85	253	188	313	218	2500	310	0.619	16.5
	8.8 #	41.1	52.4	19.7	10.6	2730	1220	7.22	4.82	273	203	340	237	2700	334	0.617	15.0
	10.0	46.3	58.9	17.0	9.00	3030	1340	7.17	4.76	303	223	379	263	3000	367	0.614	13.3
	12.5 #	56.6	72.1	13.0	6.60	3580	1560	7.04	4.66	358	260	455	314	3570	428	0.608	10.8
	14.2 #	63.3	80.7	11.1	5.45	3910	1690	6.96	4.58	391	282	503	346	3920	464	0.603	9.53
	16.0 #	70.2	89.4	9.50	4.50	4220	1810	6.87	4.50	422	302	550	377	4250	497	0.599	8.51
200x150	5.0 #	26.5	33.7	37.0	27.0	1970	1270	7.64	6.12	197	169	234	192	2390	267	0.687	26.0
	6.3 #	33.0	42.1	28.7	20.8	2420	1550	7.58	6.07	242	207	289	237	2950	326	0.684	20.7
	7.1 #	37.0	47.1	25.2	18.1	2690	1720	7.55	6.03	268	229	322	264	3280	361	0.682	18.4
	8.0	41.4	52.8	22.0	15.8	2970	1890	7.50	5.99	297	253	359	294	3640	398	0.679	16.4
	8.8 #	45.3	57.7	19.7	14.0	3220	2050	7.47	5.96	322	273	390	319	3960	430	0.677	15.0
	10.0	51.0	64.9	17.0	12.0	3570	2260	7.41	5.91	357	302	436	356	4410	475	0.674	13.2
	12.5 #	62.5	79.6	13.0	9.00	4240	2670	7.30	5.80	424	356	525	428	5290	559	0.668	10.7
	14.2 #	70.0	89.2	11.1	7.56	4640	2920	7.22	5.72	464	389	582	473	5830	610	0.663	9.48
	16.0 #	77.7	99.0	9.50	6.38	5040	3150	7.13	5.64	504	420	638	518	6370	658	0.659	8.50
220x120	5.0 #	25.7	32.7	41.0	21.0	2130	829	8.06	5.03	193	138	236	155	1880	232	0.667	25.9
	6.3 #	32.0	40.8	31.9	16.0	2610	1010	8.00	4.98	237	168	292	191	2320	283	0.664	20.7
	7.1 #	35.9	45.7	28.0	13.9	2900	1120	7.96	4.94	263	186	326	213	2570	312	0.662	18.5
	8.0 #	40.2	51.2	24.5	12.0	3200	1230	7.91	4.90	291	205	362	236	2850	343	0.659	16.4
	8.8 #	43.9	55.9	22.0	10.6	3470	1320	7.87	4.87	315	221	394	256	3090	370	0.657	15.0
	10.0 #	49.4	62.9	19.0	9.00	3840	1460	7.82	4.81	349	243	440	285	3430	407	0.654	13.2
	12.5 #	60.5	77.1	14.6	6.60	4560	1710	7.69	4.71	415	285	530	341	4090	476	0.648	10.7
	14.2 #	67.8	86.3	12.5	5.45	5000	1850	7.61	4.63	454	309	586	376	4490	517	0.643	9.52
	16.0 #	75.2	95.8	10.8	4.50	5410	1990	7.52	4.55	492	331	643	410	4870	555	0.639	8.50
250x100	5.0 #	26.5	33.7	47.0	17.0	2610	618	8.80	4.28	209	124	263	138	1620	217	0.687	26.0
	6.3 #	33.0	42.1	36.7	12.9	3210	751	8.73	4.22	257	150	326	169	1980	264	0.684	20.7
	7.1 #	37.0	47.1	32.2	11.1	3560	827	8.69	4.19	285	165	363	188	2200	291	0.682	18.4
	8.0 #	41.4	52.8	28.3	9.50	3940	909	8.64	4.15	315	182	404	209	2430	319	0.679	16.4
	8.8 #	45.3	57.7	25.4	8.36	4270	977	8.60	4.12	341	195	439	226	2630	343	0.677	15.0
	10.0 #	51.0	64.9	22.0	7.00	4730	1070	8.54	4.06	379	214	491	251	2910	376	0.674	13.2
	12.5 #	62.5	79.6	17.0	5.00	5620	1250	8.41	3.96	450	249	592	299	3440	438	0.668	10.7
	14.2 #	70.0	89.2	14.6	4.04	6170	1340	8.31	3.88	493	269	655	329	3750	473	0.663	9.48
	16.0 #	77.7	99.0	12.6	3.25	6690	1430	8.22	3.80	535	287	719	358	4050	505	0.659	8.50

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(1) For local buckling calculation $c_w = h - 3t$ and $c_f = b - 3t$.

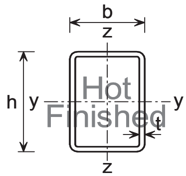
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED RECTANGULAR HOLLOW SECTIONS

Celsius® RHS



Dimensions and properties

Section Designation		Mass per	Area of	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size	Thickness	Metre	Section			Axis	Axis	Axis	Axis	Axis	Axis	Axis	Axis			Per	Per
						y-y	z-z	y-y	z-z	y-y	z-z	y-y	z-z			Metre	Tonne
h x b	t		A	c_w/t (1)	c_f/t (1)									I_T	W_t		
mm	mm	kg/m	cm^2			cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^4	cm^3	m^2	m^2
250x150	5.0 #	30.4	38.7	47.0	27.0	3360	1530	9.31	6.28	269	204	324	228	3280	337	0.787	25.9
	6.3	38.0	48.4	36.7	20.8	4140	1870	9.25	6.22	331	250	402	283	4050	413	0.784	20.6
	7.1 #	42.6	54.2	32.2	18.1	4610	2080	9.22	6.19	368	277	449	315	4520	457	0.782	18.4
	8.0	47.7	60.8	28.3	15.8	5110	2300	9.17	6.15	409	306	501	350	5020	506	0.779	16.4
	8.8 #	52.2	66.5	25.4	14.0	5550	2490	9.13	6.12	444	331	545	381	5460	547	0.777	14.9
	10.0	58.8	74.9	22.0	12.0	6170	2760	9.08	6.06	494	367	611	426	6090	605	0.774	13.2
	12.5	72.3	92.1	17.0	9.00	7390	3270	8.96	5.96	591	435	740	514	7330	717	0.768	10.6
	14.2 #	81.1	103	14.6	7.56	8140	3580	8.87	5.88	651	477	823	570	8100	784	0.763	9.38
	16.0	90.3	115	12.6	6.38	8880	3870	8.79	5.80	710	516	906	625	8870	849	0.759	8.42
260x140	5.0 #	30.4	38.7	49.0	25.0	3530	1350	9.55	5.91	272	193	331	216	3080	326	0.787	25.9
	6.3 #	38.0	48.4	38.3	19.2	4360	1660	9.49	5.86	335	237	411	267	3800	399	0.784	20.6
	7.1 #	42.6	54.2	33.6	16.7	4840	1840	9.45	5.82	372	263	459	298	4230	442	0.782	18.4
	8.0 #	47.7	60.8	29.5	14.5	5370	2030	9.40	5.78	413	290	511	331	4700	488	0.779	16.4
	8.8 #	52.2	66.5	26.5	12.9	5830	2200	9.37	5.75	449	314	557	360	5110	527	0.777	14.9
	10.0 #	58.8	74.9	23.0	11.0	6490	2430	9.31	5.70	499	347	624	402	5700	584	0.774	13.2
	12.5 #	72.3	92.1	17.8	8.20	7770	2880	9.18	5.59	597	411	756	485	6840	690	0.768	10.6
	14.2 #	81.1	103	15.3	6.86	8560	3140	9.10	5.52	658	449	840	537	7560	754	0.763	9.38
	16.0 #	90.3	115	13.3	5.75	9340	3400	9.01	5.44	718	486	925	588	8260	815	0.759	8.42
300x100	5.0 #	30.4	38.7	57.0	17.0	4150	731	10.3	4.34	276	146	354	161	2040	262	0.787	25.9
	6.3 #	38.0	48.4	44.6	12.9	5110	890	10.3	4.29	341	178	439	199	2500	319	0.784	20.6
	7.1 #	42.6	54.2	39.3	11.1	5680	981	10.2	4.25	379	196	490	221	2780	352	0.782	18.4
	8.0	47.7	60.8	34.5	9.50	6310	1080	10.2	4.21	420	216	546	245	3070	387	0.779	16.4
	8.8 #	52.2	66.5	31.1	8.36	6840	1160	10.1	4.18	456	232	594	266	3320	416	0.777	14.9
	10.0	58.8	74.9	27.0	7.00	7610	1280	10.1	4.13	508	255	666	296	3680	458	0.774	13.2
	12.5 #	72.3	92.1	21.0	5.00	9100	1490	9.94	4.02	607	297	806	354	4350	534	0.768	10.6
	14.2 #	81.1	103	18.1	4.04	10000	1610	9.85	3.94	669	321	896	390	4760	578	0.763	9.38
	16.0 #	90.3	115	15.8	3.25	10900	1720	9.75	3.87	729	344	986	425	5140	619	0.759	8.42
300x150	8.0 # rr	54.0	68.8	34.5	15.8	8010	2700	10.8	6.27	534	360	663	407	6450	613	0.879	16.3
	8.8 # rr	59.1	75.3	31.1	14.0	8710	2930	10.8	6.23	580	390	723	443	7020	664	0.877	14.8
	10.0 # rr	66.7	84.9	27.0	12.0	9720	3250	10.7	6.18	648	433	811	496	7840	736	0.874	13.1
	12.5 # rr	82.1	105	21.0	9.00	11700	3860	10.6	6.07	779	514	986	600	9450	874	0.868	10.6
	14.2 # rr	92.3	118	18.1	7.56	12900	4230	10.5	6.00	862	564	1100	666	10500	959	0.863	9.32
	16.0 # rr	103	131	15.8	6.38	14200	4600	10.4	5.92	944	613	1210	732	11500	1040	0.859	8.35

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(1) For local buckling calculation c_w = h - 3t and c_f = b - 3t.

rr External corner radius > 3t (not compliant with BS EN 10210-2)

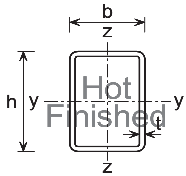
Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10210-2:2006

HOT-FINISHED RECTANGULAR HOLLOW SECTIONS

Celsius® RHS



Dimensions and properties

Section Designation		Mass per	Area of	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size h x b mm	Thickness t mm	Metre kg/m	Section A cm^2	c_w/t (1)	c_f/t (1)	Axis y-y cm^4	Axis z-z cm^4	Axis y-y cm	Axis z-z cm	Axis y-y cm^3	Axis z-z cm^3	Axis y-y cm^3	Axis z-z cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
300x200	5.0 #	38.3	48.7	57.0	37.0	6320	3400	11.4	8.35	421	340	501	380	6820	552	0.987	25.8
	6.3	47.9	61.0	44.6	28.7	7830	4190	11.3	8.29	522	419	624	472	8480	681	0.984	20.6
	7.1 #	53.7	68.4	39.3	25.2	8730	4670	11.3	8.26	582	467	698	528	9470	757	0.982	18.3
	8.0	60.3	76.8	34.5	22.0	9720	5180	11.3	8.22	648	518	779	589	10600	840	0.979	16.3
	8.8 #	66.0	84.1	31.1	19.7	10600	5630	11.2	8.18	705	563	851	643	11500	912	0.977	14.9
	10.0	74.5	94.9	27.0	17.0	11800	6280	11.2	8.13	788	628	956	721	12900	1020	0.974	13.1
	12.5	91.9	117	21.0	13.0	14300	7540	11.0	8.02	952	754	1170	877	15700	1220	0.968	10.6
	14.2 #	103	132	18.1	11.1	15800	8330	11.0	7.95	1060	833	1300	978	17500	1340	0.963	9.31
	16.0	115	147	15.8	9.50	17400	9110	10.9	7.87	1160	911	1440	1080	19300	1470	0.959	8.31
300x250	5.0 #	42.2	53.7	57.0	47.0	7410	5610	11.7	10.2	494	449	575	508	9770	697	1.09	25.8
	6.3 #	52.8	67.3	44.6	36.7	9190	6950	11.7	10.2	613	556	716	633	12200	862	1.08	20.4
	7.1 #	59.3	75.5	39.3	32.2	10300	7750	11.6	10.1	683	620	802	708	13600	960	1.08	18.3
	8.0	66.5	84.8	34.5	28.3	11400	8630	11.6	10.1	761	690	896	791	15200	1070	1.08	16.2
	8.8 #	72.9	92.9	31.1	25.4	12400	9390	11.6	10.1	829	751	979	864	16600	1160	1.08	14.8
	10.0 #	82.4	105	27.0	22.0	13900	10500	11.5	10.0	928	840	1100	971	18600	1300	1.07	12.9
	12.5 #	102	130	21.0	17.0	16900	12700	11.4	9.89	1120	1010	1350	1190	22700	1560	1.07	10.5
	14.2 #	115	146	18.1	14.6	18700	14100	11.3	9.82	1250	1130	1510	1330	25400	1730	1.06	9.25
	16.0 #	128	163	15.8	12.6	20600	15500	11.2	9.74	1380	1240	1670	1470	28100	1900	1.06	8.28
340x100	10.0	65.1	82.9	31.0	7.00	10600	1440	11.3	4.16	623	288	823	332	4300	523	0.854	13.2
350x150	5.0 #	38.3	48.7	67.0	27.0	7660	2050	12.5	6.49	437	274	543	301	5160	477	0.987	25.8
	6.3 #	47.9	61.0	52.6	20.8	9480	2530	12.5	6.43	542	337	676	373	6390	586	0.984	20.6
	7.1 #	53.7	68.4	46.3	18.1	10600	2800	12.4	6.40	604	374	756	416	7120	651	0.982	18.3
	8.0 #	60.3	76.8	40.8	15.8	11800	3110	12.4	6.36	673	414	844	464	7930	721	0.979	16.3
	8.8 #	66.0	84.1	36.8	14.0	12800	3360	12.3	6.33	732	449	922	506	8620	781	0.977	14.9
	10.0 #	74.5	94.9	32.0	12.0	14300	3740	12.3	6.27	818	498	1040	566	9630	867	0.974	13.1
	12.5 #	91.9	117	25.0	9.00	17300	4450	12.2	6.17	988	593	1260	686	11600	1030	0.968	10.6
	14.2 #	103	132	21.6	7.56	19200	4890	12.1	6.09	1100	652	1410	763	12900	1130	0.963	9.31
	16.0 #	115	147	18.9	6.38	21100	5320	12.0	6.01	1210	709	1560	840	14100	1230	0.959	8.31
350x250	6.3 #	57.8	73.6	52.6	36.7	13200	7890	13.4	10.4	754	631	892	709	15200	1010	1.18	20.4
	7.1 #	64.9	82.6	46.3	32.2	14700	8800	13.4	10.3	843	704	999	794	17000	1130	1.18	18.2
	8.0 #	72.8	92.8	40.8	28.3	16400	9800	13.3	10.3	940	784	1120	888	19000	1250	1.18	16.2
	8.8 #	79.8	102	36.8	25.4	17900	10700	13.3	10.2	1030	853	1220	970	20800	1370	1.18	14.8
	10.0 #	90.2	115	32.0	22.0	20100	11900	13.2	10.2	1150	955	1380	1090	23400	1530	1.17	13.0
	12.5 #	112	142	25.0	17.0	24400	14400	13.1	10.1	1400	1160	1690	1330	28500	1840	1.17	10.5
	14.2 #	126	160	21.6	14.6	27200	16000	13.0	10.0	1550	1280	1890	1490	31900	2040	1.16	9.22
	16.0 #	141	179	18.9	12.6	30000	17700	12.9	9.93	1720	1410	2100	1660	35300	2250	1.16	8.26

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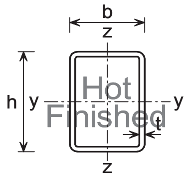
(1) For local buckling calculation $c_w = h - 3t$ and $c_f = b - 3t$.

Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

HOT-FINISHED
RECTANGULAR HOLLOW SECTIONS

Celsius® RHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size h x b	Thickness t		A	c_w/t (1)	c_f/t (1)	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	I_T	W_t	Per Metre	Per Tonne
mm	mm	kg/m	cm^2			cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^4	cm^3	m^2	m^2
400x150	6.3 #	52.8	67.3	60.5	20.8	13300	2850	14.0	6.51	663	380	836	418	7600	673	1.08	20.4
	7.1 #	59.3	75.5	53.3	18.1	14800	3170	14.0	6.47	740	422	936	467	8470	748	1.08	18.3
	8.0 #	66.5	84.8	47.0	15.8	16500	3510	13.9	6.43	824	468	1050	521	9420	828	1.08	16.2
	8.8 #	72.9	92.9	42.5	14.0	18000	3800	13.9	6.40	898	507	1140	568	10300	898	1.08	14.8
	10.0 #	82.4	105	37.0	12.0	20100	4230	13.8	6.35	1010	564	1290	636	11500	998	1.07	12.9
	12.5 #	102	130	29.0	9.00	24400	5040	13.7	6.24	1220	672	1570	772	13800	1190	1.07	10.5
	14.2 #	115	146	25.2	7.56	27100	5550	13.6	6.16	1360	740	1760	859	15300	1310	1.06	9.25
	16.0	128	163	22.0	6.38	29800	6040	13.5	6.09	1490	805	1950	947	16800	1430	1.06	8.28
400x200	6.3 #	57.8	73.6	60.5	28.7	15700	5380	14.6	8.55	785	538	960	594	12600	917	1.18	20.4
	7.1 #	64.9	82.6	53.3	25.2	17500	5990	14.6	8.51	877	599	1080	665	14100	1020	1.18	18.2
	8.0	72.8	92.8	47.0	22.0	19600	6660	14.5	8.47	978	666	1200	743	15700	1140	1.18	16.2
	8.8 #	79.8	102	42.5	19.7	21300	7240	14.5	8.44	1070	724	1320	811	17200	1230	1.18	14.8
	10.0	90.2	115	37.0	17.0	23900	8080	14.4	8.39	1200	808	1480	911	19300	1380	1.17	13.0
	12.5	112	142	29.0	13.0	29100	9740	14.3	8.28	1450	974	1810	1110	23400	1660	1.17	10.5
	14.2 #	126	160	25.2	11.1	32400	10800	14.2	8.21	1620	1080	2030	1240	26100	1830	1.16	9.22
	16.0	141	179	22.0	9.50	35700	11800	14.1	8.13	1790	1180	2260	1370	28900	2010	1.16	8.26
400x300	8.0 #	85.4	109	47.0	34.5	25700	16500	15.4	12.3	1290	1100	1520	1250	31000	1750	1.38	16.1
	8.8 #	93.6	119	42.5	31.1	28100	18000	15.3	12.3	1400	1200	1660	1360	33900	1910	1.38	14.8
	10.0 #	106	135	37.0	27.0	31500	20200	15.3	12.2	1580	1350	1870	1540	38200	2140	1.37	12.9
	12.5 #	131	167	29.0	21.0	38500	24600	15.2	12.1	1920	1640	2300	1880	46800	2590	1.37	10.4
	14.2 #	148	189	25.2	18.1	43000	27400	15.1	12.1	2150	1830	2580	2110	52500	2890	1.36	9.19
	16.0 #	166	211	22.0	15.8	47500	30300	15.0	12.0	2380	2020	2870	2350	58300	3180	1.36	8.21
450x250	8.0	85.4	109	53.3	28.3	30100	12100	16.6	10.6	1340	971	1620	1080	27100	1630	1.38	16.1
	8.8 #	93.6	119	48.1	25.4	32800	13200	16.6	10.5	1460	1060	1770	1180	29600	1770	1.38	14.8
	10.0	106	135	42.0	22.0	36900	14800	16.5	10.5	1640	1190	2000	1330	33300	1990	1.37	12.9
	12.5	131	167	33.0	17.0	45000	18000	16.4	10.4	2000	1440	2460	1630	40700	2410	1.37	10.4
	14.2 #	148	189	28.7	14.6	50300	20000	16.3	10.3	2240	1600	2760	1830	45600	2680	1.36	9.19
	16.0	166	211	25.1	12.6	55700	22000	16.2	10.2	2480	1760	3070	2030	50500	2950	1.36	8.21
500x200	8.0 #	85.4	109	59.5	22.0	34000	8140	17.7	8.65	1360	814	1710	896	21100	1430	1.38	16.1
	8.8 #	93.6	119	53.8	19.7	37200	8850	17.7	8.61	1490	885	1870	979	23000	1560	1.38	14.8
	10.0 #	106	135	47.0	17.0	41800	9890	17.6	8.56	1670	989	2110	1100	25900	1740	1.37	12.9
	12.5 #	131	167	37.0	13.0	51000	11900	17.5	8.45	2040	1190	2590	1350	31500	2100	1.37	10.4
	14.2 #	148	189	32.2	11.1	56900	13200	17.4	8.38	2280	1320	2900	1510	35200	2320	1.36	9.19
	16.0 #	166	211	28.3	9.50	63000	14500	17.3	8.30	2520	1450	3230	1670	38900	2550	1.36	8.21
500x300	8.0 #	97.9	125	59.5	34.5	43700	20000	18.7	12.6	1750	1330	2100	1480	42600	2200	1.58	16.1
	8.8 #	107	137	53.8	31.1	47800	21800	18.7	12.6	1910	1450	2300	1620	46600	2400	1.58	14.7
	10.0	122	155	47.0	27.0	53800	24400	18.6	12.6	2150	1630	2600	1830	52500	2700	1.57	12.9
	12.5 #	151	192	37.0	21.0	65800	29800	18.5	12.5	2630	1990	3200	2240	64400	3280	1.57	10.4
	14.2 #	170	217	32.2	18.1	73700	33200	18.4	12.4	2950	2220	3590	2520	72200	3660	1.56	9.16
	16.0	191	243	28.3	15.8	81800	36800	18.3	12.3	3270	2450	4010	2800	80300	4040	1.56	8.17
	20.0 ^	235	300	22.0	12.0	98800	44100	18.2	12.1	3950	2940	4890	3410	97400	4840	1.55	6.59

Celsius® is a trademark of Tata Steel. A fuller description of the relationship between Hot Finished Rectangular Hollow Sections (HFRHS) and the Celsius® range of sections manufactured by Tata Steel is given in note 12.

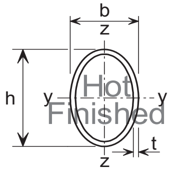
(1) For local buckling calculation c_w = h - 3t and c_f = b - 3t.

^ SAW process (single longitudinal seam weld, slightly proud)

Check avialability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

HOT-FINISHED
ELLIPTICAL HOLLOW SECTIONS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size h x b mm	Thickness t mm	kg/m	A cm^2	Axis y-y cm^4	Axis z-z cm^4	Axis y-y cm	Axis z-z cm	Axis y-y cm^3	Axis z-z cm^3	Axis y-y cm^3	Axis z-z cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
150 x 75	4.0 #	10.7	13.6	301	101	4.70	2.72	40.1	26.9	56.1	34.4	303	60.1	0.363	33.9
	5.0 #	13.3	16.9	367	122	4.66	2.69	48.9	32.5	68.9	42.0	367	72.2	0.363	27.4
	6.3 #	16.5	21.0	448	147	4.62	2.64	59.7	39.1	84.9	51.5	443	86.3	0.363	22.0
200 x 100	5.0 #	17.9	22.8	897	302	6.27	3.64	89.7	60.4	125	76.8	905	135	0.484	27.1
	6.3 #	22.3	28.4	1100	368	6.23	3.60	110	73.5	155	94.7	1110	163	0.484	21.7
	8.0 #	28.0	35.7	1360	446	6.17	3.54	136	89.3	193	117	1350	197	0.484	17.3
	10.0 #	34.5	44.0	1640	529	6.10	3.47	164	106	235	141	1610	232	0.484	14.0
	12.5 #	42.4	54.0	1950	619	6.02	3.39	195	124	284	169	1890	269	0.484	11.4
250 x 125	6.3 #	28.2	35.9	2210	742	7.84	4.55	176	119	246	151	2220	265	0.605	21.5
	8.0 #	35.4	45.1	2730	909	7.78	4.49	219	145	307	188	2730	323	0.605	17.1
	10.0 #	43.8	55.8	3320	1090	7.71	4.42	265	174	376	228	3290	385	0.605	13.8
	12.5 #	53.9	68.7	4000	1290	7.63	4.34	320	207	458	276	3920	453	0.605	11.2
300 x 150	8.0 #	42.8	54.5	4810	1620	9.39	5.44	321	215	449	275	4850	481	0.726	17.0
	10.0 #	53.0	67.5	5870	1950	9.32	5.37	391	260	551	336	5870	577	0.726	13.7
	12.5	65.5	83.4	7120	2330	9.24	5.29	475	311	674	409	7050	686	0.726	11.1
	16.0 #	82.5	105	8730	2810	9.12	5.17	582	374	837	503	8530	818	0.726	8.78
400 x 200	8.0 #	57.6	73.4	11700	3970	12.6	7.35	584	397	811	500	11900	890	0.969	16.9
	10.0 #	71.5	91.1	14300	4830	12.5	7.28	717	483	1000	615	14500	1080	0.969	13.6
	12.5	88.6	113	17500	5840	12.5	7.19	877	584	1230	753	17600	1300	0.969	10.9
	16.0	112	143	21700	7140	12.3	7.07	1090	714	1540	936	21600	1580	0.969	8.64
500 x 250	10.0 #	90.0	115	28500	9680	15.8	9.19	1140	775	1590	976	29000	1740	1.21	13.4
	12.5 #	112	142	35000	11800	15.7	9.10	1400	943	1960	1200	35300	2110	1.21	10.8
	16.0 #	142	180	43700	14500	15.6	8.98	1750	1160	2460	1500	43700	2590	1.21	8.54

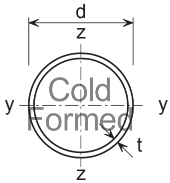
Celsius® is a trademark of Tata Steel. A fuller description of the relationship between Hot Finished Elliptical Hollow Sections (HFEHS) and the Celsius® range of sections manufactured by Tata Steel is given in note 12.

Check availability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

COLD-FORMED
CIRCULAR HOLLOW SECTIONS

Hybox® CHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Outside Diameter d mm	Thickness t mm	kg/m	A cm^2	d/t	I cm^4	i cm	W_{el} cm^3	W_{pl} cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
33.7	3.0	2.27	2.89	11.2	3.44	1.09	2.04	2.84	6.88	4.08	0.106	46.6
42.4	3.0	2.91	3.71	14.1	7.25	1.40	3.42	4.67	14.5	6.84	0.133	45.6
48.3	3.0	3.35	4.27	16.1	11.0	1.61	4.55	6.17	22.0	9.11	0.152	45.3
	4.0 #	4.37	5.57	12.1	13.8	1.57	5.70	7.87	27.5	11.4	0.152	34.8
60.3	3.0 #	4.24	5.40	20.1	22.2	2.03	7.37	9.86	44.4	14.7	0.189	44.6
	4.0	5.55	7.07	15.1	28.2	2.00	9.34	12.7	56.3	18.7	0.189	34.0
76.1	3.0	5.41	6.89	25.4	46.1	2.59	12.1	16.0	92.2	24.2	0.239	44.2
	4.0	7.11	9.06	19.0	59.1	2.55	15.5	20.8	118	31.0	0.239	33.7
88.9	3.0	6.36	8.10	29.6	74.8	3.04	16.8	22.1	150	33.6	0.279	43.8
	3.5 #	7.37	9.39	25.4	85.7	3.02	19.3	25.5	171	38.6	0.279	37.9
	4.0	8.38	10.7	22.2	96.3	3.00	21.7	28.9	193	43.3	0.279	33.2
	5.0	10.3	13.2	17.8	116	2.97	26.2	35.2	233	52.4	0.279	27.0
	6.3	12.8	16.3	14.1	140	2.93	31.5	43.1	280	63.1	0.279	21.7
114.3	3.0 #	8.23	10.5	38.1	163	3.94	28.4	37.2	325	56.9	0.359	43.4
	3.5	9.56	12.2	32.7	187	3.92	32.7	43.0	374	65.5	0.359	37.7
	4.0 #	10.9	13.9	28.6	211	3.90	36.9	48.7	422	73.9	0.359	33.0
	5.0	13.5	17.2	22.9	257	3.87	45.0	59.8	514	89.9	0.359	26.6
	6.0	16.0	20.4	19.1	300	3.83	52.5	70.4	600	105	0.359	22.4
	6.3	16.8	21.4	18.1	313	3.82	54.7	73.6	625	109	0.359	21.4
139.7	3.0 #	10.1	12.9	46.6	301	4.83	43.1	56.1	602	86.2	0.439	43.4
	4.0 #	13.4	17.1	34.9	393	4.80	56.2	73.7	786	112	0.439	32.8
	5.0	16.6	21.2	27.9	481	4.77	68.8	90.8	961	138	0.439	26.4
	6.0	19.8	25.2	23.3	564	4.73	80.8	107	1130	162	0.439	22.2
	6.3	20.7	26.4	22.2	589	4.72	84.3	112	1180	169	0.439	21.2
	8.0	26.0	33.1	17.5	720	4.66	103	139	1440	206	0.439	16.9
	10.0	32.0	40.7	14.0	862	4.60	123	169	1720	247	0.439	13.7
168.3	4.0	16.2	20.6	42.1	697	5.81	82.8	108	1390	166	0.529	32.6
	4.5 #	18.2	23.2	37.4	777	5.79	92.4	121	1550	185	0.529	29.1
	5.0	20.1	25.7	33.7	856	5.78	102	133	1710	203	0.529	26.3
	6.0	24.0	30.6	28.1	1010	5.74	120	158	2020	240	0.529	22.0
	6.3	25.2	32.1	26.7	1050	5.73	125	165	2110	250	0.529	21.0
	8.0	31.6	40.3	21.0	1300	5.67	154	206	2600	308	0.529	16.7
	10.0	39.0	49.7	16.8	1560	5.61	186	251	3130	372	0.529	13.5
	12.5	48.0	61.2	13.5	1870	5.53	222	304	3740	444	0.529	11.0
193.7	4.0 #	18.7	23.8	48.4	1070	6.71	111	144	2150	222	0.609	32.5
	4.5 #	21.0	26.7	43.0	1200	6.69	124	161	2400	247	0.609	29.0
	5.0	23.3	29.6	38.7	1320	6.67	136	178	2640	273	0.609	26.2
	6.0	27.8	35.4	32.3	1560	6.64	161	211	3120	322	0.609	21.9
	6.3	29.1	37.1	30.7	1630	6.63	168	221	3260	337	0.609	20.9
	8.0	36.6	46.7	24.2	2020	6.57	208	276	4030	416	0.609	16.6
	10.0	45.3	57.7	19.4	2440	6.50	252	338	4880	504	0.609	13.5
	12.5	55.9	71.2	15.5	2930	6.42	303	411	5870	606	0.609	10.9

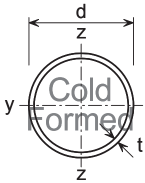
Hybox® is a trademark of Tata Steel. A fuller description of the relationship between Cold Formed Circular Hollow Sections (CFCHS) and the Hybox® range of sections manufactured by Tata Steel is given in note 12.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10219-2:2006

COLD-FORMED
CIRCULAR HOLLOW SECTIONS

Hybox® CHS



Dimensions and properties

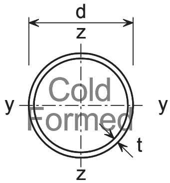
Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Outside Diameter d mm	Thickness t mm	kg/m	A cm^2	d/t	I cm^4	i cm	W_{el} cm^3	W_{pl} cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
219.1	4.5 #	23.8	30.3	48.7	1750	7.59	159	207	3490	319	0.688	28.9
	5.0	26.4	33.6	43.8	1930	7.57	176	229	3860	352	0.688	26.1
	6.0	31.5	40.2	36.5	2280	7.54	208	273	4560	417	0.688	21.8
	6.3	33.1	42.1	34.8	2390	7.53	218	285	4770	436	0.688	20.8
	8.0	41.6	53.1	27.4	2960	7.47	270	357	5920	540	0.688	16.5
	10.0	51.6	65.7	21.9	3600	7.40	328	438	7200	657	0.688	13.3
	12.0 #	61.3	78.1	18.3	4200	7.33	383	515	8400	767	0.688	11.2
	12.5	63.7	81.1	17.5	4350	7.32	397	534	8690	793	0.688	10.8
	16.0	80.1	102	13.7	5300	7.20	483	661	10600	967	0.688	8.60
244.5	5.0 #	29.5	37.6	48.9	2700	8.47	221	287	5400	441	0.768	26.0
	6.0	35.3	45.0	40.8	3200	8.43	262	341	6400	523	0.768	21.7
	6.3	37.0	47.1	38.8	3350	8.42	274	358	6690	547	0.768	20.7
	8.0	46.7	59.4	30.6	4160	8.37	340	448	8320	681	0.768	16.4
	10.0	57.8	73.7	24.5	5070	8.30	415	550	10100	830	0.768	13.3
	12.0 #	68.8	87.7	20.4	5940	8.23	486	649	11900	972	0.768	11.1
	12.5	71.5	91.1	19.6	6150	8.21	503	673	12300	1010	0.768	10.8
	16.0	90.2	115	15.3	7530	8.10	616	837	15100	1230	0.768	8.52
273	4.0 #	26.5	33.8	68.3	3060	9.51	224	289	6120	448	0.858	32.3
	4.5 #	29.8	38.0	60.7	3420	9.49	251	324	6840	501	0.858	28.8
	5.0 #	33.0	42.1	54.6	3780	9.48	277	359	7560	554	0.858	26.0
	6.0	39.5	50.3	45.5	4490	9.44	329	428	8970	657	0.858	21.7
	6.3	41.4	52.8	43.3	4700	9.43	344	448	9390	688	0.858	20.7
	8.0	52.3	66.6	34.1	5850	9.37	429	562	11700	857	0.858	16.4
	10.0	64.9	82.6	27.3	7150	9.31	524	692	14300	1050	0.858	13.2
	12.0 #	77.2	98.4	22.8	8400	9.24	615	818	16800	1230	0.858	11.1
	12.5	80.3	102	21.8	8700	9.22	637	849	17400	1270	0.858	10.7
	16.0	101	129	17.1	10700	9.10	784	1060	21400	1570	0.858	8.46
323.9	5.0 #	39.3	50.1	64.8	6370	11.3	393	509	12700	787	1.02	25.9
	6.0	47.0	59.9	54.0	7570	11.2	468	606	15100	935	1.02	21.7
	6.3 #	49.3	62.9	51.4	7930	11.2	490	636	15900	979	1.02	20.7
	8.0	62.3	79.4	40.5	9910	11.2	612	799	19800	1220	1.02	16.3
	10.0	77.4	98.6	32.4	12200	11.1	751	986	24300	1500	1.02	13.2
	12.0 #	92.3	118	27.0	14300	11.0	884	1170	28600	1770	1.02	11.0
	12.5	96.0	122	25.9	14800	11.0	917	1210	29700	1830	1.02	10.6
	16.0	121	155	20.2	18400	10.9	1140	1520	36800	2270	1.02	8.39
355.6	5.0 #	43.2	55.1	71.1	8460	12.4	476	615	16900	952	1.12	25.9
	6.0	51.7	65.9	59.3	10100	12.4	566	733	20100	1130	1.12	21.6
	6.3 #	54.3	69.1	56.4	10500	12.4	593	769	21100	1190	1.12	20.6
	8.0	68.6	87.4	44.5	13200	12.3	742	967	26400	1490	1.12	16.4
	10.0	85.2	109	35.6	16200	12.2	912	1200	32400	1830	1.12	13.1
	12.0 #	102	130	29.6	19100	12.2	1080	1420	38300	2150	1.12	11.0
	12.5	106	135	28.4	19900	12.1	1120	1470	39700	2230	1.12	10.6
	16.0	134	171	22.2	24700	12.0	1390	1850	49300	2770	1.12	8.36

Hybox® is a trademark of Tata Steel. A fuller description of the relationship between Cold Formed Circular Hollow Sections (CFCHS) and the Hybox® range of sections manufactured by Tata Steel is given in note 12.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

COLD-FORMED
CIRCULAR HOLLOW SECTIONS

Hybox® CHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Outside Diameter d mm	Thickness t mm	kg/m	A cm^2	d/t	I cm^4	i cm	W_{el} cm^3	W_{pl} cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
406.4	6.0 #	59.2	75.5	67.7	15100	14.2	745	962	30300	1490	1.28	21.6
	6.3 #	62.2	79.2	64.5	15800	14.1	780	1010	31700	1560	1.28	20.6
	8.0	78.6	100	50.8	19900	14.1	978	1270	39700	1960	1.28	16.3
	10.0	97.8	125	40.6	24500	14.0	1210	1570	49000	2410	1.28	13.1
	12.0 #	117	149	33.9	28900	14.0	1420	1870	57900	2850	1.28	11.0
	12.5	121	155	32.5	30000	13.9	1480	1940	60100	2960	1.28	10.5
	16.0	154	196	25.4	37400	13.8	1840	2440	74900	3690	1.28	8.31
457	6.0 #	66.7	85.0	76.2	21600	15.9	946	1220	43200	1890	1.44	21.6
	6.3 #	70.0	89.2	72.5	22700	15.9	991	1280	45300	1980	1.44	20.6
	8.0	88.6	113	57.1	28400	15.9	1250	1610	56900	2490	1.44	16.3
	10.0	110	140	45.7	35100	15.8	1540	2000	70200	3070	1.44	13.1
	12.0 #	132	168	38.1	41600	15.7	1820	2380	83100	3640	1.44	10.9
	12.5	137	175	36.6	43100	15.7	1890	2470	86300	3780	1.44	10.5
	16.0	174	222	28.6	54000	15.6	2360	3110	108000	4720	1.44	8.28
508	6.0 #	74.3	94.6	84.7	29800	17.7	1170	1510	59600	2350	1.60	21.6
	6.3 #	77.9	99.3	80.6	31200	17.7	1230	1590	62500	2460	1.60	20.5
	8.0 #	98.6	126	63.5	39300	17.7	1550	2000	78600	3090	1.60	16.2
	10.0	123	156	50.8	48500	17.6	1910	2480	97000	3820	1.60	13.0
	12.0 #	147	187	42.3	57500	17.5	2270	2950	115000	4530	1.60	10.9
	12.5	153	195	40.6	59800	17.5	2350	3070	120000	4710	1.60	10.5
	16.0 #	194	247	31.8	74900	17.4	2950	3870	150000	5900	1.60	8.24

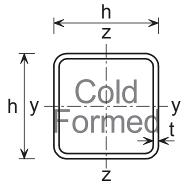
Hybox® is a trademark of Tata Steel. A fuller description of the relationship between Cold Formed Circular Hollow Sections (CFCHS) and the Hybox® range of sections manufactured by Tata Steel is given in note 12.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10219-2:2006

COLD-FORMED
SQUARE HOLLOW SECTIONS

Hybox® SHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Size	Thickness										Per Metre	Per Tonne
h x h	t		A	c/t (1)	I	i	W_{el}	W_{pl}	I_T	W_t		
mm	mm	kg/m	cm^2		cm^4	cm	cm^3	cm^3	cm^4	cm^3	m^2	m^2
25x25	2.0 #	1.36	1.74	9.50	1.48	0.924	1.19	1.47	2.53	1.80	0.093	68.2
	2.5	1.64	2.09	7.00	1.69	0.899	1.35	1.71	2.97	2.07	0.091	55.5
30x30	2.0 #	1.68	2.14	12.0	2.72	1.13	1.81	2.21	4.54	2.75	0.113	67.3
	2.5 #	2.03	2.59	9.00	3.16	1.10	2.10	2.61	5.40	3.20	0.111	54.6
	3.0	2.36	3.01	7.00	3.50	1.08	2.34	2.96	6.15	3.58	0.110	46.5
40x40	2.0 #	2.31	2.94	17.0	6.94	1.54	3.47	4.13	11.3	5.23	0.153	66.4
	2.5	2.82	3.59	13.0	8.22	1.51	4.11	4.97	13.6	6.21	0.151	53.6
	3.0	3.30	4.21	10.3	9.32	1.49	4.66	5.72	15.8	7.07	0.150	45.5
	4.0	4.20	5.35	7.00	11.1	1.44	5.54	7.01	19.4	8.48	0.146	34.7
50x50	2.5	3.60	4.59	17.0	16.9	1.92	6.78	8.07	27.5	10.2	0.191	53.1
	3.0	4.25	5.41	13.7	19.5	1.90	7.79	9.39	32.1	11.8	0.190	44.8
	4.0	5.45	6.95	9.50	23.7	1.85	9.49	11.7	40.4	14.4	0.186	34.0
	5.0	6.56	8.36	7.00	27.0	1.80	10.8	13.7	47.5	16.6	0.183	27.8
60x60	3.0	5.19	6.61	17.0	35.1	2.31	11.7	14.0	57.1	17.7	0.230	44.4
	4.0	6.71	8.55	12.0	43.6	2.26	14.5	17.6	72.6	22.0	0.226	33.7
	5.0	8.13	10.4	9.00	50.5	2.21	16.8	20.9	86.4	25.6	0.223	27.4
	6.0 #	9.45	12.0	7.00	56.1	2.16	18.7	23.7	98.4	28.6	0.219	23.2
70x70	3.0	6.13	7.81	20.3	57.5	2.71	16.4	19.4	92.4	24.7	0.270	44.0
	3.5	7.06	8.99	17.0	65.1	2.69	18.6	22.2	106	28.0	0.268	38.1
	4.0	7.97	10.1	14.5	72.1	2.67	20.6	24.8	119	31.1	0.266	33.5
	5.0	9.70	12.4	11.0	84.6	2.62	24.2	29.6	142	36.7	0.263	27.1
	6.0 #	11.3	14.4	8.67	95.2	2.57	27.2	33.8	163	41.4	0.259	22.9
80x80	3.0	7.07	9.01	23.7	87.8	3.12	22.0	25.8	140	33.0	0.310	43.7
	3.5	8.16	10.4	19.9	99.8	3.10	25.0	29.5	161	37.6	0.308	37.9
	4.0	9.22	11.7	17.0	111	3.07	27.8	33.1	180	41.8	0.306	33.0
	5.0	11.3	14.4	13.0	131	3.03	32.9	39.7	218	49.7	0.303	26.9
	6.0	13.2	16.8	10.3	149	2.98	37.3	45.8	252	56.6	0.299	22.6
90x90	3.0	8.01	10.2	27.0	127	3.53	28.3	33.0	201	42.5	0.350	43.8
	3.5	9.26	11.8	22.7	145	3.51	32.2	37.9	232	48.5	0.348	37.6
	4.0	10.5	13.3	19.5	162	3.48	36.0	42.6	261	54.2	0.346	33.0
	5.0	12.8	16.4	15.0	193	3.43	42.9	51.4	316	64.7	0.343	26.7
	6.0 #	15.1	19.2	12.0	220	3.39	49.0	59.5	368	74.2	0.339	22.4
100x100	3.0	8.96	11.4	30.3	177	3.94	35.4	41.2	279	53.2	0.390	43.7
	4.0	11.7	14.9	22.0	226	3.89	45.3	53.3	362	68.1	0.386	32.9
	5.0	14.4	18.4	17.0	271	3.84	54.2	64.6	441	81.7	0.383	26.6
	6.0	17.0	21.6	13.7	311	3.79	62.3	75.1	514	94.1	0.379	22.3
	8.0	21.4	27.2	9.50	366	3.67	73.2	91.1	645	114	0.366	17.1
120x120	3.0 #	10.8	13.8	37.0	312	4.76	52.1	60.2	488	78.2	0.470	43.4
	4.0	14.2	18.1	27.0	402	4.71	67.0	78.3	637	101	0.466	32.7
	5.0	17.5	22.4	21.0	485	4.66	80.9	95.4	778	122	0.463	26.4
	6.0	20.7	26.4	17.0	562	4.61	93.7	112	913	141	0.459	22.1
	8.0	26.4	33.6	12.0	677	4.49	113	138	1160	175	0.446	16.9
	10.0	31.8	40.6	9.00	777	4.38	129	162	1380	203	0.437	13.7

Hybox® is a trademark of Tata Steel. A fuller description of the relationship between Cold Formed Square Hollow Sections (CFSHS) and the Hybox® range of sections manufactured by Tata Steel is given in note 12.

(1) For local buckling calculation c = h - 3t.

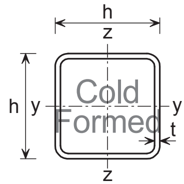
Check availability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10219-2:2006

COLD-FORMED SQUARE HOLLOW SECTIONS

Hybox® SHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Size	Thickness										Per Metre	Per Tonne
h x h	t		A	c/t (1)	I	i	W_{el}	W_{pl}	I_T	W_t		
mm	mm	kg/m	cm^2		cm^4	cm	cm^3	cm^3	cm^4	cm^3	m^2	m^2
140x140	4.0	16.8	21.3	32.0	652	5.52	93.1	108	1020	140	0.546	32.6
	5.0	20.7	26.4	25.0	791	5.48	113	132	1260	170	0.543	26.2
	6.0	24.5	31.2	20.3	920	5.43	131	155	1480	198	0.539	22.0
	8.0	31.4	40.0	14.5	1130	5.30	161	194	1900	248	0.526	16.7
	10.0	38.1	48.6	11.0	1310	5.20	187	230	2270	291	0.517	13.5
150x150	4.0 #	18.0	22.9	34.5	808	5.93	108	125	1270	162	0.586	32.5
	5.0	22.3	28.4	27.0	982	5.89	131	153	1550	197	0.583	26.2
	6.0	26.4	33.6	22.0	1150	5.84	153	180	1830	230	0.579	21.9
	8.0	33.9	43.2	15.8	1410	5.71	188	226	2360	289	0.566	16.7
	10.0	41.3	52.6	12.0	1650	5.61	220	269	2840	341	0.557	13.5
160x160	4.0 #	19.3	24.5	37.0	987	6.34	123	143	1540	185	0.626	32.5
	5.0	23.8	30.4	29.0	1200	6.29	150	175	1900	226	0.623	26.2
	6.0	28.3	36.0	23.7	1410	6.25	176	206	2240	264	0.619	21.9
	8.0	36.5	46.4	17.0	1740	6.12	218	260	2900	334	0.606	16.6
	10.0	44.4	56.6	13.0	2050	6.02	256	311	3490	395	0.597	13.4
180x180	5.0	27.0	34.4	33.0	1740	7.11	193	224	2720	290	0.703	26.1
	6.0	32.1	40.8	27.0	2040	7.06	226	264	3220	340	0.699	21.8
	6.3 #	33.3	42.4	25.6	2100	7.03	233	273	3380	354	0.693	20.8
	8.0	41.5	52.8	19.5	2550	6.94	283	336	4190	432	0.686	16.5
	10.0	50.7	64.6	15.0	3020	6.84	335	404	5070	515	0.677	13.3
	12.0 #	58.5	74.5	12.0	3320	6.68	369	454	5870	584	0.658	11.3
	12.5	60.5	77.0	11.4	3410	6.65	378	467	6050	600	0.656	10.8
200x200	5.0	30.1	38.4	37.0	2410	7.93	241	279	3760	362	0.783	26.0
	6.0	35.8	45.6	30.3	2830	7.88	283	330	4460	426	0.779	21.7
	6.3 #	37.2	47.4	28.7	2920	7.85	292	341	4680	444	0.773	20.7
	8.0	46.5	59.2	22.0	3570	7.76	357	421	5820	544	0.766	16.5
	10.0	57.0	72.6	17.0	4250	7.65	425	508	7070	651	0.757	13.3
	12.0 #	66.0	84.1	13.7	4730	7.50	473	576	8230	743	0.738	11.2
	12.5	68.3	87.0	13.0	4860	7.47	486	594	8500	765	0.736	10.7
250x250	6.0	45.2	57.6	38.7	5670	9.92	454	524	8840	681	0.979	21.6
	6.3 #	47.1	60.0	36.7	5870	9.89	470	544	9290	711	0.973	20.6
	8.0	59.1	75.2	28.3	7230	9.80	578	676	11600	878	0.966	16.3
	10.0	72.7	92.6	22.0	8710	9.70	697	822	14200	1060	0.957	13.2
	12.0 #	84.8	108	17.8	9860	9.55	789	944	16700	1230	0.938	11.1
	12.5	88.0	112	17.0	10200	9.52	813	975	17300	1270	0.936	10.7
300x300	6.0	54.7	69.6	47.0	9960	12.0	664	764	15400	997	1.18	21.6
	6.3 #	57.0	72.6	44.6	10300	11.9	689	795	16200	1040	1.17	20.5
	8.0	71.6	91.2	34.5	12800	11.8	853	991	20300	1290	1.17	16.4
	10.0	88.4	113	27.0	15500	11.7	1040	1210	25000	1570	1.16	13.1
	12.0 #	104	132	22.0	17800	11.6	1180	1400	29500	1830	1.14	11.0
	12.5	108	137	21.0	18300	11.6	1220	1450	30600	1890	1.14	10.6

Hybox® is a trademark of Tata Steel. A fuller description of the relationship between Cold Formed Square Hollow Sections (CFSHS) and the Hybox® range of sections manufactured by Tata Steel is given in note 12.

(1) For local buckling calculation c = h - 3t.

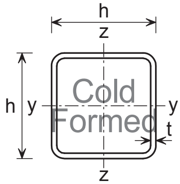
Check availability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10219-2:2006

COLD-FORMED SQUARE HOLLOW SECTIONS

Hybox® SHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Size	Thickness										Per Metre	Per Tonne
h x h	t		A	c/t (1)	I	i	W_{el}	W_{pl}	I_T	W_t		
mm	mm	kg/m	cm^2		cm^4	cm	cm^3	cm^3	cm^4	cm^3	m^2	m^2
350x350	6.0 #	64.1	81.6	55.3	16000	14.0	915	1050	24700	1370	1.38	21.5
	6.3 #	66.9	85.2	52.6	16600	14.0	951	1090	25900	1440	1.37	20.4
	8.0	84.2	107	40.8	20700	13.9	1180	1370	32600	1790	1.37	16.3
	10.0	104	133	32.0	25200	13.8	1440	1680	40100	2180	1.36	13.1
	12.0 #	123	156	26.2	29100	13.6	1660	1950	47600	2550	1.34	10.9
	12.5	127	162	25.0	30000	13.6	1720	2020	49400	2640	1.34	10.5
400x400	6.0 #	73.5	93.6	63.7	24100	16.0	1210	1380	37000	1810	1.58	21.5
	6.3 #	76.8	97.8	60.5	25100	16.0	1260	1440	38900	1890	1.57	20.4
	8.0	96.7	123	47.0	31300	15.9	1560	1800	48900	2360	1.57	16.2
	10.0	120	153	37.0	38200	15.8	1910	2210	60400	2890	1.56	13.0
	12.0 #	141	180	30.3	44300	15.7	2220	2590	71800	3400	1.54	10.9
	12.5	147	187	29.0	45900	15.7	2290	2680	74600	3520	1.54	10.5

Hybox® is a trademark of Tata Steel. A fuller description of the relationship between Cold Formed Square Hollow Sections (CFSHS) and the Hybox® range of sections manufactured by Tata Steel is given in note 12.

(1) For local buckling calculation c = h - 3t.

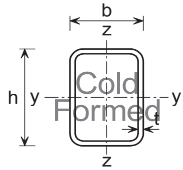
Check availability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10219-2:2006

COLD-FORMED RECTANGULAR HOLLOW SECTIONS

Hybox® RHS



Dimensions and properties

Section Designation		Mass per	Area of	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size	Thickness	Metre	Section			Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z			Per Metre	Per Tonne
h x b	t		A	c_w/t (1)	c_f/t (1)									I_T	W_t		
mm	mm	kg/m	cm^2			cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^4	cm^3	m^2	m^2
50 x 25	2.0 #	2.15	2.74	22.0	9.50	8.38	2.81	1.75	1.01	3.35	2.25	4.26	2.62	7.06	3.92	0.143	66.5
	2.5	2.62	3.34	17.0	7.00	9.89	3.28	1.72	0.991	3.95	2.62	5.11	3.12	8.43	4.60	0.141	53.9
	3.0	3.07	3.91	13.7	5.33	11.2	3.67	1.69	0.969	4.47	2.93	5.86	3.56	9.64	5.18	0.140	45.6
50 x 30	2.0 #	2.31	2.94	22.0	12.0	9.54	4.29	1.80	1.21	3.81	2.86	4.74	3.33	9.77	4.84	0.153	66.4
	2.5	2.82	3.59	17.0	9.00	11.3	5.05	1.77	1.19	4.52	3.37	5.70	3.98	11.7	5.72	0.151	53.6
	3.0	3.30	4.21	13.7	7.00	12.8	5.70	1.75	1.16	5.13	3.80	6.57	4.58	13.5	6.49	0.150	45.5
	4.0	4.20	5.35	9.50	4.50	15.3	6.69	1.69	1.12	6.10	4.46	8.05	5.58	16.5	7.71	0.146	34.7
60 x 40	2.5 #	3.60	4.59	21.0	13.0	22.1	11.7	2.19	1.60	7.36	5.87	9.06	6.84	25.1	9.72	0.191	53.1
	3.0	4.25	5.41	17.0	10.3	25.4	13.4	2.17	1.58	8.46	6.72	10.5	7.94	29.3	11.2	0.190	44.8
	4.0	5.45	6.95	12.0	7.00	31.0	16.3	2.11	1.53	10.3	8.14	13.2	9.89	36.7	13.7	0.186	34.0
	5.0	6.56	8.36	9.00	5.00	35.3	18.4	2.06	1.48	11.8	9.21	15.4	11.5	42.8	15.6	0.183	27.8
70 x 40	3.0	4.72	6.01	20.3	10.3	37.3	15.5	2.49	1.61	10.7	7.75	13.4	9.05	36.5	13.2	0.210	44.5
	4.0	6.08	7.75	14.5	7.00	46.0	18.9	2.44	1.56	13.1	9.44	16.8	11.3	45.8	16.2	0.206	33.8
	5.0	7.34	9.36	11.0	5.00	52.9	21.5	2.38	1.52	15.1	10.8	19.8	13.3	53.8	18.7	0.203	27.6
70 x 50	3.0 #	5.19	6.61	20.3	13.7	44.1	26.1	2.58	1.99	12.6	10.4	15.4	12.2	53.6	17.1	0.230	44.4
	4.0	6.71	8.55	14.5	9.50	54.7	32.2	2.53	1.94	15.6	12.9	19.5	15.4	68.1	21.2	0.226	33.7
	5.0	8.13	10.4	11.0	7.00	63.5	37.2	2.48	1.90	18.1	14.9	23.1	18.2	80.8	24.6	0.223	27.4
80 x 40	3.0	5.19	6.61	23.7	10.3	52.3	17.6	2.81	1.63	13.1	8.78	16.5	10.2	43.9	15.3	0.230	44.4
	4.0	6.71	8.55	17.0	7.00	64.8	21.5	2.75	1.59	16.2	10.7	20.9	12.8	55.2	18.8	0.226	33.7
	5.0	8.13	10.4	13.0	5.00	75.1	24.6	2.69	1.54	18.8	12.3	24.7	15.0	65.0	21.7	0.223	27.4
80 x 50	3.0	5.66	7.21	23.7	13.7	61.1	29.4	2.91	2.02	15.3	11.8	18.8	13.6	65.0	19.7	0.250	44.3
	4.0	7.34	9.35	17.0	9.50	76.4	36.5	2.86	1.98	19.1	14.6	24.0	17.2	82.7	24.6	0.246	33.5
	5.0	8.91	11.4	13.0	7.00	89.2	42.3	2.80	1.93	22.3	16.9	28.5	20.5	98.4	28.7	0.243	27.2
80 x 60	3.0	6.13	7.81	23.7	17.0	70.0	44.9	3.00	2.40	17.5	15.0	21.2	17.4	88.3	24.1	0.270	44.0
	3.5	7.06	8.99	19.9	14.1	79.3	50.7	2.97	2.37	19.8	16.9	24.1	19.8	101	27.3	0.268	38.1
	4.0	7.97	10.1	17.0	12.0	87.9	56.1	2.94	2.35	22.0	18.7	27.0	22.1	113	30.3	0.266	33.5
	5.0	9.70	12.4	13.0	9.00	103	65.7	2.89	2.31	25.8	21.9	32.2	26.4	136	35.7	0.263	27.1
90 x 50	3.0 #	6.13	7.81	27.0	13.7	81.9	32.7	3.24	2.05	18.2	13.1	22.6	15.0	76.7	22.4	0.270	44.0
	4.0 #	7.97	10.1	19.5	9.50	103	40.7	3.18	2.00	22.8	16.3	28.8	19.1	97.7	28.0	0.266	33.5
	5.0	9.70	12.4	15.0	7.00	121	47.4	3.12	1.96	26.8	18.9	34.4	22.7	116	32.7	0.263	27.1

Hybox® is a trademark of Tata Steel. A fuller description of the relationship between Cold Formed Rectangular Hollow Sections (CFRHS) and the Hybox® range of sections manufactured by Tata Steel is given in note 12.

(1) For local buckling calculation $c_w = d - 3t$ and $c_f = h - 3t$.

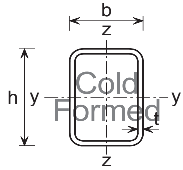
Check availability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10219-2:2006

COLD-FORMED RECTANGULAR HOLLOW SECTIONS

Hybox® RHS



Dimensions and properties

Section Designation		Mass per	Area of	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size	Thickness	Metre	Section			Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z			Per Metre	Per Tonne
h x b	t		A	c_w/t (1)	c_f/t (1)									I_T	W_t		
mm	mm	kg/m	cm^2			cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^4	cm^3	m^2	m^2
100 x 40	3.0	6.13	7.81	30.3	10.3	92.3	21.7	3.44	1.67	18.5	10.8	23.7	12.4	59.0	19.4	0.270	44.0
	4.0	7.97	10.1	22.0	7.00	116	26.7	3.38	1.62	23.1	13.3	30.3	15.7	74.5	24.0	0.266	33.5
	5.0 #	9.70	12.4	17.0	5.00	136	30.8	3.31	1.58	27.1	15.4	36.1	18.5	87.9	27.9	0.263	27.1
100 x 50	3.0	6.60	8.41	30.3	13.7	106	36.1	3.56	2.07	21.3	14.4	26.7	16.4	88.6	25.0	0.290	44.1
	4.0	8.59	10.9	22.0	9.50	134	44.9	3.50	2.03	26.8	18.0	34.1	20.9	113	31.3	0.286	33.2
	5.0	10.5	13.4	17.0	7.00	158	52.5	3.44	1.98	31.6	21.0	40.8	25.0	135	36.8	0.283	27.0
	6.0	12.3	15.6	13.7	5.33	179	58.7	3.38	1.94	35.8	23.5	46.9	28.5	154	41.4	0.279	22.7
100 x 60	3.0	7.07	9.01	30.3	17.0	121	54.6	3.66	2.46	24.1	18.2	29.6	20.8	122	30.6	0.310	43.7
	3.5	8.16	10.4	25.6	14.1	137	61.9	3.63	2.44	27.4	20.6	33.8	23.8	139	34.8	0.308	37.9
	4.0	9.22	11.7	22.0	12.0	153	68.7	3.60	2.42	30.5	22.9	37.9	26.6	156	38.7	0.306	33.0
	5.0	11.3	14.4	17.0	9.00	181	80.8	3.55	2.37	36.2	26.9	45.6	31.9	188	45.8	0.303	26.9
	6.0	13.2	16.8	13.7	7.00	205	91.2	3.49	2.33	41.1	30.4	52.5	36.6	216	51.9	0.299	22.6
100 x 80	3.0 #	8.01	10.2	30.3	23.7	149	106	3.82	3.22	29.8	26.4	35.4	30.4	196	41.9	0.350	43.8
	4.0	10.5	13.3	22.0	17.0	189	134	3.77	3.17	37.9	33.5	45.6	39.2	254	53.4	0.346	33.0
	5.0	12.8	16.4	17.0	13.0	226	160	3.72	3.12	45.2	39.9	55.1	47.2	308	63.7	0.343	26.7
	6.0	15.1	19.2	13.7	10.3	258	182	3.67	3.08	51.7	45.5	63.8	54.7	357	73.0	0.339	22.4
120 x 40	3.0 #	7.07	9.01	37.0	10.3	148	25.8	4.05	1.69	24.7	12.9	32.2	14.6	74.6	23.5	0.310	43.7
	4.0 #	9.22	11.7	27.0	7.00	187	31.9	3.99	1.65	31.1	15.9	41.2	18.5	94.2	29.2	0.306	33.0
	5.0 #	11.3	14.4	21.0	5.00	221	36.9	3.92	1.60	36.8	18.5	49.4	22.0	111	34.1	0.303	26.9
120 x 60	3.0	8.01	10.2	37.0	17.0	189	64.4	4.30	2.51	31.5	21.5	39.2	24.2	156	37.1	0.350	43.8
	3.5	9.26	11.8	31.3	14.1	216	73.1	4.28	2.49	35.9	24.4	44.9	27.7	179	42.2	0.348	37.6
	4.0	10.5	13.3	27.0	12.0	241	81.2	4.25	2.47	40.1	27.1	50.5	31.1	201	47.0	0.346	33.0
	5.0	12.8	16.4	21.0	9.00	287	96.0	4.19	2.42	47.8	32.0	60.9	37.4	242	55.8	0.343	26.7
	6.0	15.1	19.2	17.0	7.00	328	109	4.13	2.38	54.7	36.3	70.6	43.1	280	63.6	0.339	22.4
120 x 80	3.0	8.96	11.4	37.0	23.7	230	123	4.49	3.29	38.4	30.9	46.2	35.0	255	50.8	0.390	43.7
	4.0	11.7	14.9	27.0	17.0	295	157	4.44	3.24	49.1	39.3	59.8	45.2	331	64.9	0.386	32.9
	5.0	14.4	18.4	21.0	13.0	353	188	4.39	3.20	58.9	46.9	72.4	54.7	402	77.8	0.383	26.6
	6.0	17.0	21.6	17.0	10.3	406	215	4.33	3.15	67.7	53.8	84.3	63.5	469	89.4	0.379	22.3
	8.0	21.4	27.2	12.0	7.00	476	252	4.18	3.04	79.3	62.9	102	76.9	584	108	0.366	17.1
140 x 80	3.0 #	9.90	12.6	43.7	23.7	334	141	5.15	3.35	47.8	35.3	58.2	39.6	317	59.7	0.430	43.4
	4.0	13.0	16.5	32.0	17.0	430	180	5.10	3.30	61.4	45.1	75.5	51.3	412	76.5	0.426	32.8
	5.0 #	16.0	20.4	25.0	13.0	517	216	5.04	3.26	73.9	54.0	91.8	62.2	501	91.8	0.423	26.5
	6.0	18.9	24.0	20.3	10.3	597	248	4.98	3.21	85.3	62.0	107	72.4	584	106	0.419	22.2
	8.0	23.9	30.4	14.5	7.00	708	293	4.82	3.10	101	73.3	131	88.4	731	129	0.406	17.0
	10.0	28.7	36.6	11.0	5.00	804	330	4.69	3.01	115	82.6	152	103	851	147	0.397	13.8

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(1) For local buckling calculation c_w = d - 3t and c_f = h - 3t.

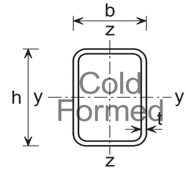
Check availability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10219-2:2006

COLD-FORMED
RECTANGULAR HOLLOW SECTIONS

Hybox® RHS



Dimensions and properties

Section Designation		Mass per	Area of	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size h x b mm	Thickness t mm	Metre kg/m	Section A cm^2	c_w/t (1)	c_f/t (1)	Axis y-y cm^4	Axis z-z cm^4	Axis y-y cm	Axis z-z cm	Axis y-y cm^3	Axis z-z cm^3	Axis y-y cm^3	Axis z-z cm^3	I_T cm^4	W_t cm^3	Per Metre m^2	Per Tonne m^2
150 x 100	3.0 #	11.3	14.4	47.0	30.3	461	248	5.65	4.15	61.4	49.5	73.5	55.8	507	81.4	0.490	43.3
	4.0	14.9	18.9	34.5	22.0	595	319	5.60	4.10	79.3	63.7	95.7	72.5	662	105	0.486	32.7
	5.0	18.3	23.4	27.0	17.0	719	384	5.55	4.05	95.9	76.8	117	88.3	809	127	0.483	26.3
	6.0	21.7	27.6	22.0	13.7	835	444	5.50	4.01	111	88.8	137	103	948	147	0.479	22.1
	8.0	27.7	35.2	15.8	9.50	1010	536	5.35	3.90	134	107	169	128	1210	182	0.466	16.8
	10.0	33.4	42.6	12.0	7.00	1160	614	5.22	3.80	155	123	199	150	1430	211	0.457	13.7
160 x 80	3.0 #	10.8	13.8	50.3	23.7	464	159	5.80	3.39	58.0	39.8	71.4	44.3	380	68.6	0.470	43.4
	4.0	14.2	18.1	37.0	17.0	598	204	5.74	3.35	74.7	50.9	92.9	57.4	494	88.0	0.466	32.7
	5.0	17.5	22.4	29.0	13.0	722	244	5.68	3.30	90.2	61.0	113	69.7	601	106	0.463	26.4
	6.0	20.7	26.4	23.7	10.3	836	281	5.62	3.26	105	70.2	132	81.3	702	122	0.459	22.1
	8.0	26.4	33.6	17.0	7.00	1000	335	5.46	3.16	125	83.7	163	100	882	150	0.446	16.9
	10.0 #	31.8	40.6	13.0	5.00	1150	380	5.32	3.06	143	95.0	191	117	1030	172	0.437	13.7
180 x 80	3.0	11.8	15.0	57.0	23.7	621	177	6.43	3.43	69.0	44.2	85.8	48.9	445	77.5	0.510	43.3
	4.0	15.5	19.7	42.0	17.0	802	227	6.37	3.39	89.1	56.7	112	63.5	578	99.6	0.506	32.6
	5.0	19.1	24.4	33.0	13.0	971	272	6.31	3.34	108	68.1	137	77.2	704	120	0.503	26.3
	6.0 #	22.6	28.8	27.0	10.3	1130	314	6.25	3.30	125	78.5	160	90.2	823	139	0.499	22.1
	8.0	28.9	36.8	19.5	7.00	1360	377	6.08	3.20	151	94.1	198	111	1040	170	0.486	16.8
	10.0 #	35.0	44.6	15.0	5.00	1570	429	5.94	3.10	174	107	234	131	1210	196	0.477	13.6
180 x 100	4.0 #	16.8	21.3	42.0	22.0	926	374	6.59	4.18	103	74.8	126	84.0	854	127	0.546	32.6
	5.0	20.7	26.4	33.0	17.0	1120	452	6.53	4.14	125	90.4	154	103	1050	154	0.543	26.2
	6.0	24.5	31.2	27.0	13.7	1310	524	6.48	4.10	146	105	181	120	1230	179	0.539	22.0
	8.0	31.4	40.0	19.5	9.50	1600	637	6.32	3.99	178	127	226	150	1570	222	0.526	16.7
	10.0	38.1	48.6	15.0	7.00	1860	736	6.19	3.89	207	147	268	177	1860	260	0.517	13.5
200 x 100	4.0	18.0	22.9	47.0	22.0	1200	411	7.23	4.23	120	82.2	148	91.7	985	142	0.586	32.5
	5.0	22.3	28.4	37.0	17.0	1460	497	7.17	4.19	146	99.4	181	112	1210	172	0.583	26.2
	6.0	26.4	33.6	30.3	13.7	1700	577	7.12	4.14	170	115	213	132	1420	200	0.579	21.9
	8.0	33.9	43.2	22.0	9.50	2090	705	6.95	4.04	209	141	267	165	1810	250	0.566	16.7
	10.0	41.3	52.6	17.0	7.00	2440	818	6.82	3.94	244	164	318	195	2150	292	0.557	13.5
200 x 120	4.0	19.3	24.5	47.0	27.0	1350	618	7.43	5.02	135	103	164	115	1350	172	0.626	32.5
	5.0	23.8	30.4	37.0	21.0	1650	750	7.37	4.97	165	125	201	141	1650	210	0.623	26.2
	6.0	28.3	36.0	30.3	17.0	1930	874	7.32	4.93	193	146	237	166	1950	245	0.619	21.9
	8.0	36.5	46.4	22.0	12.0	2390	1080	7.17	4.82	239	180	298	209	2510	308	0.606	16.6
	10.0	44.4	56.6	17.0	9.00	2810	1260	7.04	4.72	281	210	356	250	3010	364	0.597	13.4
200 x 150	4.0 #	21.2	26.9	47.0	34.5	1580	1020	7.67	6.16	158	136	187	154	1940	219	0.686	32.4
	5.0 #	26.2	33.4	37.0	27.0	1940	1250	7.62	6.11	193	166	230	189	2390	267	0.683	26.1
	6.0	31.1	39.6	30.3	22.0	2270	1460	7.56	6.06	227	194	271	223	2830	313	0.679	21.8
	8.0	40.2	51.2	22.0	15.8	2830	1820	7.43	5.95	283	242	344	283	3670	396	0.666	16.6
	10.0	49.1	62.6	17.0	12.0	3350	2140	7.31	5.85	335	286	413	339	4430	471	0.657	13.4

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(1) For local buckling calculation $c_w = d - 3t$ and $c_f = h - 3t$.

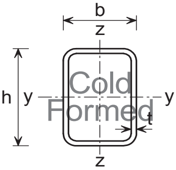
Check availability

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1:2005
BS EN 10219-2:2006

COLD-FORMED RECTANGULAR HOLLOW SECTIONS

Hybox® RHS



Dimensions and properties

Section Designation		Mass per	Area of	Ratios for Local Buckling		Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Torsional Constants		Surface Area	
Size	Thickness	Metre	Section			Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z			Per Metre	Per Tonne
h x b	t		A	c_w/t (1)	c_f/t (1)									I_T	W_t		
mm	mm	kg/m	cm^2			cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^4	cm^3	m^2	m^2
250 x 150	5.0	30.1	38.4	47.0	27.0	3300	1510	9.28	6.27	264	201	320	225	3290	337	0.783	26.0
	6.0	35.8	45.6	38.7	22.0	3890	1770	9.23	6.23	311	236	378	266	3890	396	0.779	21.7
	6.3 #	37.2	47.4	36.7	20.8	4000	1830	9.18	6.20	320	243	391	276	4080	412	0.773	20.7
	8.0	46.5	59.2	28.3	15.8	4890	2220	9.08	6.12	391	296	482	340	5050	504	0.766	16.5
	10.0	57.0	72.6	22.0	12.0	5830	2630	8.96	6.02	466	351	582	409	6120	602	0.757	13.3
	12.0	66.0	84.1	17.8	9.50	6460	2930	8.77	5.90	517	390	658	463	7090	684	0.738	11.2
	12.5	68.3	87.0	17.0	9.00	6630	3000	8.73	5.87	531	400	678	477	7320	704	0.736	10.7
300 x 100	8.0	46.5	59.2	34.5	9.50	5980	1050	10.0	4.20	399	209	523	238	3080	385	0.766	16.5
	10.0	57.0	72.6	27.0	7.00	7110	1220	9.90	4.11	474	245	631	285	3680	455	0.757	13.3
300 x 200	6.0	45.2	57.6	47.0	30.3	7370	3960	11.3	8.29	491	396	588	446	8120	651	0.979	21.6
	6.3 #	47.1	60.0	44.6	28.7	7620	4100	11.3	8.27	508	410	610	463	8520	680	0.973	20.6
	8.0	59.1	75.2	34.5	22.0	9390	5040	11.2	8.19	626	504	757	574	10600	838	0.966	16.3
	10.0	72.7	92.6	27.0	17.0	11300	6060	11.1	8.09	754	606	921	698	13000	1010	0.957	13.2
	12.0 #	84.8	108	22.0	13.7	12800	6850	10.9	7.96	853	685	1060	801	15200	1170	0.938	11.1
	12.5	88.0	112	21.0	13.0	13200	7060	10.8	7.94	879	706	1090	828	15800	1200	0.936	10.7
400 x 200	6.0 #	54.7	69.6	63.7	30.3	14800	5090	14.6	8.55	739	509	906	562	12100	877	1.18	21.6
	6.3 #	57.0	72.6	60.5	28.7	15300	5290	14.5	8.53	766	529	942	585	12700	916	1.17	20.5
	8.0	71.6	91.2	47.0	22.0	19000	6520	14.4	8.45	949	652	1170	728	15800	1130	1.17	16.4
	10.0	88.4	113	37.0	17.0	23000	7860	14.3	8.36	1150	786	1430	888	19400	1370	1.16	13.1
	12.0 #	104	132	30.3	13.7	26200	8980	14.1	8.24	1310	898	1660	1030	22800	1590	1.14	11.0
	12.5	108	137	29.0	13.0	27100	9260	14.1	8.22	1360	926	1710	1060	23600	1640	1.14	10.6
450 x 250	6.0 #	64.1	81.6	72.0	38.7	22700	9250	16.7	10.6	1010	740	1220	817	20700	1250	1.38	21.5
	6.3 #	66.9	85.2	68.4	36.7	23600	9620	16.6	10.6	1050	769	1270	851	21700	1310	1.37	20.4
	8.0 #	84.2	107	53.3	28.3	29300	11900	16.5	10.5	1300	953	1590	1060	27200	1630	1.37	16.3
	10.0 #	104	133	42.0	22.0	35700	14500	16.4	10.4	1590	1160	1950	1300	33500	1980	1.36	13.1
	12.0 #	123	156	34.5	17.8	41100	16700	16.2	10.3	1830	1330	2260	1520	39600	2310	1.34	10.9
	12.5 #	127	162	33.0	17.0	42500	17200	16.2	10.3	1890	1380	2350	1570	41100	2390	1.34	10.5
500 x 300	6.0 #	73.5	93.6	80.3	47.0	33000	15200	18.8	12.7	1320	1010	1580	1120	32400	1690	1.58	21.5
	6.3 #	76.8	97.8	76.4	44.6	34300	15800	18.7	12.7	1370	1050	1650	1170	34100	1770	1.57	20.4
	8.0 #	96.7	123	59.5	34.5	42800	19600	18.6	12.6	1710	1310	2060	1460	42800	2200	1.57	16.2
	10.0 #	120	153	47.0	27.0	52300	23900	18.5	12.5	2090	1600	2540	1790	52700	2690	1.56	13.0
	12.0 #	141	180	38.7	22.0	60600	27700	18.3	12.4	2420	1850	2960	2090	62600	3160	1.54	10.9
	12.5 #	147	187	37.0	21.0	62700	28700	18.3	12.4	2510	1910	3070	2170	65000	3270	1.54	10.5

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(1) For local buckling calculation $c_w = d - 3t$ and $c_f = h - 3t$.

Check availability

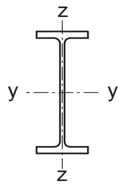
FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

MEMBERSHIP CAPACTITES

S275

BENDING

UNIVERSAL BEAMS
Advance® UKB



RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S275

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
1016x305x487 +	1	4930	5920	**9860**	**9860**	9280	8260	7360	6560	5860	5250	4730	4300	3950	3640	3380
1016x305x437 +	1	4420	5300	**8840**	**8840**	8310	7400	6590	5870	5240	4700	4240	3850	3530	3260	3030
1016x305x393 +	1	3990	4730	**7980**	**7980**	7450	6630	5900	5250	4690	4200	3780	3440	3150	2910	2700
1016x305x349 +	1	3610	4400	**7220**	**7220**	6850	6110	5450	4860	4350	3900	3520	3200	2930	2710	2510
1016x305x314 +	1	3260	3940	**6520**	**6520**	6150	5480	4890	4360	3890	3490	3150	2860	2620	2420	2250
1016x305x272 +	1	2830	3400	**5650**	**5650**	5330	4740	4220	3770	3360	3020	2720	2470	2270	2090	1940
1016x305x249 +	1	2770	3010	**5540**	5530	4900	4330	3830	3380	3000	2670	2410	2190	2010	1850	1720
1016x305x222 +	1	2640	2600	**5280**	4990	4390	3850	3370	2960	2600	2310	2080	1890	1730	1600	1490
914x419x388	1	3240	4680	**6480**	**6480**	**6480**	6160	5550	5000	4520	4100	3730	3400	3120	2880	2680
914x419x343	1	2920	4100	**5840**	**5840**	**5840**	5450	4900	4410	3980	3600	3270	2980	2730	2520	2340
914x305x289	1	2900	3330	**5800**	**5800**	5320	4720	4190	3720	3310	2960	2660	2420	2220	2050	1900
914x305x253	1	2570	2900	**5140**	**5140**	4670	4130	3660	3250	2890	2580	2320	2110	1930	1780	1660
914x305x224	1	2350	2530	**4700**	4680	4140	3660	3220	2850	2520	2250	2020	1840	1680	1550	1440
914x305x201	1	2210	2210	**4410**	4230	3720	3270	2860	2510	2210	1970	1770	1610	1480	1360	1260
838x292x226	1	2220	2430	**4450**	**4450**	3990	3520	3100	2730	2420	2160	1940	1760	1620	1490	1390
838x292x194	1	2000	2020	**4010**	3910	3430	3000	2620	2300	2020	1800	1620	1470	1350	1250	1160
838x292x176	1	1890	1800	**3780**	3570	3120	2710	2360	2060	1800	1600	1440	1310	1200	1110	1030
762x267x197	1	1950	1900	**3890**	3790	3290	2850	2480	2160	1900	1690	1520	1380	1270	1170	1090
762x267x173	1	1760	1640	**3520**	3330	2880	2490	2160	1870	1640	1460	1310	1190	1090	1010	939
762x267x147	1	1560	1370	**3130**	2850	2450	2100	1810	1560	1370	1210	1090	994	911	841	781
762x267x134	1	1520	1280	**3050**	2710	2320	1980	1700	1460	1280	1140	1020	929	851	786	730
686x254x170	1	1630	1490	**3260**	3100	2660	2280	1970	1700	1490	1330	1190	1090	995	918	853
686x254x152	1	1470	1330	**2950**	2770	2380	2040	1750	1510	1330	1180	1060	964	884	816	757
686x254x140	1	1370	1210	**2750**	2550	2180	1860	1600	1380	1210	1070	966	878	805	743	690
686x254x125	1	1280	1060	**2570**	2290	1940	1650	1410	1210	1060	941	847	770	706	651	605

+ These sections are in addition to the range of BS 4 sections

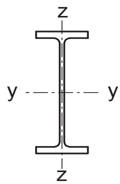
Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

BENDING

UNIVERSAL BEAMS
Advance® UKB



RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S275

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m) 2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
610x305x238	1	1890	1980	**3780**	**3780**	3430	2970	2580	2250	1980	1760	1590	1440	1320	1220	1130
610x305x179	1	1440	1470	**2880**	**2880**	2570	2210	1920	1670	1470	1310	1180	1070	980	905	840
610x305x149	1	1200	1220	**2410**	**2410**	2130	1840	1590	1380	1220	1080	974	885	812	749	696
610x229x140	1	1300	1100	**2590**	2390	2020	1710	1460	1250	1100	976	878	798	732	675	627
610x229x125	1	1170	974	**2340**	2130	1800	1520	1290	1110	974	866	779	708	649	599	557
610x229x113	1	1090	869	**2180**	1930	1620	1370	1160	994	869	773	696	632	580	535	497
610x229x101	1	1060	792	**2130**	1800	1500	1260	1060	905	792	704	634	576	528	488	*453*
610x178x100 +	1	1110	738	2130	1750	1440	1180	984	844	738	656	591	537	492	454	*422*
610x178x92 +	1	1090	691	2030	1660	1350	1100	921	789	691	614	552	502	460	425	*395*
610x178x82 +	1	1000	603	1810	1470	1190	965	804	690	603	536	483	439	402	*371*	*345*
533x312x272 +	1	1910	2080	**3820**	**3820**	3610	3110	2700	2360	2080	1850	1670	1520	1390	1280	*1190*
533x312x219 +	1	1630	1620	**3260**	**3260**	2880	2460	2120	1850	1620	1440	1300	1180	1080	997	*926*
533x312x182 +	1	1340	1330	**2680**	**2680**	2370	2030	1750	1520	1330	1190	1070	971	890	*821*	*763*
533x312x150 +	1	1120	1100	**2240**	**2240**	1960	1670	1440	1250	1100	977	879	799	732	*676*	*628*
533x210x138 +	1	1290	957	**2590**	2220	1830	1520	1280	1090	957	851	766	696	638	*589*	*547*
533x210x122	1	1110	847	**2230**	1940	1610	1340	1130	968	847	753	678	616	565	*521*	*484*
533x210x109	1	1020	750	**2040**	1740	1440	1190	1000	857	750	666	600	545	500	*461*	*428*
533x210x101	1	952	692	**1900**	1610	1330	1100	923	791	692	615	554	503	461	*426*	*396*
533x210x92	1	909	649	**1820**	1520	1250	1030	865	742	649	577	519	472	*433*	*399*	*371*
533x210x82	1	865	566	1680	1360	1110	905	755	647	566	503	453	412	*377*	*348*	*324*
533x165x85 +	1	902	558	1700	1370	1100	892	743	637	558	496	446	405	372	*343*	*319*
533x165x74 +	1	871	497	1560	1240	988	796	663	568	497	442	398	362	*331*	*306*	*284*
533x165x66 +	1	793	429	1380	1090	857	687	572	491	429	382	343	312	*286*	*264*	*245*
457x191x161 +	1	1390	1000	**2770**	2370	1930	1590	1330	1140	1000	890	801	728	*667*	*616*	*572*
457x191x133 +	1	1160	814	**2320**	1940	1580	1300	1080	930	814	723	651	*592*	*542*	*501*	*465*
457x191x106 +	1	947	633	**1890**	1530	1240	1010	844	724	633	563	506	*460*	*422*	*390*	*362*
457x191x98	1	852	591	**1700**	1420	1150	944	789	676	591	526	473	*430*	*394*	*364*	*338*
457x191x89	1	789	534	**1580**	1290	1040	853	712	610	534	474	427	*388*	*356*	*328*	*305*
457x191x82	1	756	504	**1510**	1220	984	805	671	575	504	448	403	*366*	*336*	*310*	*288*
457x191x74	1	693	455	1380	1110	891	727	606	520	455	404	364	*331*	*303*	*280*	*260*
457x191x67	1	650	405	1250	997	798	647	539	462	405	360	324	*294*	*270*	*249*	*231*
457x152x82	1	798	480	1510	1200	951	768	640	549	480	427	384	*349*	*320*	*295*	*274*
457x152x74	1	721	431	1360	1070	854	690	575	493	431	383	345	*314*	*287*	*265*	*246*
457x152x67	1	697	400	1280	1010	795	639	533	457	400	355	320	*291*	*266*	*246*	*228*
457x152x60	1	624	354	1140	893	704	566	472	404	354	315	283	*257*	*236*	*218*	*202*
457x152x52	1	578	301	1000	774	602	482	402	344	301	268	*241*	*219*	*201*	*185*	*172*

\+ These sections are in addition to the range of BS 4 sections

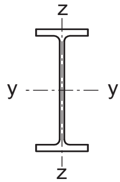
Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

BENDING

UNIVERSAL BEAMS
Advance® UKB



RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S275

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
406x178x85 +	1	742	459	**1480**	**1480**	1450	1290	1140	1020	908	815	735	668	612	565	525
406x178x74	1	664	413	**1330**	**1330**	1300	1160	1030	913	816	732	660	600	550	508	472
406x178x67	1	612	370	**1220**	**1220**	1180	1040	926	822	733	657	592	538	494	456	423
406x178x60	1	549	330	**1100**	**1100**	1050	933	826	734	654	586	528	480	440	406	377
406x178x54	1	529	290	**1060**	**1060**	958	842	741	653	579	516	464	422	387	357	332
406x140x53 +	1	549	284	**1100**	1100	959	838	733	643	567	504	454	412	378	349	324
406x140x46	1	473	244	**946**	944	826	722	631	554	488	434	391	355	326	301	279
406x140x39	1	438	199	**877**	813	703	607	524	455	398	354	319	290	265	245	228
356x171x67	1	568	333	**1140**	**1140**	1090	960	844	746	662	592	533	484	444	410	381
356x171x57	1	501	278	**1000**	**1000**	930	813	712	626	554	494	444	404	370	342	317
356x171x51	1	455	246	**910**	**910**	832	725	634	557	492	438	394	358	329	303	282
356x171x45	1	425	213	**850**	**850**	738	639	555	485	426	379	341	310	284	262	244
356x127x39	1	408	181	**817**	764	653	558	479	414	362	322	290	264	242	223	207
356x127x33	1	366	149	**731**	650	551	467	397	341	299	265	239	217	199	184	171
305x165x54	1	422	233	**844**	**844**	795	689	600	526	464	414	372	338	310	286	266
305x165x46	1	357	198	**714**	**714**	675	585	510	447	395	352	317	288	264	244	*226*
305x165x40	1	319	171	**637**	**637**	590	510	443	388	342	305	274	249	228	211	*196*
305x127x48	1	474	196	**948**	864	726	612	520	447	391	348	313	284	261	241	*223*
305x127x42	1	420	169	**840**	753	631	531	450	386	338	300	270	246	225	208	*193*
305x127x37	1	372	148	**745**	663	555	466	395	339	296	264	237	216	198	182	*169*
305x102x33	1	350	132	**700**	600	501	419	353	302	265	235	212	192	176	163	*151*
305x102x28	1	315	111	622	516	426	353	296	253	222	197	177	161	148	136	*127*
305x102x25	1	299	94.1	555	454	369	301	251	215	188	167	150	137	125	116	*107*
254x146x43	1	321	156	**642**	**642**	562	478	410	355	311	277	249	226	*208*	*192*	*178*
254x146x37	1	280	133	**560**	**560**	482	409	350	303	266	236	213	193	*177*	*163*	*152*
254x146x31	1	260	108	**521**	486	405	339	288	247	216	192	173	157	*144*	*133*	*124*
254x102x28	1	283	97.1	**566**	463	377	310	259	222	194	173	155	141	*129*	*119*	*111*
254x102x25	1	265	84.2	510	410	331	269	224	192	168	150	135	122	*112*	*104*	*96.2*
254x102x22	1	248	71.2	450	357	283	228	190	163	142	127	114	104	*95.0*	*87.7*	*81.4*
203x133x30	1	231	86.4	**462**	411	333	275	230	197	173	154	*138*	*126*	*115*	*106*	*98.7*
203x133x25	1	204	71.0	**408**	344	277	227	189	162	142	126	*114*	*103*	*94.6*	*87.3*	*81.1*
203x102x23	1	197	64.4	**393**	318	253	206	172	147	129	114	*103*	*93.6*	*85.8*	*79.2*	*73.5*
178x102x19	1	157	47.0	310	238	187	150	125	107	94.1	*83.6*	*75.2*	*68.4*	*62.7*	*57.9*	*53.7*
152x89x16	1	130	33.8	238	176	135	108	90.2	*77.3*	*67.7*	*60.1*	*54.1*	*49.2*	*45.1*	*41.6*	*38.7*
127x76x13	1	102	23.1	172	122	92.4	73.9	*61.6*	*52.8*	*46.2*	*41.1*	*37.0*	*33.6*	*30.8*	*28.4*	*26.4*

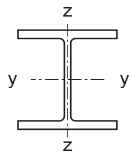
+ These sections are in addition to the range of BS 4 sections

Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

UNIVERSAL COLUMNS
Advance® UKC



RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S275

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
356x406x634	1	3040	3490	**6090**	**6090**	**6090**	5310	4550	3960	3480	3100	2790	2540	*2330*	*2150*	*1990*
356x406x551	1	2630	2960	**5260**	**5260**	**5260**	4520	3870	3360	2950	2630	2370	*2150*	*1970*	*1820*	*1690*
356x406x467	1	2290	2550	**4570**	**4570**	**4570**	3890	3330	2900	2550	2270	2040	*1860*	*1700*	*1570*	*1460*
356x406x393	1	1920	2100	**3840**	**3840**	3810	3210	2750	2380	2100	1860	*1680*	*1520*	*1400*	*1290*	*1200*
356x406x340	1	1640	1780	**3290**	**3290**	3240	2730	2340	2030	1780	1590	*1430*	*1300*	*1190*	*1100*	*1020*
356x406x287	1	1440	1540	**2880**	**2880**	2800	2360	2020	1750	1540	1370	*1230*	*1120*	*1030*	*948*	*880*
356x406x235	1	1150	1240	**2300**	**2300**	2250	1900	1630	1410	1240	*1100*	*994*	*903*	*828*	*764*	*710*
356x368x202	1	1030	1050	**2060**	**2060**	1930	1620	1390	1200	1050	*936*	*842*	*765*	*702*	*648*	*601*
356x368x177	1	907	916	**1810**	**1810**	1690	1420	1210	1040	916	*814*	*733*	*666*	*610*	*563*	*523*
356x368x153	1	772	786	**1540**	**1540**	1440	1210	1030	895	786	*698*	*629*	*571*	*524*	*484*	*449*
356x368x129	2	645	657	**1290**	**1290**	1210	1010	865	749	657	*584*	*526*	*478*	*438*	*404*	*375*
305x305x283	1	1490	1300	**2980**	**2980**	2490	2050	1730	1490	1300	*1160*	*1040*	*947*	*868*	*801*	*744*
305x305x240	1	1320	1130	**2630**	**2630**	2160	1780	1500	1290	*1130*	*1000*	*900*	*819*	*750*	*693*	*643*
305x305x198	1	1070	912	**2140**	**2140**	1750	1440	1210	1040	*912*	*810*	*729*	*663*	*608*	*561*	*521*
305x305x158	1	871	710	**1740**	1700	1370	1130	946	812	*710*	*631*	*568*	*517*	*474*	*437*	*406*
305x305x137	1	756	609	**1510**	1460	1170	965	811	696	*609*	*541*	*487*	*443*	*406*	*375*	*348*
305x305x118	1	657	519	**1310**	1250	1000	824	691	593	*519*	*461*	*415*	*377*	*346*	*319*	*296*
305x305x97	2	558	438	**1120**	1060	848	696	584	500	*438*	*389*	*350*	*318*	*292*	*269*	*250*
254x254x167	1	903	642	**1810**	1610	1260	1030	856	*734*	*642*	*571*	*514*	*467*	*428*	*395*	*367*
254x254x132	1	705	495	**1410**	1240	976	791	661	*566*	*495*	*440*	*396*	*360*	*330*	*305*	*283*
254x254x107	1	577	393	**1150**	990	776	629	525	*450*	*393*	*350*	*315*	*286*	*262*	*242*	*225*
254x254x89	1	467	324	**933**	814	639	518	432	*371*	*324*	*288*	*259*	*236*	*216*	*200*	*185*
254x254x73	1	407	273	**814**	689	539	436	*364*	*312*	*273*	*243*	*218*	*198*	*182*	*168*	*156*
203x203x127 +	1	686	402	**1370**	1040	802	643	*536*	*459*	*402*	*357*	*322*	*292*	*268*	*247*	*230*
203x203x113 +	1	624	352	**1250**	918	703	563	*470*	*402*	*352*	*313*	*282*	*256*	*235*	*217*	*201*
203x203x100 +	1	545	304	**1090**	794	608	487	*406*	*348*	*304*	*270*	*243*	*221*	*203*	*187*	*174*
203x203x86	1	475	259	933	677	517	414	*345*	*296*	*259*	*230*	*207*	*188*	*173*	*159*	*148*
203x203x71	1	371	212	**742**	551	423	339	*282*	*242*	*212*	*188*	*169*	*154*	*141*	*130*	*121*
203x203x60	1	352	180	658	474	361	*289*	*241*	*206*	*180*	*160*	*144*	*131*	*120*	*111*	*103*
203x203x52	1	298	156	566	409	312	*250*	*208*	*178*	*156*	*139*	*125*	*113*	*104*	*96.0*	*89.2*
203x203x46	1	269	137	500	360	274	*219*	*182*	*156*	*137*	*122*	*109*	*99.5*	*91.2*	*84.2*	*78.2*
152x152x51 +	1	316	120	468	321	*241*	*193*	*161*	*138*	*120*	*107*	*96.4*	*87.6*	*80.3*	*74.1*	*68.8*
152x152x44 +	1	271	102	398	273	*205*	*164*	*136*	*117*	*102*	*90.9*	*81.8*	*74.4*	*68.2*	*63.0*	*58.5*
152x152x37	1	226	84.9	331	226	*170*	*136*	*113*	*97.0*	*84.9*	*75.5*	*67.9*	*61.8*	*56.6*	*52.3*	*48.5*
152x152x30	1	184	68.1	266	182	*136*	*109*	*90.8*	*77.8*	*68.1*	*60.5*	*54.5*	*49.5*	*45.4*	*41.9*	*38.9*
152x152x23	3	158	45.1	178	120	*90.2*	*72.2*	*60.1*	*51.5*	*45.1*	*40.1*	*36.1*	*32.8*	*30.1*	*27.8*	*25.8*

\+ These sections are in addition to the range of BS 4 sections

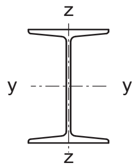
Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

BENDING

JOISTS



RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S275

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
254x203x82	1	520	285	**1040**	**1040**	1020	869	745	648	570	507	457	415	381	351	326
254x114x37	1	352	126	**705**	601	489	402	337	289	252	224	202	184	168	155	144
203x152x52	1	350	143	**700**	683	551	454	382	328	287	255	229	209	191	176	164
152x127x37	1	300	76.7	551	402	307	246	205	175	153	136	123	112	102	94.4	87.7
127x114x29	1	231	49.8	375	265	199	159	133	114	99.6	88.5	79.6	72.4	66.4	61.3	56.9
127x114x27	1	178	47.3	342	248	189	151	126	108	94.6	84.1	75.7	68.8	63.1	58.2	54.1
127x76x16	1	140	28.6	218	152	114	91.5	76.3	65.4	57.2	50.8	45.8	41.6	38.1	35.2	32.7
114x114x27	1	224	41.5	323	221	166	133	111	94.9	83.1	73.8	66.4	60.4	55.4	51.1	47.5
102x102x23	1	185	31.1	245	166	124	99.4	82.9	71.0	62.2	55.2	49.7	45.2	41.4	38.2	35.5
102x44x7	1	82.2	9.74	77.9	51.9	38.9	31.2	26.0	22.3	19.5	17.3	15.6	14.2	13.0	12.0	11.1
89x89x19	1	166	22.7	182	121	91.0	72.8	60.6	52.0	45.5	40.4	36.4	33.1	30.3	28.0	26.0
76x76x15	1	127	14.9	119	79.5	59.6	47.7	39.7	34.1	29.8	26.5	23.8	21.7	19.9	18.3	17.0
76x76x13	1	85.8	13.4	107	71.4	53.6	42.9	35.7	30.6	26.8	23.8	21.4	19.5	17.9	16.5	15.3

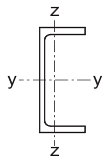
Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

BENDING

PARALLEL FLANGE CHANNELS
Advance® UKPFC



RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S275

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
430x100x64	1	794	324	**1590**	1390	1190	1010	861	740	648	576	518	471	432	399	370
380x100x54	1	621	247	**1240**	1090	920	776	659	565	494	440	396	360	330	304	283
300x100x46	1	481	170	**962**	804	657	541	453	388	340	302	272	247	226	209	*194*
300x90x41	1	475	156	926	752	610	499	417	357	312	278	250	227	208	*192*	*179*
260x90x35	1	376	117	728	578	461	374	312	267	234	208	187	170	*156*	*144*	*134*
260x75x28	1	331	90.2	590	459	360	289	241	206	180	160	144	131	*120*	*111*	*103*
230x90x32	1	321	97.6	627	490	387	312	260	223	195	174	156	*142*	*130*	*120*	*112*
230x75x26	1	282	76.5	512	392	305	245	204	175	153	136	122	*111*	*102*	*94.1*	*87.4*
200x90x30	1	271	80.0	533	407	318	256	213	183	160	*142*	*128*	*116*	*107*	*98.5*	*91.5*
200x75x23	1	237	62.4	431	324	250	200	166	143	125	*111*	*99.9*	*90.8*	*83.2*	*76.8*	*71.3*
180x90x26	1	230	63.8	440	330	255	204	170	146	*128*	*113*	*102*	*92.8*	*85.1*	*78.5*	*72.9*
180x75x20	1	211	48.4	351	256	194	155	129	111	*96.8*	*86.0*	*77.4*	*70.4*	*64.5*	*59.6*	*55.3*
150x90x24	1	198	49.2	357	259	197	158	131	*113*	*98.5*	*87.5*	*78.8*	*71.6*	*65.6*	*60.6*	*56.3*
150x75x18	1	171	36.3	272	193	145	116	96.8	*83.0*	*72.6*	*64.5*	*58.1*	*52.8*	*48.4*	*44.7*	*41.5*
125x65x15	1	147	24.7	194	132	98.9	79.1	*65.9*	*56.5*	*49.4*	*44.0*	*39.6*	*36.0*	*33.0*	*30.4*	*28.3*
100x50x10	1	102	13.4	108	71.7	53.8	*43.0*	*35.9*	*30.7*	*26.9*	*23.9*	*21.5*	*19.6*	*17.9*	*16.6*	*15.4*

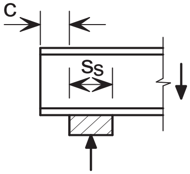
Section classification given applies to members subject to bending about the y-y axis only

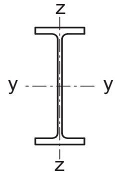
Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint t
the compression flange. Self weight of the section has not been allowed for
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.
FOR EXPLANATION OF TABLES SEE NOTE 5

WEB BEARING AND BUCKLING

UNIVERSAL BEAMS
Advance® UKB





Unstiffened webs

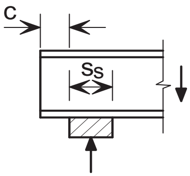
Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
1016x305x487 +	4930	F_{Rd} (c = 0)	938	1020	1100	1200	1290	1400	1670	1980	2480	2860	3240	3620	4010
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	290
		F_{Rd} ($c \geq c_{lim}$)	3480	3560	3640	3710	3790	3870	4060	4250	4630	5010	5400	5780	6160
1016x305x437 +	4420	F_{Rd} (c = 0)	801	872	950	1030	1120	1210	1470	1740	2160	2500	2850	3190	3530
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	270
		F_{Rd} ($c \geq c_{lim}$)	2940	3010	3070	3140	3210	3280	3450	3620	3970	4310	4650	5000	5340
1016x305x393 +	3990	F_{Rd} (c = 0)	681	746	816	892	974	1060	1290	1540	1900	2470	2750	3020	3290
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	300
		F_{Rd} ($c \geq c_{lim}$)	2470	2530	2600	2660	2720	2780	2940	3090	3410	3720	4530	4680	4830
1016x305x349 +	3610	F_{Rd} (c = 0)	598	996	1040	1090	1140	1190	1320	1450	1670	1880	2090	2300	2510
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	290
		F_{Rd} ($c \geq c_{lim}$)	2140	2200	2250	2310	2890	2920	2990	3050	3180	3310	3420	3540	3650
1016x305x314 +	3260	F_{Rd} (c = 0)	771	807	845	883	923	964	1070	1180	1350	1530	1700	1870	2040
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	270
		F_{Rd} ($c \geq c_{lim}$)	2220	2250	2270	2300	2320	2340	2400	2450	2560	2660	2760	2860	2950
1016x305x272 +	2830	F_{Rd} (c = 0)	568	595	623	652	682	713	792	870	999	1130	1260	1380	1510
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	270
		F_{Rd} ($c \geq c_{lim}$)	1620	1630	1650	1670	1690	1710	1750	1790	1870	1950	2030	2100	2170
1016x305x249 +	2770	F_{Rd} (c = 0)	553	580	609	638	669	700	781	848	978	1110	1240	1360	1490
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	270
		F_{Rd} ($c \geq c_{lim}$)	1540	1560	1580	1600	1620	1640	1680	1720	1810	1890	1970	2040	2120
1016x305x222 +	2640	F_{Rd} (c = 0)	509	535	562	590	619	648	718	780	902	1020	1150	1270	1390
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	270
		F_{Rd} ($c \geq c_{lim}$)	1390	1410	1420	1440	1460	1480	1520	1570	1650	1730	1800	1870	1940
914x419x388	3240	F_{Rd} (c = 0)	651	710	774	843	916	993	1420	1570	1830	2060	2300	2530	2770
		c_{lim} (mm)	570	560	550	540	530	520	500	470	420	370	320	280	280
		F_{Rd} ($c \geq c_{lim}$)	2260	2310	2370	2430	2480	2540	2680	2820	3410	3550	3680	3800	3920
914x419x343	2920	F_{Rd} (c = 0)	817	858	900	943	988	1030	1150	1280	1480	1670	1870	2060	2250
		c_{lim} (mm)	570	560	550	540	530	520	500	470	420	370	320	270	260
		F_{Rd} ($c \geq c_{lim}$)	1860	1910	1960	2440	2470	2500	2560	2620	2740	2850	2960	3060	3160

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

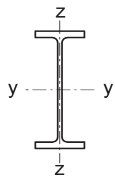
+ These sections are in addition to the range of BS 4 sections

If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
914x305x289	2900	F_{Rd} (c = 0)	464	519	881	925	970	1020	1140	1250	1440	1640	1830	2020	2210
		c_{lim} (mm)	580	570	560	550	540	530	510	480	430	380	330	280	250
		F_{Rd} (c ≥ c_{lim})	1640	1700	1750	1800	1850	1900	2490	2550	2670	2790	2900	3000	3110
914x305x253	2570	F_{Rd} (c = 0)	619	652	685	720	756	792	888	971	1120	1280	1430	1580	1730
		c_{lim} (mm)	580	570	560	550	540	530	510	480	430	380	330	280	230
		F_{Rd} (c ≥ c_{lim})	1750	1780	1800	1820	1840	1860	1910	1960	2060	2150	2240	2330	2410
914x305x224	2350	F_{Rd} (c = 0)	514	542	571	600	631	662	742	807	937	1070	1190	1320	1450
		c_{lim} (mm)	580	570	560	550	540	530	510	480	430	380	330	280	230
		F_{Rd} (c ≥ c_{lim})	1430	1450	1470	1490	1510	1530	1570	1620	1700	1780	1860	1930	2000
914x305x201	2210	F_{Rd} (c = 0)	456	481	507	534	562	590	657	716	833	949	1070	1180	1300
		c_{lim} (mm)	580	570	560	550	540	530	510	480	430	380	330	280	230
		F_{Rd} (c ≥ c_{lim})	1250	1270	1280	1300	1320	1340	1380	1420	1500	1570	1640	1710	1770
838x292x226	2220	F_{Rd} (c = 0)	541	572	603	636	669	704	794	870	1010	1160	1300	1440	1580
		c_{lim} (mm)	540	530	520	510	500	490	460	440	390	340	290	240	220
		F_{Rd} (c ≥ c_{lim})	1540	1560	1580	1600	1620	1640	1690	1730	1820	1910	1990	2070	2140
838x292x194	2000	F_{Rd} (c = 0)	440	465	492	519	548	577	648	708	828	947	1070	1180	1300
		c_{lim} (mm)	540	530	520	510	500	490	460	440	390	340	290	240	200
		F_{Rd} (c ≥ c_{lim})	1220	1240	1260	1280	1290	1310	1350	1390	1470	1540	1610	1680	1740
838x292x176	1890	F_{Rd} (c = 0)	393	416	441	466	492	518	579	634	742	850	958	1070	1170
		c_{lim} (mm)	540	530	520	510	500	490	460	440	390	340	290	240	190
		F_{Rd} (c ≥ c_{lim})	1080	1100	1110	1130	1140	1160	1200	1230	1310	1370	1440	1500	1560
762x267x197	1950	F_{Rd} (c = 0)	510	541	574	609	644	680	774	849	997	1150	1290	1440	1590
		c_{lim} (mm)	480	470	460	450	440	430	410	380	330	280	230	200	200
		F_{Rd} (c ≥ c_{lim})	1080	1120	1500	1520	1540	1560	1610	1660	1750	1830	1920	2000	2070
762x267x173	1760	F_{Rd} (c = 0)	420	447	475	504	534	565	638	701	826	950	1070	1200	1320
		c_{lim} (mm)	480	470	460	450	440	430	410	380	330	280	230	190	190
		F_{Rd} (c ≥ c_{lim})	1180	1200	1220	1240	1250	1270	1310	1350	1430	1510	1580	1650	1710
762x267x147	1560	F_{Rd} (c = 0)	330	351	374	397	422	447	501	551	651	751	851	951	1050
		c_{lim} (mm)	480	470	460	450	440	430	410	380	330	280	230	180	170
		F_{Rd} (c ≥ c_{lim})	907	922	937	952	967	981	1020	1050	1120	1180	1230	1290	1340
762x267x134	1520	F_{Rd} (c = 0)	292	312	332	353	375	398	444	489	579	668	758	847	936
		c_{lim} (mm)	480	470	460	450	440	430	410	380	330	280	230	180	160
		F_{Rd} (c ≥ c_{lim})	795	809	823	836	850	863	895	926	984	1040	1090	1140	1150

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

If c < c_{lim}, then use F_{Rd} value for c = 0.

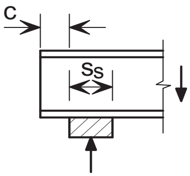
FOR EXPLANATION OF TABLES SEE NOTE 6.

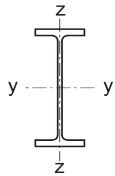
BS EN 1993-1-5: 2007
BS 4-1: 2005

WEB BEARING AND BUCKLING

S275 / Advance® 275

UNIVERSAL BEAMS
Advance® UKB





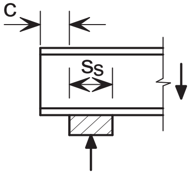
Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
686x254x170	1630	F_{Rd} (c = 0)	270	475	507	540	574	609	697	768	911	1050	1200	1340	1480
		c_{lim} (mm)	440	430	420	410	400	390	360	340	290	240	190	190	190
		F_{Rd} ($c \geq c_{lim}$)	947	986	1020	1060	1360	1380	1420	1470	1550	1630	1710	1780	1850
686x254x152	1470	F_{Rd} (c = 0)	363	389	415	443	471	501	570	630	748	866	983	1100	1220
		c_{lim} (mm)	440	430	420	410	400	390	360	340	290	240	190	180	180
		F_{Rd} ($c \geq c_{lim}$)	1030	1050	1070	1080	1100	1110	1150	1190	1260	1330	1400	1460	1520
686x254x140	1370	F_{Rd} (c = 0)	317	340	363	388	413	439	498	550	655	759	863	967	1070
		c_{lim} (mm)	440	430	420	410	400	390	360	340	290	240	190	170	170
		F_{Rd} ($c \geq c_{lim}$)	891	907	922	937	951	965	1000	1030	1100	1160	1220	1270	1330
686x254x125	1280	F_{Rd} (c = 0)	277	297	318	340	363	387	435	482	575	668	761	853	946
		c_{lim} (mm)	440	430	420	410	400	390	360	340	290	240	190	160	160
		F_{Rd} ($c \geq c_{lim}$)	766	780	794	808	821	834	866	897	956	1010	1060	1110	1160
610x305x238	1890	F_{Rd} (c = 0)	445	497	553	615	681	752	942	1120	1360	1610	1850	2090	2340
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	200	200	200	200
		F_{Rd} ($c \geq c_{lim}$)	1570	1620	1660	1710	1760	1810	1930	2050	2300	2540	2790	3110	3230
610x305x179	1440	F_{Rd} (c = 0)	291	331	375	541	577	614	711	789	940	1090	1240	1390	1540
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	190	190	190
		F_{Rd} ($c \geq c_{lim}$)	999	1040	1070	1110	1150	1190	1430	1480	1560	1640	1720	1790	1860
610x305x149	1210	F_{Rd} (c = 0)	302	324	348	373	398	425	490	543	649	755	861	966	1070
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	170	170	170
		F_{Rd} ($c \geq c_{lim}$)	869	883	898	912	926	939	972	1010	1070	1120	1180	1230	1280
610x229x140	1300	F_{Rd} (c = 0)	227	394	423	454	486	519	596	661	792	923	1050	1180	1310
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	170	170	170
		F_{Rd} ($c \geq c_{lim}$)	797	831	866	901	1130	1150	1190	1230	1300	1380	1440	1510	1570
610x229x125	1170	F_{Rd} (c = 0)	298	321	345	371	397	425	486	540	648	756	863	971	1080
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	160	160	160
		F_{Rd} ($c \geq c_{lim}$)	851	866	881	896	911	925	960	994	1060	1120	1180	1230	1280
610x229x113	1090	F_{Rd} (c = 0)	255	275	297	319	342	366	417	464	558	652	745	839	933
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	720	733	747	760	773	786	817	847	904	957	1010	1060	1100
610x229x101	1060	F_{Rd} (c = 0)	228	247	267	287	308	330	373	416	502	588	673	759	844
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	633	646	659	671	683	695	724	752	806	855	902	947	951

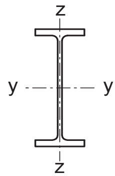
 A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
610x178x100 +	1110	F_{Rd} (c = 0)	259	281	303	326	350	375	424	473	571	668	765	863	959
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	726	741	755	769	783	796	829	861	921	977	1030	1080	1130
610x178x92 +	1090	F_{Rd} (c = 0)	242	262	284	306	329	350	396	443	536	628	721	813	905
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	668	683	696	710	724	737	769	799	857	911	963	1010	1050
610x178x82 +	1000	F_{Rd} (c = 0)	202	219	237	256	275	290	330	369	448	525	603	681	758
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	140	130	130
		F_{Rd} ($c \geq c_{lim}$)	548	560	572	584	595	606	634	660	710	756	800	822	822
533x312x272 +	1910	F_{Rd} (c = 0)	579	638	702	771	844	923	1130	1360	1660	1940	2220	2500	2780
		c_{lim} (mm)	340	330	320	310	300	290	260	240	230	230	230	230	230
		F_{Rd} ($c \geq c_{lim}$)	2060	2110	2170	2230	2280	2340	2480	2620	2900	3180	3460	3740	4020
533x312x219 +	1630	F_{Rd} (c = 0)	417	468	525	587	654	725	917	1080	1320	1560	1800	2050	2290
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	190	190	190	190
		F_{Rd} ($c \geq c_{lim}$)	1460	1510	1560	1610	1660	1710	1830	1950	2190	2430	2680	2920	3160
533x312x182 +	1340	F_{Rd} (c = 0)	316	359	407	459	516	576	739	850	1050	1250	1450	1660	1860
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	160	160	160	160
		F_{Rd} ($c \geq c_{lim}$)	1090	1130	1170	1210	1250	1290	1390	1490	1700	1900	2080	2170	2260
533x312x150 +	1120	F_{Rd} (c = 0)	239	275	316	361	488	523	610	680	819	959	1100	1240	1360
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	170	170	170	170
		F_{Rd} ($c \geq c_{lim}$)	814	848	881	915	949	982	1190	1230	1300	1380	1450	1510	1570
533x210x138 +	1290	F_{Rd} (c = 0)	248	290	338	391	449	510	643	740	935	1130	1330	1520	1800
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	140	140	170
		F_{Rd} ($c \geq c_{lim}$)	885	924	963	1000	1040	1080	1180	1280	1470	1660	1870	1960	2090
533x210x122	1120	F_{Rd} (c = 0)	207	243	285	331	478	514	593	664	804	943	1080	1220	1340
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	160	160	160	160
		F_{Rd} ($c \geq c_{lim}$)	729	763	796	830	864	897	981	1200	1280	1350	1420	1490	1550
533x210x109	1020	F_{Rd} (c = 0)	174	312	338	366	395	425	488	547	664	780	897	1010	1110
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	150	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	608	639	670	701	889	904	941	976	1040	1110	1170	1220	1280
533x210x101	952	F_{Rd} (c = 0)	246	268	291	315	341	367	420	471	572	674	775	876	962
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	539	719	733	747	760	774	806	837	896	951	1000	1050	1100
533x210x92	909	F_{Rd} (c = 0)	216	236	257	278	301	324	370	415	506	596	686	776	853
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	612	625	638	651	663	675	704	733	786	836	883	927	957
533x210x82	865	F_{Rd} (c = 0)	191	209	228	248	269	287	328	369	451	533	614	696	765
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	130	130	130
		F_{Rd} ($c \geq c_{lim}$)	532	544	556	568	579	591	618	644	693	739	783	824	824

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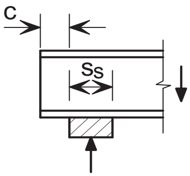
+ These sections are in addition to the range of BS 4 sections

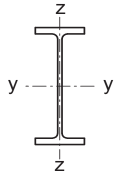
If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
533x165x85 +	902	F_{Rd} (c = 0)	219	239	260	282	306	328	374	421	513	606	698	790	868
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	619	633	646	659	671	684	714	743	798	849	897	943	987
533x165x74 +	871	F_{Rd} (c = 0)	193	211	231	251	272	289	332	374	457	541	624	707	778
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	535	548	560	572	584	596	624	651	702	749	794	836	846
533x165x66 +	793	F_{Rd} (c = 0)	160	176	192	209	225	240	275	311	382	452	522	592	652
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	436	447	458	469	479	489	513	537	580	621	659	661	661
457x191x161 +	1390	F_{Rd} (c = 0)	359	410	467	530	598	670	865	985	1220	1460	1700	1940	2180
		c_{lim} (mm)	290	280	270	260	250	240	220	190	180	180	180	180	180
		F_{Rd} ($c \geq c_{lim}$)	1320	1370	1420	1460	1510	1560	1680	1800	2040	2280	2510	2750	2990
457x191x133 +	1160	F_{Rd} (c = 0)	270	314	363	418	477	541	686	788	991	1190	1400	1600	1800
		c_{lim} (mm)	290	280	270	260	250	240	220	190	150	150	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	978	1020	1060	1100	1140	1180	1280	1380	1590	1790	1990	2190	2420
457x191x106 +	947	F_{Rd} (c = 0)	191	227	269	316	366	421	520	604	771	938	1110	1330	1410
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	130	130	150	150
		F_{Rd} ($c \geq c_{lim}$)	677	711	744	778	811	844	928	1010	1180	1370	1450	1550	1620
457x191x98	852	F_{Rd} (c = 0)	172	205	243	285	331	443	515	581	713	845	977	1090	1160
		c_{lim} (mm)	290	280	270	260	250	240	220	190	150	150	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	605	636	666	696	726	756	832	1010	1080	1140	1210	1270	1320
457x191x89	789	F_{Rd} (c = 0)	149	179	215	316	344	373	432	488	600	712	824	920	976
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	520	547	575	603	631	772	806	838	899	957	1010	1060	1110
457x191x82	756	F_{Rd} (c = 0)	135	236	259	284	309	335	386	437	539	640	742	829	880
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	130	130	130	130
		F_{Rd} ($c \geq c_{lim}$)	470	497	645	658	671	684	716	745	802	855	905	952	997
457x191x74	693	F_{Rd} (c = 0)	175	193	212	233	254	275	317	359	443	527	611	683	725
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	500	512	523	535	546	556	583	608	655	699	741	780	791
457x191x67	650	F_{Rd} (c = 0)	153	169	187	205	224	241	278	316	391	466	541	605	643
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	432	442	453	463	474	484	508	530	573	614	651	670	670

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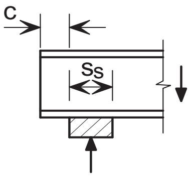
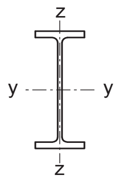
+ These sections are in addition to the range of BS 4 sections

If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

UNIVERSAL BEAMS
Advance® UKB





Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
457x152x82	798	F_{Rd} (c = 0)	143	174	209	314	343	372	429	485	597	709	821	918	974
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	510	538	565	593	621	769	803	835	897	954	1010	1060	1110
457x152x74	721	F_{Rd} (c = 0)	196	216	238	261	284	308	355	402	496	590	683	764	811
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	130	130	130	130
		F_{Rd} ($c \geq c_{lim}$)	433	459	594	606	618	630	659	687	739	788	834	877	919
457x152x67	697	F_{Rd} (c = 0)	173	191	210	231	252	271	313	356	440	524	608	680	722
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	493	505	517	528	539	550	577	602	650	694	736	776	788
457x152x60	624	F_{Rd} (c = 0)	138	153	169	186	203	217	252	286	354	422	490	549	583
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	390	400	410	419	428	437	459	480	519	556	584	584	584
457x152x52	578	F_{Rd} (c = 0)	119	132	146	161	175	187	217	247	308	368	427	479	485
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	328	337	346	355	363	372	392	411	446	479	485	485	485
406x178x85 +	742	F_{Rd} (c = 0)	152	183	220	261	306	354	431	504	648	835	971	1050	1110
		c_{lim} (mm)	260	250	240	230	220	210	180	160	120	130	130	130	130
		F_{Rd} ($c \geq c_{lim}$)	535	564	592	621	650	679	751	824	991	1080	1140	1200	1260
406x178x74	664	F_{Rd} (c = 0)	128	157	248	274	300	327	380	432	537	642	747	804	855
		c_{lim} (mm)	260	250	240	230	220	210	180	160	120	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	447	473	499	525	643	656	687	717	773	825	874	920	965
406x178x67	612	F_{Rd} (c = 0)	170	189	210	232	255	276	322	367	457	547	637	687	730
		c_{lim} (mm)	260	250	240	230	220	210	180	160	120	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	381	405	516	527	539	550	577	603	652	698	740	781	819
406x178x60	549	F_{Rd} (c = 0)	135	151	168	186	205	220	257	293	366	439	511	551	586
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	110	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	387	397	407	417	426	436	458	479	519	556	591	603	603
406x178x54	529	F_{Rd} (c = 0)	125	140	157	174	191	205	239	274	343	412	481	520	553
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	352	362	372	381	391	400	422	442	481	517	551	557	557

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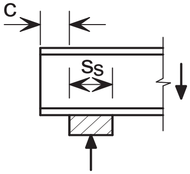
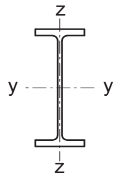
+ These sections are in addition to the range of BS 4 sections
If $c < c_{lim}$, then use F_{Rd} value for c = 0.
FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
406x140x53 +	549	F_{Rd} (c = 0)	133	149	166	184	202	217	253	290	363	435	508	548	583
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	110	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	379	389	399	409	419	428	451	472	513	550	585	601	601
406x140x46	473	F_{Rd} (c = 0)	97.3	109	122	135	148	159	186	213	267	321	375	393	393
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	274	282	289	297	304	311	328	344	375	393	393	393	393
406x140x39	438	F_{Rd} (c = 0)	83.6	94.2	106	117	127	137	161	185	233	281	325	328	328
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	228	236	243	250	257	263	279	294	322	328	328	328	328
356x171x67	568	F_{Rd} (c = 0)	121	149	181	218	294	322	377	432	543	653	732	785	835
		c_{lim} (mm)	230	220	210	200	190	180	150	130	120	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	421	446	471	496	521	547	662	692	748	800	849	895	939
356x171x57	501	F_{Rd} (c = 0)	94.4	119	185	207	230	248	292	336	424	511	574	617	656
		c_{lim} (mm)	230	220	210	200	190	180	150	130	110	110	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	325	347	369	459	470	480	506	530	576	618	658	695	731
356x171x51	455	F_{Rd} (c = 0)	120	136	153	171	190	204	241	278	351	424	477	512	546
		c_{lim} (mm)	230	220	210	200	190	180	150	130	100	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	272	354	364	374	383	392	414	435	473	509	543	563	563
356x171x45	425	F_{Rd} (c = 0)	104	119	134	151	166	179	212	245	310	375	423	455	478
		c_{lim} (mm)	230	220	210	200	190	180	150	130	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	294	304	313	322	330	339	359	378	414	447	477	478	478
356x127x39	408	F_{Rd} (c = 0)	92.4	105	119	134	147	158	188	217	275	333	375	404	404
		c_{lim} (mm)	230	220	210	200	190	180	150	130	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	262	270	278	286	294	301	319	336	368	397	404	404	404
356x127x33	366	F_{Rd} (c = 0)	74.3	85.0	96.6	108	118	128	152	176	225	273	307	307	307
		c_{lim} (mm)	230	220	210	200	190	180	150	130	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	206	213	220	227	233	240	255	270	297	307	307	307	307
305x165x54	422	F_{Rd} (c = 0)	96.7	121	149	182	239	261	310	359	456	543	590	634	675
		c_{lim} (mm)	190	180	170	160	150	140	120	110	110	110	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	333	355	377	398	420	442	520	545	592	636	677	715	752
305x165x46	357	F_{Rd} (c = 0)	103	118	135	152	170	185	220	255	325	388	422	454	483
		c_{lim} (mm)	190	180	170	160	150	140	120	100	100	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	303	312	321	330	338	346	366	384	419	451	480	491	491
305x165x40	319	F_{Rd} (c = 0)	81.0	93.2	106	121	135	146	174	202	259	309	336	358	358
		c_{lim} (mm)	190	180	170	160	150	140	120	90	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	234	242	249	256	263	270	286	301	329	356	358	358	358

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

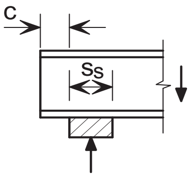
+ These sections are in addition to the range of BS 4 sections

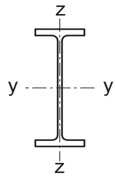
If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING

UNIVERSAL BEAMS
Advance® UKB



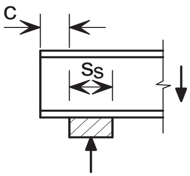


Unstiffened webs

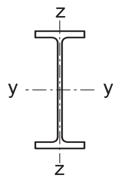
Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
305x127x48	474	F_{Rd} (c = 0)	91.4	119	153	192	228	253	315	377	501	624	756	813	867
		c_{lim} (mm)	190	180	170	160	150	140	120	90	90	90	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	328	353	377	402	427	452	514	575	731	791	860	911	960
305x127x42	420	F_{Rd} (c = 0)	74.2	99.4	130	165	193	215	270	355	455	544	594	639	682
		c_{lim} (mm)	190	180	170	160	150	140	120	90	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	263	285	307	329	351	373	428	530	581	627	671	712	750
305x127x37	372	F_{Rd} (c = 0)	61.6	84.1	145	166	182	198	238	277	356	427	466	502	536
		c_{lim} (mm)	190	180	170	160	150	140	120	90	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	216	236	255	275	294	366	389	411	452	489	523	556	572
305x102x33	350	F_{Rd} (c = 0)	54.6	108	124	141	154	167	201	234	300	363	396	427	452
		c_{lim} (mm)	200	190	180	170	160	150	120	100	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	194	212	285	294	302	311	331	349	384	416	445	452	452
305x102x28	315	F_{Rd} (c = 0)	74.9	87.2	101	113	124	136	163	191	246	297	325	343	343
		c_{lim} (mm)	200	190	180	170	160	150	120	100	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	149	218	226	234	241	248	265	281	310	337	343	343	343
305x102x25	299	F_{Rd} (c = 0)	68.2	79.8	92.5	103	114	124	150	176	227	276	302	309	309
		c_{lim} (mm)	200	190	180	170	160	150	120	100	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	116	195	202	210	217	224	240	255	283	309	309	309	309
254x146x43	321	F_{Rd} (c = 0)	80.4	103	129	159	192	213	262	312	411	488	532	572	610
		c_{lim} (mm)	160	150	140	130	120	110	90	90	90	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	278	298	317	337	357	377	426	472	517	566	604	640	674
254x146x37	280	F_{Rd} (c = 0)	64.4	84.0	127	146	164	179	217	254	329	371	405	436	465
		c_{lim} (mm)	160	150	140	130	120	110	90	90	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	220	237	254	304	312	321	340	359	394	426	456	484	486
254x146x31	260	F_{Rd} (c = 0)	49.5	68.7	112	129	143	157	191	225	293	331	362	391	417
		c_{lim} (mm)	160	150	140	130	120	110	90	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	168	185	201	218	267	275	294	311	344	374	402	419	419

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
If $c < c_{lim}$, then use F_{Rd} value for c = 0.
FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
254x102x28	283	F_{Rd} (c = 0)	49.3	69.6	94.9	139	154	169	205	242	315	359	393	424	454
		c_{lim} (mm)	170	160	150	140	130	120	90	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	174	192	209	226	244	299	320	339	375	408	438	466	469
254x102x25	265	F_{Rd} (c = 0)	40.4	60.1	108	123	136	150	183	216	283	323	354	383	406
		c_{lim} (mm)	170	160	150	140	130	120	90	70	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	142	158	175	191	208	262	282	300	333	363	391	406	406
254x102x22	248	F_{Rd} (c = 0)	31.8	51.1	95.8	108	120	132	162	193	252	289	318	343	348
		c_{lim} (mm)	170	160	150	140	130	120	90	70	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	111	127	143	158	221	229	247	263	294	322	347	348	348
203x133x30	231	F_{Rd} (c = 0)	54.6	75.0	100	129	148	165	209	253	341	419	458	495	529
		c_{lim} (mm)	130	120	110	100	90	80	70	70	70	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	188	206	224	241	259	276	320	364	429	474	509	542	574
203x133x25	204	F_{Rd} (c = 0)	41.8	60.3	83.6	106	122	137	177	216	293	329	360	390	417
		c_{lim} (mm)	130	120	110	100	90	80	60	60	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	143	158	174	190	205	221	260	296	336	367	396	423	441
203x102x23	197	F_{Rd} (c = 0)	42.4	59.8	81.5	105	119	134	181	216	267	298	327	354	378
		c_{lim} (mm)	130	120	110	100	90	80	70	70	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	148	162	177	192	207	243	261	278	308	336	362	384	384
178x102x19	157	F_{Rd} (c = 0)	33.9	49.5	69.3	87.5	101	114	155	186	222	249	274	296	307
		c_{lim} (mm)	110	100	90	80	70	60	60	60	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	117	130	143	156	169	196	212	227	254	278	300	307	307
152x89x16	130	F_{Rd} (c = 0)	29.9	44.7	63.6	79.4	91.8	104	135	166	210	236	260	281	297
		c_{lim} (mm)	100	90	80	70	60	50	50	50	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	104	116	128	141	153	166	196	210	239	262	283	297	297
127x76x13	102	F_{Rd} (c = 0)	25.8	39.0	55.9	69.4	80.4	91.4	119	146	183	206	226	245	255
		c_{lim} (mm)	80	70	60	50	50	50	50	50	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	89.6	101	112	123	134	145	169	182	206	227	246	255	255

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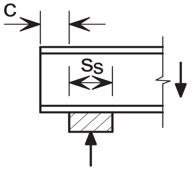
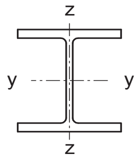
If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

UNIVERSAL COLUMNS
Advance® UKC





Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
356x406x634	3040	F_{Rd} (c = 0)	1900	2020	2140	2280	2420	2570	2960	3390	4330	5010	5600	6180	6760
		c_{lim} (mm)	390	390	390	390	390	390	390	390	390	390	390	390	390
		F_{Rd} ($c \geq c_{lim}$)	7160	7270	7390	7510	7620	7740	8030	8320	8910	9490	10100	10700	11200
356x406x551	2630	F_{Rd} (c = 0)	1550	1660	1770	1890	2020	2150	2510	2900	3740	4260	4770	5290	5810
		c_{lim} (mm)	350	350	350	350	350	350	350	350	350	350	350	350	350
		F_{Rd} ($c \geq c_{lim}$)	5780	5890	5990	6090	6200	6300	6560	6810	7330	7850	8360	8880	9390
356x406x467	2290	F_{Rd} (c = 0)	1270	1370	1470	1570	1690	1810	2130	2480	3170	3620	4080	4540	4990
		c_{lim} (mm)	320	320	320	320	320	320	320	320	320	320	320	320	320
		F_{Rd} ($c \geq c_{lim}$)	4650	4740	4840	4930	5020	5110	5340	5570	6020	6480	6940	7390	7850
356x406x393	1920	F_{Rd} (c = 0)	990	1070	1160	1250	1350	1450	1740	2040	2570	2960	3350	3740	4130
		c_{lim} (mm)	280	280	280	280	280	280	280	280	280	280	280	280	280
		F_{Rd} ($c \geq c_{lim}$)	3570	3650	3720	3800	3880	3960	4150	4350	4740	5130	5520	5910	6300
356x406x340	1640	F_{Rd} (c = 0)	801	872	948	1030	1120	1210	1460	1730	2150	2490	2830	3170	3510
		c_{lim} (mm)	260	260	260	260	260	260	260	260	260	260	260	260	260
		F_{Rd} ($c \geq c_{lim}$)	2850	2920	2980	3050	3120	3190	3360	3530	3870	4200	4540	4880	5220
356x406x287	1440	F_{Rd} (c = 0)	649	712	780	854	932	1020	1240	1480	1820	2120	2420	2720	3020
		c_{lim} (mm)	230	230	230	230	230	230	230	230	230	230	230	230	230
		F_{Rd} ($c \geq c_{lim}$)	2270	2330	2390	2450	2510	2570	2720	2870	3170	3470	3770	4070	4370
356x406x235	1150	F_{Rd} (c = 0)	482	534	590	650	715	784	971	1170	1410	1660	1900	2150	2390
		c_{lim} (mm)	220	210	210	210	210	210	210	210	210	210	210	210	210
		F_{Rd} ($c \geq c_{lim}$)	1660	1710	1760	1810	1850	1900	2020	2150	2390	2630	2880	3120	3370
356x368x202	1030	F_{Rd} (c = 0)	398	444	495	550	609	673	843	1000	1220	1440	1660	1870	2090
		c_{lim} (mm)	220	210	200	190	190	190	190	190	190	190	190	190	190
		F_{Rd} ($c \geq c_{lim}$)	1360	1410	1450	1490	1540	1580	1690	1800	2020	2240	2450	2670	2890
356x368x177	907	F_{Rd} (c = 0)	327	367	412	461	513	569	721	844	1030	1230	1420	1610	1800
		c_{lim} (mm)	220	210	200	190	180	170	170	170	170	170	170	170	170
		F_{Rd} ($c \geq c_{lim}$)	1110	1140	1180	1220	1260	1300	1390	1490	1680	1870	2060	2250	2440
356x368x153	772	F_{Rd} (c = 0)	262	296	335	377	423	471	603	696	859	1020	1190	1350	1510
		c_{lim} (mm)	220	210	200	190	180	170	160	160	160	160	160	160	160
		F_{Rd} ($c \geq c_{lim}$)	876	908	941	973	1010	1040	1120	1200	1360	1530	1680	1760	1830
356x368x129	645	F_{Rd} (c = 0)	203	232	266	302	341	383	494	563	701	838	998	1070	1130
		c_{lim} (mm)	220	210	200	190	180	170	140	140	140	140	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	671	698	726	753	781	809	877	946	1050	1110	1190	1240	1300

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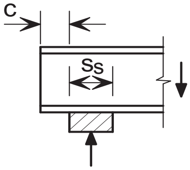
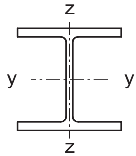
If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



UNIVERSAL COLUMNS
Advance® UKC



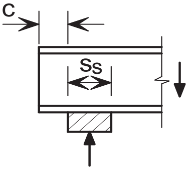
Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
305x305x283	1490	F_{Rd} (c = 0)	739	810	888	972	1060	1160	1410	1690	2070	2410	2750	3100	3440
		c_{lim} (mm)	250	250	250	250	250	250	250	250	250	250	250	250	250
		F_{Rd} ($c \geq c_{lim}$)	2690	2760	2830	2900	2970	3030	3210	3380	3720	4060	4400	4740	5090
305x305x240	1320	F_{Rd} (c = 0)	605	669	739	814	896	982	1220	1460	1770	2070	2380	2680	2990
		c_{lim} (mm)	220	220	220	220	220	220	220	220	220	220	220	220	220
		F_{Rd} ($c \geq c_{lim}$)	2170	2230	2290	2350	2410	2470	2630	2780	3080	3390	3690	4000	4300
305x305x198	1070	F_{Rd} (c = 0)	456	509	568	632	701	775	973	1150	1400	1660	1910	2160	2420
		c_{lim} (mm)	200	200	200	200	200	200	200	200	200	200	200	200	200
		F_{Rd} ($c \geq c_{lim}$)	1610	1660	1710	1760	1810	1860	1990	2110	2370	2620	2870	3130	3380
305x305x158	871	F_{Rd} (c = 0)	328	373	423	477	536	599	768	883	1090	1300	1510	1720	1930
		c_{lim} (mm)	190	180	170	170	170	170	170	170	170	170	170	170	170
		F_{Rd} ($c \geq c_{lim}$)	1140	1180	1220	1260	1310	1350	1450	1560	1770	1980	2190	2400	2600
305x305x137	756	F_{Rd} (c = 0)	266	305	349	397	450	505	650	741	924	1110	1290	1470	1660
		c_{lim} (mm)	190	180	170	160	150	150	150	150	150	150	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	910	947	983	1020	1060	1090	1180	1280	1460	1640	1820	2010	2190
305x305x118	657	F_{Rd} (c = 0)	213	247	286	329	375	425	539	619	778	937	1100	1260	1410
		c_{lim} (mm)	190	180	170	160	150	140	140	140	140	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	721	753	784	816	848	880	959	1040	1200	1360	1520	1680	1810
305x305x97	558	F_{Rd} (c = 0)	165	194	228	265	306	350	437	505	641	777	913	1030	1100
		c_{lim} (mm)	190	180	170	160	150	140	120	120	120	120	120	130	130
		F_{Rd} ($c \geq c_{lim}$)	550	577	604	631	658	686	754	822	958	1050	1120	1180	1240
254x254x167	903	F_{Rd} (c = 0)	424	478	538	603	674	749	952	1110	1360	1620	1870	2130	2380
		c_{lim} (mm)	190	190	190	190	190	190	190	190	190	190	190	190	190
		F_{Rd} ($c \geq c_{lim}$)	1520	1570	1620	1670	1730	1780	1900	2030	2290	2540	2790	3050	3300
254x254x132	705	F_{Rd} (c = 0)	300	343	392	445	503	565	728	829	1030	1240	1440	1640	1840
		c_{lim} (mm)	160	160	160	160	160	160	160	160	160	160	160	160	160
		F_{Rd} ($c \geq c_{lim}$)	1050	1090	1130	1180	1220	1260	1360	1460	1660	1860	2070	2270	2470
254x254x107	577	F_{Rd} (c = 0)	221	258	299	345	395	448	567	652	821	991	1160	1330	1500
		c_{lim} (mm)	160	150	140	140	140	140	140	140	140	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	764	798	832	866	900	934	1020	1100	1270	1440	1610	1780	1950
254x254x89	467	F_{Rd} (c = 0)	167	196	230	267	308	352	440	509	645	781	918	1050	1190
		c_{lim} (mm)	160	150	140	130	130	130	130	130	130	130	130	130	130
		F_{Rd} ($c \geq c_{lim}$)	566	593	620	647	675	702	770	838	975	1110	1250	1390	1450
254x254x73	407	F_{Rd} (c = 0)	129	155	185	218	255	293	360	419	537	656	774	851	905
		c_{lim} (mm)	160	150	140	130	120	110	110	110	110	110	110	120	120
		F_{Rd} ($c \geq c_{lim}$)	433	456	480	504	527	551	610	669	801	858	911	968	1020

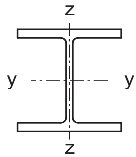
Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.



UNIVERSAL COLUMNS
Advance® UKC



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm)												
			Stiff bearing length, s_s (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
203x203x127 +	686	F_{Rd} (c = 0)	351	402	460	523	592	665	856	976	1220	1460	1700	1940	2180
		c_{lim} (mm)	170	170	170	170	170	170	170	170	170	170	170	170	170
		F_{Rd} ($c \geq c_{lim}$)	1280	1330	1380	1430	1470	1520	1640	1760	2000	2240	2480	2720	2960
203x203x113 +	624	F_{Rd} (c = 0)	296	343	395	453	516	583	743	851	1070	1280	1500	1720	1930
		c_{lim} (mm)	160	160	160	160	160	160	160	160	160	160	160	160	160
		F_{Rd} ($c \geq c_{lim}$)	1070	1110	1160	1200	1240	1290	1400	1500	1720	1940	2150	2370	2580
203x203x100 +	545	F_{Rd} (c = 0)	245	287	334	386	443	504	635	731	923	1120	1310	1500	1690
		c_{lim} (mm)	140	140	140	140	140	140	140	140	140	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	876	914	953	991	1030	1070	1160	1260	1450	1640	1840	2030	2220
203x203x86	475	F_{Rd} (c = 0)	198	234	276	323	374	428	532	616	785	953	1120	1290	1460
		c_{lim} (mm)	130	130	130	130	130	130	130	130	130	130	130	130	130
		F_{Rd} ($c \geq c_{lim}$)	698	732	765	799	833	866	950	1030	1200	1370	1540	1710	1880
203x203x71	371	F_{Rd} (c = 0)	147	176	210	247	287	331	407	473	606	738	871	1000	1140
		c_{lim} (mm)	130	120	120	120	120	120	120	120	120	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	508	535	561	588	614	641	707	773	906	1040	1170	1300	1440
203x203x60	352	F_{Rd} (c = 0)	121	150	184	222	263	301	366	430	560	689	818	947	1080
		c_{lim} (mm)	130	120	110	100	100	100	100	100	100	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	417	443	469	494	520	546	611	675	805	934	1060	1190	1320
203x203x52	298	F_{Rd} (c = 0)	97.7	122	150	183	218	247	301	355	464	573	681	786	838
		c_{lim} (mm)	130	120	110	100	90	90	90	90	90	90	90	100	100
		F_{Rd} ($c \geq c_{lim}$)	331	352	374	396	417	439	493	548	656	774	826	880	926
203x203x46	269	F_{Rd} (c = 0)	81.9	104	131	161	193	215	264	314	413	512	602	649	692
		c_{lim} (mm)	130	120	110	100	90	90	90	90	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	275	295	315	335	354	374	424	473	572	631	680	721	760
152x152x51 +	316	F_{Rd} (c = 0)	127	161	201	247	296	331	407	482	633	785	936	1090	1240
		c_{lim} (mm)	100	100	100	100	100	100	100	100	100	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	454	485	515	545	575	606	681	757	908	1060	1210	1360	1510
152x152x44 +	271	F_{Rd} (c = 0)	102	131	167	207	248	275	340	405	536	666	797	928	1060
		c_{lim} (mm)	100	90	90	90	90	90	90	90	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	359	385	411	437	463	490	555	620	751	881	1010	1140	1270
152x152x37	226	F_{Rd} (c = 0)	78.6	104	134	169	199	221	276	331	441	551	661	771	881
		c_{lim} (mm)	100	90	80	80	80	80	80	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	273	295	317	339	361	383	438	493	603	713	823	933	1050
152x152x30	184	F_{Rd} (c = 0)	57.6	78.2	104	132	153	171	216	260	350	439	528	592	633
		c_{lim} (mm)	100	90	80	70	70	70	70	70	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	197	214	232	250	268	286	331	375	465	561	604	647	685
152x152x23	158	F_{Rd} (c = 0)	39.3	58.4	82.5	103	119	135	175	215	295	375	429	465	498
		c_{lim} (mm)	100	90	80	70	60	50	50	50	50	50	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	133	149	165	181	197	213	252	292	372	428	467	500	531

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

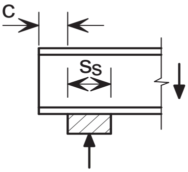
+ These sections are in addition to the range of BS 4 sections

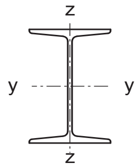
If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING

JOISTS



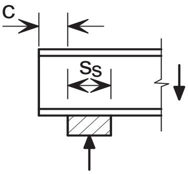


Unstiffened webs

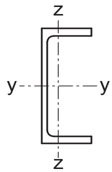
Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
254x203x82	520	F_{Rd} (c = 0)	170	199	232	269	309	352	443	510	646	781	916	1050	1190
		c_{lim} (mm)	150	140	130	130	130	130	130	130	130	130	130	130	130
		F_{Rd} ($c \geq c_{lim}$)	588	615	642	669	696	723	790	858	993	1130	1260	1410	1470
254x114x37	352	F_{Rd} (c = 0)	73.4	97.2	126	159	187	208	260	313	417	522	593	640	683
		c_{lim} (mm)	160	150	140	130	120	110	80	80	80	80	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	261	282	303	324	345	365	418	470	569	617	670	711	750
203x152x52	350	F_{Rd} (c = 0)	114	140	170	205	242	279	338	397	515	633	751	869	987
		c_{lim} (mm)	120	110	110	110	110	110	110	110	110	110	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	400	423	447	471	494	518	577	636	754	872	990	1110	1200
152x127x37	300	F_{Rd} (c = 0)	93.3	126	167	213	246	275	346	418	561	704	847	990	1130
		c_{lim} (mm)	90	80	80	80	80	80	80	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	339	368	397	425	454	482	554	625	768	911	1050	1200	1340
127x114x29	231	F_{Rd} (c = 0)	76.4	109	151	192	220	248	318	388	529	669	809	949	1090
		c_{lim} (mm)	70	70	70	70	70	70	70	70	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	280	309	337	365	393	421	491	561	701	841	982	1120	1260
127x114x27	178	F_{Rd} (c = 0)	64.5	88.0	117	150	173	193	244	295	396	498	600	702	803
		c_{lim} (mm)	70	70	70	70	70	70	70	70	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	229	249	269	290	310	330	381	432	534	636	737	839	941
127x76x16	140	F_{Rd} (c = 0)	38.6	56.9	80.2	101	116	132	170	209	286	363	440	491	526
		c_{lim} (mm)	80	70	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	139	154	169	185	200	216	254	293	370	447	494	531	563
114x114x27	224	F_{Rd} (c = 0)	68.6	99.5	138	175	201	228	293	358	489	619	750	881	1010
		c_{lim} (mm)	70	60	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	250	276	302	328	354	380	446	511	642	772	903	1030	1160
102x102x23	185	F_{Rd} (c = 0)	62.2	93.6	134	166	192	219	284	349	480	610	741	872	1000
		c_{lim} (mm)	60	60	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	230	256	282	308	334	360	426	491	622	752	883	1010	1140
102x44x7	82.2	F_{Rd} (c = 0)	16.4	32.1	46.9	58.7	70.5	82.3	112	141	201	258	285	310	334
		c_{lim} (mm)	60	50	40	40	40	40	40	40	40	40	40	40	40
		F_{Rd} ($c \geq c_{lim}$)	60.8	72.7	84.5	96.3	108	120	150	179	238	278	303	327	349
89x89x19	166	F_{Rd} (c = 0)	55.9	87.9	129	157	184	210	275	340	471	602	732	863	993
		c_{lim} (mm)	60	60	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	210	236	262	288	314	341	406	471	602	732	863	994	1120
76x76x15	127	F_{Rd} (c = 0)	43.6	74.5	111	135	160	184	245	306	429	551	674	796	918
		c_{lim} (mm)	50	50	50	50	50	50	50	50	50	50	50	50	50
		F_{Rd} ($c \geq c_{lim}$)	164	189	213	238	262	287	348	409	532	654	776	899	1020
76x76x13	85.8	F_{Rd} (c = 0)	32.2	49.1	70.8	87.6	102	116	151	186	256	326	396	466	536
		c_{lim} (mm)	50	50	50	50	50	50	50	50	50	50	50	50	50
		F_{Rd} ($c \geq c_{lim}$)	115	129	143	157	171	185	220	255	325	395	465	535	606

If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.



PARALLEL FLANGE CHANNELS
Advance® UKPFC



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
430x100x64	750	F_{Rd} (c = 0)	118	151	190	234	283	313	386	458	604	814	948	1030	1100
		c_{lim} (mm)	270	260	250	240	230	220	190	170	120	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	445	474	503	532	561	591	663	736	978	1060	1120	1180	1240
380x100x54	581	F_{Rd} (c = 0)	101	129	163	202	243	269	332	440	553	667	759	815	868
		c_{lim} (mm)	230	220	210	200	190	180	160	130	110	110	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	374	399	424	450	475	500	563	711	771	826	878	927	974
300x100x46	443	F_{Rd} (c = 0)	92.8	120	152	189	227	250	310	370	489	608	727	823	877
		c_{lim} (mm)	180	170	160	150	140	130	110	90	90	90	90	100	100
		F_{Rd} ($c \geq c_{lim}$)	341	365	389	413	436	460	520	580	699	809	864	928	976
300x90x41	445	F_{Rd} (c = 0)	85.8	114	149	188	220	245	307	369	493	616	770	830	885
		c_{lim} (mm)	180	170	160	150	140	130	110	90	90	90	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	319	344	369	394	418	443	505	567	691	806	878	930	980
260x90x35	349	F_{Rd} (c = 0)	73.0	98.3	129	164	191	213	268	323	433	543	650	701	749
		c_{lim} (mm)	160	150	140	130	120	110	80	80	80	80	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	268	290	312	334	356	378	433	488	598	676	735	780	823
260x75x28	308	F_{Rd} (c = 0)	53.5	76.1	104	133	153	172	220	268	364	447	489	528	564
		c_{lim} (mm)	160	150	140	130	120	110	90	70	70	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	197	217	236	255	274	294	342	413	458	509	547	582	615
230x90x32	294	F_{Rd} (c = 0)	70.7	94.3	123	156	183	203	255	306	409	513	612	660	704
		c_{lim} (mm)	140	130	120	110	100	90	80	80	80	80	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	258	278	299	320	340	361	412	464	567	637	691	733	774
230x75x26	258	F_{Rd} (c = 0)	53.7	74.4	100	129	147	165	210	255	344	413	452	488	522
		c_{lim} (mm)	140	130	120	110	100	90	70	70	70	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	196	214	232	250	268	286	331	385	427	472	506	539	570
200x90x30	244	F_{Rd} (c = 0)	68.3	90.2	117	147	174	193	241	289	385	482	577	622	665
		c_{lim} (mm)	120	110	100	90	80	80	80	80	80	80	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	247	266	286	305	324	343	392	440	536	603	651	692	730
200x75x23	213	F_{Rd} (c = 0)	51.6	70.6	94.2	121	139	155	197	238	320	380	417	450	481
		c_{lim} (mm)	120	110	100	90	80	70	70	70	70	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	187	204	220	237	253	270	311	356	395	434	466	496	524

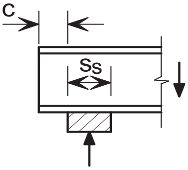
Advance® and UKPFC are trademarks of Tata Steel. A fuller description of the relationship between Parallel Flange Channels (PFC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

If $c < c_{lim}$, then use F_{Rd} value for c = 0.

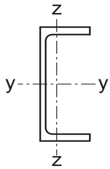
Resistances assume no eccentricity of the applied force relative to the web.

FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



PARALLEL FLANGE CHANNELS
Advance® UKPFC

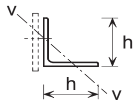


Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
180x90x26	207	F_{Rd} (c = 0)	58.8	79.3	105	133	155	173	217	262	351	441	520	562	600
		c_{lim} (mm)	110	100	90	80	80	80	80	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	211	229	247	265	282	300	345	390	479	538	582	620	655
180x75x20	191	F_{Rd} (c = 0)	43.3	62.8	87.5	111	127	144	185	226	309	393	432	467	500
		c_{lim} (mm)	110	100	90	80	70	60	60	60	60	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	157	174	190	207	223	240	281	322	400	442	477	509	539
150x90x24	175	F_{Rd} (c = 0)	56.4	77.1	103	131	151	169	214	259	348	437	527	620	663
		c_{lim} (mm)	90	80	70	70	70	70	70	70	70	70	70	80	80
		F_{Rd} ($c \geq c_{lim}$)	203	220	238	256	274	292	337	381	471	560	636	681	721
150x75x18	152	F_{Rd} (c = 0)	39.5	57.4	80.0	101	116	131	169	207	283	364	400	433	463
		c_{lim} (mm)	90	80	70	60	60	60	60	60	60	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	142	157	172	187	202	218	255	293	369	407	440	470	498
125x65x15	129	F_{Rd} (c = 0)	34.9	53.2	76.5	94.8	110	125	163	201	276	352	428	475	510
		c_{lim} (mm)	80	70	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	128	143	158	173	188	203	241	279	354	430	477	513	545
100x50x10	90.3	F_{Rd} (c = 0)	26.1	43.3	64.5	78.2	92.0	106	140	174	243	312	381	440	472
		c_{lim} (mm)	60	50	50	50	50	50	50	50	50	50	50	50	50
		F_{Rd} ($c \geq c_{lim}$)	97.3	111	125	139	152	166	200	235	304	372	436	470	500

Advance® and UKPFC are trademarks of Tata Steel. A fuller description of the relationship between Parallel Flange Channels (PFC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
If $c < c_{lim}$, then use F_{Rd} value for c = 0.
Resistances assume no eccentricity of the applied force relative to the web.
FOR EXPLANATION OF TABLES SEE NOTE 6.

EQUAL ANGLES
Advance® UKA - Equal Angles



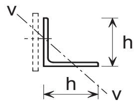
Section Designation		Mass per Metre	Radius of Gyration Axis v-v	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
h x h	t					No.	Diameter	$N_{u,Rd}$
mm	mm	kg/m	cm	cm^2			mm	kN
200x200	24	71.1	3.90	90.6	Weld	0	-	2060
					M24	1	26	1840
					M24	2	26	1690
					M20	3	22	1590
	20	59.9	3.92	76.3	Weld	0	-	1730
					M24	1	26	1540
					M24	2	26	1420
					M20	3	22	1330
	18	54.3	3.90	69.1	Weld	0	-	1570
					M24	1	26	1390
					M24	2	26	1290
					M20	3	22	1210
	16	48.5	3.94	61.8	Weld	0	-	1450
					M24	1	26	1290
					M24	2	26	1190
					M20	3	22	1120
150x150	18 +	40.1	2.93	51.2	Weld	0	-	1160
					M24	1	26	1030
					M20	2	22	927
	15	33.8	2.93	43.0	Weld	0	-	1010
					M24	1	26	896
					M20	2	22	807
	12	27.3	2.95	34.8	Weld	0	-	818
					M24	1	26	722
					M20	2	22	651
	10	23.0	2.97	29.3	Weld	0	-	688
					M24	1	26	606
					M20	2	22	546
120x120	15 +	26.6	2.34	34.0	Weld	0	-	803
					M24	1	26	685
					M20	1	22	705
	12	21.6	2.35	27.5	Weld	0	-	648
					M24	1	26	552
					M20	1	22	568
	10	18.2	2.36	23.2	Weld	0	-	546
					M24	1	26	464
					M20	1	22	477
	8 +	14.7	2.38	18.8	Weld	0	-	441
					M24	1	26	375
					M20	1	22	385

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range in BS EN 10056-1.

FOR EXPLANATION OF TABLES SEE NOTE 7.

EQUAL ANGLES
Advance® UKA - Equal Angles



Section Designation		Mass per Metre	Radius of Gyration Axis v-v	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
h x h	t					No.	Diameter	$N_{u,Rd}$
mm	mm	kg/m	cm	cm^2			mm	kN
100x100	15 +	21.9	1.94	28.0	Weld	0	-	663
					M24	1	26	545
					M20	1	22	565
	12	17.8	1.94	22.7	Weld	0	-	536
					M24	1	26	440
					M20	1	22	456
	10	15.0	1.95	19.2	Weld	0	-	452
					M24	1	26	371
					M20	1	22	384
	8	12.2	1.96	15.5	Weld	0	-	364
					M24	1	26	298
					M20	1	22	309
90x90	12 +	15.9	1.75	20.3	Weld	0	-	480
					M20	1	22	400
					M16	1	18	416
	10	13.4	1.75	17.1	Weld	0	-	403
					M20	1	22	336
					M16	1	18	349
	8	10.9	1.76	13.9	Weld	0	-	327
					M20	1	22	272
					M16	1	18	282
	7	9.61	1.77	12.2	Weld	0	-	287
					M20	1	22	238
					M16	1	18	247
80x80	10	11.9	1.55	15.1	Weld	0	-	357
					M20	1	22	289
					M16	1	18	302
	8	9.63	1.56	12.3	Weld	0	-	290
					M20	1	22	234
					M16	1	18	245
75x75	8	8.99	1.46	11.4	Weld	0	-	269
					M20	1	22	214
					M16	1	18	225
	6	6.85	1.47	8.73	Weld	0	-	205
					M20	1	22	163
					M16	1	18	171

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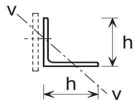
+ These sections are in addition to the range in BS EN 10056-1.

FOR EXPLANATION OF TABLES SEE NOTE 7.

EQUAL ANGLES
Advance® UKA - Equal Angles

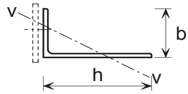


Section Designation		Mass per Metre	Radius of Gyration Axis v-v	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
h x h	t					No.	Diameter	$N_{u,Rd}$
mm	mm	kg/m	cm	cm²			mm	kN
70x70	7	7.38	1.36	9.40	Weld	0	-	221
					M20	1	22	173
					M16	1	18	182
	6	6.38	1.37	8.13	Weld	0	-	191
					M20	1	22	149
					M16	1	18	157
65x65	7	6.83	1.26	8.73	Weld	0	-	206
					M20	1	22	157
					M16	1	18	166
60x60	8	7.09	1.16	9.03	Weld	0	-	213
					M16	1	18	169
	6	5.42	1.17	6.91	Weld	0	-	163
					M16	1	18	129
	5	4.57	1.17	5.82	Weld	0	-	137
					M16	1	18	108
50x50	6	4.47	0.968	5.69	Weld	0	-	134
					M12	1	14	108
	5	3.77	0.973	4.80	Weld	0	-	113
					M12	1	14	91.0
	4	3.06	0.979	3.89	Weld	0	-	91.4
					M12	1	14	73.5
45x45	4.5	3.06	0.870	3.90	Weld	0	-	91.8
					M12	1	14	71.8
40x40	5	2.97	0.773	3.79	Weld	0	-	89.5
					M12	1	14	67.5
	4	2.42	0.777	3.08	Weld	0	-	72.5
					M12	1	14	54.7
35x35	4	2.09	0.678	2.67	Weld	0	-	62.9
					M12	1	14	45.2
30x30	4	1.78	0.577	2.27	Weld	0	-	53.6
					M12	1	14	35.8
	3	1.36	0.581	1.74	Weld	0	-	40.9
					M12	1	14	27.4
25x25	4	1.45	0.482	1.85	Weld	0	-	43.9
					M12	1	14	26.2
	3	1.12	0.484	1.42	Weld	0	-	33.5
					M12	1	14	20.1
20x20	3	0.882	0.383	1.12	Weld	0	-	26.5
					M12	1	14	13.1

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in note 12.

FOR EXPLANATION OF TABLES SEE NOTE 7.

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



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Section Designation		Mass per Metre	Radius of Gyration Axis v-v	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
h x b	t					No.	Diameter	$N_{u,Rd}$
mm	mm	kg/m	cm	cm^2			mm	kN
200x150	18 +	47.1	3.22	60.1	Weld	0	-	1330
					M24	1	26	1150
					M20	2	22	1050
	15	39.6	3.23	50.5	Weld	0	-	1160
					M24	1	26	999
					M20	2	22	910
	12	32.0	3.25	40.8	Weld	0	-	934
					M24	1	26	805
					M20	2	22	733
200x100	15	33.8	2.12	43.0	Weld	0	-	952
					M24	1	26	751
					M20	1	22	771
	12	27.3	2.14	34.8	Weld	0	-	769
					M24	1	26	607
					M20	1	22	622
	10	23.0	2.15	29.2	Weld	0	-	645
					M24	1	26	508
					M20	1	22	521
150x90	15	26.6	1.93	33.9	Weld	0	-	764
					M20	1	22	617
					M16	1	18	637
	12	21.6	1.94	27.5	Weld	0	-	618
					M20	1	22	499
					M16	1	18	515
	10	18.2	1.95	23.2	Weld	0	-	521
					M20	1	22	420
					M16	1	18	433
150x75	15	24.8	1.58	31.7	Weld	0	-	703
					M20	1	22	544
					M16	1	18	563
	12	20.2	1.59	25.7	Weld	0	-	569
					M20	1	22	440
					M16	1	18	455
	10	17.0	1.60	21.7	Weld	0	-	480
					M20	1	22	370
					M16	1	18	383

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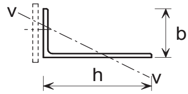
+ These sections are in addition to the range in BS EN 10056-1.
FOR EXPLANATION OF TABLES SEE NOTE 7.

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



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Section Designation		Mass per Metre	Radius of Gyration Axis v-v	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
h x b	t					No.	Diameter	$N_{u,Rd}$
mm	mm	kg/m	cm	cm^2			mm	kN
125x75	12	17.8	1.61	22.7	Weld	0	-	511
					M20	1	22	398
					M16	1	18	414
	10	15.0	1.61	19.1	Weld	0	-	430
					M20	1	22	334
					M16	1	18	348
	8	12.2	1.63	15.5	Weld	0	-	348
					M20	1	22	271
					M16	1	18	281
100x75	12	15.4	1.59	19.7	Weld	0	-	453
					M20	1	22	357
					M16	1	18	373
	10	13.0	1.59	16.6	Weld	0	-	381
					M20	1	22	300
					M16	1	18	313
	8	10.6	1.60	13.5	Weld	0	-	309
					M20	1	22	243
					M16	1	18	254
100x65	10 +	12.3	1.39	15.6	Weld	0	-	354
					M20	1	22	267
					M16	1	18	280
	8 +	9.94	1.40	12.7	Weld	0	-	287
					M20	1	22	217
					M16	1	18	227
	7 +	8.77	1.40	11.2	Weld	0	-	253
					M20	1	22	191
					M16	1	18	200
100x50	8	8.97	1.06	11.4	Weld	0	-	252
					M12	1	14	197
	6	6.84	1.07	8.71	Weld	0	-	192
					M12	1	14	150
80x60	7	7.36	1.28	9.38	Weld	0	-	215
					M16	1	18	168

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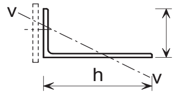
FOR EXPLANATION OF TABLES SEE NOTE 7.

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



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Section Designation h x b mm	Section Designation t mm	Mass per Metre kg/m	Radius of Gyration Axis v-v cm	Gross Area cm^2	Bolt Size	Holes Deducted From Angle No.	Holes Deducted From Angle Diameter mm	Tension Resistance $N_{u,Rd}$ kN
80x40	8	7.07	0.838	9.01	Weld	0	-	200
					M12	1	14	149
	6	5.41	0.845	6.89	Weld	0	-	152
					M12	1	14	113
75x50	8	7.39	1.07	9.41	Weld	0	-	214
					M12	1	14	169
	6	5.65	1.08	7.19	Weld	0	-	163
					M12	1	14	129
70x50	6	5.41	1.07	6.89	Weld	0	-	157
					M12	1	14	125
65x50	5	4.35	1.07	5.54	Weld	0	-	127
					M12	1	14	101
60x40	6	4.46	0.855	5.68	Weld	0	-	129
					M12	1	14	96.6
	5	3.76	0.860	4.79	Weld	0	-	109
					M12	1	14	81.3
60x30	5	3.36	0.633	4.28	Weld	0	-	94.8
					M12	1	14	64.6
50x30	5	2.96	0.639	3.78	Weld	0	-	85.1
					M12	1	14	57.8
45x30	4	2.25	0.640	2.87	Weld	0	-	65.1
					M12	1	14	44.1
40x25	4	1.93	0.534	2.46	Weld	0	-	55.6
					M12	1	14	34.6
40x20	4	1.77	0.417	2.26	Weld	0	-	50.1
					M12	1	14	28.0
30x20	4	1.46	0.421	1.86	Weld	0	-	42.4
					M12	1	14	22.5
	3	1.12	0.424	1.43	Weld	0	-	32.5
					M12	1	14	17.4

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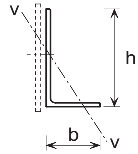
FOR EXPLANATION OF TABLES SEE NOTE 7.

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



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Section Designation h x b mm	t mm	Mass per Metre kg/m	Radius of Gyration Axis v-v cm	Gross Area cm^2	Bolt Size	Holes Deducted From Angle No.	Diameter mm	Tension Resistance $N_{u,Rd}$ kN
200x150	18 +	47.1	3.22	60.1	Weld	0	-	1400
					M24	1	26	1270
					M24	2	26	1170
					M20	3	22	1090
	15	39.6	3.23	50.5	Weld	0	-	1220
					M24	1	26	1110
					M24	2	26	1010
					M20	3	22	945
	12	32.0	3.25	40.8	Weld	0	-	983
					M24	1	26	891
					M24	2	26	817
					M20	3	22	762
200x100	15	33.8	2.12	43.0	Weld	0	-	1080
					M24	1	26	1000
					M24	2	26	911
					M20	3	22	842
	12	27.3	2.14	34.8	Weld	0	-	868
					M24	1	26	809
					M24	2	26	735
					M20	3	22	679
	10	23.0	2.15	29.2	Weld	0	-	727
					M24	1	26	677
					M24	2	26	615
					M20	3	22	569
150x90	15	26.6	1.93	33.9	Weld	0	-	838
					M24	1	26	771
					M20	2	22	681
	12	21.6	1.94	27.5	Weld	0	-	678
					M24	1	26	622
					M20	2	22	550
	10	18.2	1.95	23.2	Weld	0	-	570
					M24	1	26	522
					M20	2	22	463
150x75	15	24.8	1.58	31.7	Weld	0	-	796
					M24	1	26	740
					M20	2	22	651
	12	20.2	1.59	25.7	Weld	0	-	643
					M24	1	26	597
					M20	2	22	526
	10	17.0	1.60	21.7	Weld	0	-	541
					M24	1	26	501
					M20	2	22	442

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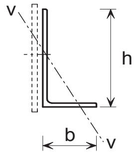
FOR EXPLANATION OF TABLES SEE NOTE 7.

BS EN 1993-1-1:2005
BS EN 10056-1:1999

TENSION

S275 / Advance® 275

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



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Section Designation h x b	Section Designation t	Mass per Metre	Radius of Gyration Axis v-v	Gross Area	Bolt Size	Holes Deducted From Angle: No.	Holes Deducted From Angle: Diameter	Tension Resistance $N_{u,Rd}$
mm	mm	kg/m	cm	cm^2			mm	kN
125x75	12	17.8	1.61	22.7	Weld	0	-	561
					M24	1	26	498
					M20	2	22	427
	10	15.0	1.61	19.1	Weld	0	-	471
					M24	1	26	417
					M20	2	22	358
	8	12.2	1.63	15.5	Weld	0	-	381
					M24	1	26	337
					M20	2	22	289
100x75	12	15.4	1.59	19.7	Weld	0	-	478
					M24	1	26	399
					M20	1	22	415
	10	13.0	1.59	16.6	Weld	0	-	402
					M24	1	26	335
					M20	1	22	348
	8	10.6	1.60	13.5	Weld	0	-	326
					M24	1	26	271
					M20	1	22	282
100x65	10 +	12.3	1.39	15.6	Weld	0	-	383
					M24	1	26	321
					M20	1	22	334
	8 +	9.94	1.40	12.7	Weld	0	-	310
					M24	1	26	260
					M20	1	22	271
	7 +	8.77	1.40	11.2	Weld	0	-	273
					M24	1	26	229
					M20	1	22	238
100x50	8	8.97	1.06	11.4	Weld	0	-	285
					M24	1	26	242
					M20	1	22	253
	6	6.84	1.07	8.71	Weld	0	-	217
					M24	1	26	184
					M20	1	22	192
80x60	7	7.36	1.28	9.38	Weld	0	-	227
					M20	1	22	186
					M16	1	18	195

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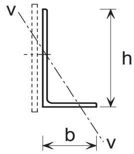
FOR EXPLANATION OF TABLES SEE NOTE 7.

TENSION

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



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Section Designation		Mass per Metre	Radius of Gyration Axis	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
h x b	t		v-v			No.	Diameter	$N_{u,Rd}$
mm	mm	kg/m	cm	cm^2			mm	kN
80x40	8	7.07	0.838	9.01	Weld	0	-	226
					M20	1	22	189
					M16	1	18	200
	6	5.41	0.845	6.89	Weld	0	-	172
					M20	1	22	144
					M16	1	18	151
75x50	8	7.39	1.07	9.41	Weld	0	-	231
					M20	1	22	187
					M16	1	18	197
	6	5.65	1.08	7.19	Weld	0	-	176
					M20	1	22	142
					M16	1	18	150
70x50	6	5.41	1.07	6.89	Weld	0	-	167
					M20	1	22	132
					M16	1	18	140
65x50	5	4.35	1.07	5.54	Weld	0	-	133
					M20	1	22	102
					M16	1	18	109
60x40	6	4.46	0.855	5.68	Weld	0	-	139
					M16	1	18	112
	5	3.76	0.860	4.79	Weld	0	-	117
					M16	1	18	93.9
60x30	5	3.36	0.633	4.28	Weld	0	-	107
					M16	1	18	86.9
50x30	5	2.96	0.639	3.78	Weld	0	-	93.4
					M12	1	14	77.0
45x30	4	2.25	0.640	2.87	Weld	0	-	70.1
					M12	1	14	55.6
40x25	4	1.93	0.534	2.46	Weld	0	-	60.6
					M12	1	14	46.1
40x20	4	1.77	0.417	2.26	Weld	0	-	56.7
					M12	1	14	43.4
30x20	4	1.46	0.421	1.86	Weld	0	-	45.7
					M12	1	14	30.2
	3	1.12	0.424	1.43	Weld	0	-	35.0
					M12	1	14	23.1

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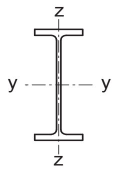
FOR EXPLANATION OF TABLES SEE NOTE 7.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
1016x305x487 +	$N_{b,y,Rd}$	15800	15800	15800	15800	15800	15800	15700	15600	15400	15200	15100	14900	14700
	$N_{b,z,Rd}$	14700	13300	11700	10000	8420	7000	5820	4870	4120	3520	3030	2640	2310
	$N_{b,T,Rd}$	15300	14300	13500	12900	12300	11900	11500	11200	11000	10800	10700	10500	10400
1016x305x437 +	$N_{b,y,Rd}$	14200	14200	14200	14200	14200	14200	14100	14000	13800	13700	13500	13400	13200
	$N_{b,z,Rd}$	13200	11900	10400	8920	7460	6180	5140	4300	3630	3100	2670	2320	2030
	$N_{b,T,Rd}$	13700	12800	12000	11400	10800	10300	9970	9670	9420	9220	9060	8920	8810
1016x305x393 +	$N_{b,y,Rd}$	12800	12800	12800	12800	12800	12800	12700	12500	12400	12300	12100	12000	11900
	$N_{b,z,Rd}$	11800	10600	9290	7910	6590	5450	4520	3770	3180	2710	2340	2030	1780
	$N_{b,T,Rd}$	12200	11400	10700	10000	9450	8980	8580	8260	8000	7780	7610	7460	7340
* 1016x305x349 +	$N_{b,y,Rd}$	*11400*	*11400*	*11400*	*11400*	*11400*	*11400*	*11400*	*11300*	*11200*	*11200*	11100	11100	11100
	$N_{b,z,Rd}$	11100	10300	9230	7960	6640	5450	4480	3710	3100	2630	2250	1950	1700
	$N_{b,T,Rd}$	11100	10600	10000	9470	8960	8500	8100	7760	7470	7230	7020	6860	6710
* 1016x305x314 +	$N_{b,y,Rd}$	*10000*	*10000*	*10000*	*10000*	*10000*	*10000*	*10000*	*9930*	*9870*	*9810*	*9740*	*9680*	*9610*
	$N_{b,z,Rd}$	*9510*	*8790*	8250	7090	5900	4830	3960	3270	2740	2320	1980	1710	1500
	$N_{b,T,Rd}$	*9740*	*9240*	*8740*	8240	7750	7300	6900	6550	6260	6020	5810	5640	5500
* 1016x305x272 +	$N_{b,y,Rd}$	*8400*	*8400*	*8400*	*8400*	*8400*	*8400*	*8370*	*8320*	*8260*	*8210*	*8160*	*8100*	*8050*
	$N_{b,z,Rd}$	*7970*	*7380*	*6670*	*5810*	5100	4170	3420	2820	2360	2000	1710	1480	1290
	$N_{b,T,Rd}$	*8150*	*7730*	*7300*	*6850*	*6400*	*5970*	5580	5230	4940	4700	4490	4320	4180
* 1016x305x249 +	$N_{b,y,Rd}$	*7600*	*7600*	*7600*	*7600*	*7600*	*7600*	*7570*	*7520*	*7470*	*7420*	*7370*	*7320*	*7270*
	$N_{b,z,Rd}$	*7180*	*6620*	*5930*	5270	4430	3590	2920	2400	2010	1690	1450	1250	1090
	$N_{b,T,Rd}$	*7360*	*6970*	*6550*	*6110*	*5660*	5220	4830	4480	4180	3940	3730	3560	3420
* 1016x305x222 +	$N_{b,y,Rd}$	*6660*	*6660*	*6660*	*6660*	*6660*	*6660*	*6620*	*6580*	*6540*	*6500*	*6450*	*6410*	*6360*
	$N_{b,z,Rd}$	*6250*	*5740*	*5090*	4450	3720	2980	2410	1980	1650	1390	1190	1020	893
	$N_{b,T,Rd}$	*6440*	*6080*	*5690*	*5280*	*4840*	4420	4030	3700	3420	3180	2990	2830	2700
914x419x388	$N_{b,y,Rd}$	13100	13100	13100	13100	13100	13100	13000	12900	12800	12700	12600	12500	12400
	$N_{b,z,Rd}$	12900	12400	11700	11000	10200	9280	8290	7310	6410	5610	4910	4320	3820
	$N_{b,T,Rd}$	13100	12600	12100	11700	11200	10800	10300	9930	9550	9210	8900	8630	8390
* 914x419x343	$N_{b,y,Rd}$	*11300*	*11300*	*11300*	*11300*	*11300*	*11300*	*11200*	*11100*	*11000*	*11000*	*10900*	10900	10900
	$N_{b,z,Rd}$	*11100*	10900	10400	9710	8960	8120	7240	6370	5570	4860	4260	3740	3310
	$N_{b,T,Rd}$	*11300*	10900	10500	10000	9630	9210	8790	8390	8020	7670	7360	7090	6840

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+ These sections are in addition to the range of BS 4 sections.

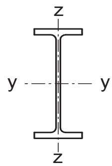
* Section may be Class 4 under axial compression.

Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 914x305x289	$N_{b,y,Rd}$	*9380*	*9380*	*9380*	*9380*	*9380*	*9360*	*9300*	*9240*	*9170*	*9100*	*9040*	*8960*	*8890*
	$N_{b,z,Rd}$	*8900*	8530	7670	6640	5560	4580	3760	3120	2610	2210	1900	1640	1430
	$N_{b,T,Rd}$	*9110*	8660	8190	7710	7240	6800	6400	6050	5750	5510	5300	5120	4970
* 914x305x253	$N_{b,y,Rd}$	*7970*	*7970*	*7970*	*7970*	*7970*	*7960*	*7910*	*7860*	*7800*	*7750*	*7690*	*7630*	*7570*
	$N_{b,z,Rd}$	*7570*	*7020*	6380	5770	4810	3940	3230	2680	2240	1900	1620	1400	1230
	$N_{b,T,Rd}$	*7750*	*7350*	*6930*	*6500*	6060	5640	5250	4910	4620	4370	4170	4000	3850
* 914x305x224	$N_{b,y,Rd}$	*6880*	*6880*	*6880*	*6880*	*6880*	*6860*	*6820*	*6770*	*6730*	*6680*	*6630*	*6580*	*6520*
	$N_{b,z,Rd}$	*6520*	*6030*	*5440*	4880	4140	3380	2760	2280	1900	1610	1380	1190	1040
	$N_{b,T,Rd}$	*6680*	*6330*	*5960*	*5560*	*5150*	4740	4370	4040	3760	3520	3330	3160	3020
* 914x305x201	$N_{b,y,Rd}$	*6020*	*6020*	*6020*	*6020*	*6020*	*6010*	*5970*	*5930*	*5890*	*5840*	*5800*	*5760*	*5710*
	$N_{b,z,Rd}$	*5690*	*5250*	*4710*	*4070*	3560	2880	2350	1930	1610	1360	1160	1000	876
	$N_{b,T,Rd}$	*5840*	*5530*	*5190*	*4820*	*4430*	*4050*	3690	3380	3110	2890	2700	2540	2410
* 838x292x226	$N_{b,y,Rd}$	*7170*	*7170*	*7170*	*7170*	*7170*	*7130*	*7080*	*7030*	*6980*	*6920*	*6860*	*6800*	*6740*
	$N_{b,z,Rd}$	*6780*	6260	5770	5050	4180	3410	2790	2300	1920	1630	1390	1200	1050
	$N_{b,T,Rd}$	*6940*	*6570*	*6190*	*5790*	5390	5010	4670	4370	4130	3920	3750	3600	3480
* 838x292x194	$N_{b,y,Rd}$	*5950*	*5950*	*5950*	*5950*	*5950*	*5910*	*5870*	*5830*	*5780*	*5740*	*5690*	*5640*	*5590*
	$N_{b,z,Rd}$	*5610*	*5170*	*4620*	4190	3430	2770	2260	1860	1550	1310	1120	966	843
	$N_{b,T,Rd}$	*5750*	*5430*	*5100*	*4730*	*4360*	4000	3670	3390	3150	2950	2780	2640	2530
* 838x292x176	$N_{b,y,Rd}$	*5290*	*5290*	*5290*	*5290*	*5290*	*5260*	*5220*	*5180*	*5140*	*5100*	*5060*	*5010*	*4960*
	$N_{b,z,Rd}$	*4980*	*4570*	*4070*	3500	3000	2420	1960	1610	1340	1130	966	834	727
	$N_{b,T,Rd}$	*5110*	*4820*	*4510*	*4170*	*3820*	3480	3160	2890	2660	2470	2310	2180	2070
* 762x267x197	$N_{b,y,Rd}$	*6340*	*6340*	*6340*	*6340*	*6320*	*6270*	*6220*	*6170*	*6110*	*6050*	*5990*	*5930*	*5860*
	$N_{b,z,Rd}$	*5910*	5590	4850	4010	3220	2580	2080	1710	1420	1190	1020	880	767
	$N_{b,T,Rd}$	*6070*	*5710*	5340	4960	4590	4260	3980	3750	3560	3400	3280	3170	3080
* 762x267x173	$N_{b,y,Rd}$	*5420*	*5420*	*5420*	*5420*	*5400*	*5360*	*5310*	*5270*	*5220*	*5170*	*5120*	*5070*	*5010*
	$N_{b,z,Rd}$	*5040*	*4570*	4190	3430	2740	2180	1760	1440	1190	1000	857	739	644
	$N_{b,T,Rd}$	*5180*	*4870*	*4530*	4170	3820	3510	3230	3000	2810	2660	2540	2430	2350
* 762x267x147	$N_{b,y,Rd}$	*4440*	*4440*	*4440*	*4440*	*4430*	*4390*	*4360*	*4320*	*4280*	*4240*	*4200*	*4150*	*4110*
	$N_{b,z,Rd}$	*4120*	*3730*	*3240*	2810	2220	1760	1410	1150	956	804	686	591	514
	$N_{b,T,Rd}$	*4240*	*3980*	*3680*	*3360*	*3040*	2750	2490	2270	2100	1960	1840	1750	1670
* 762x267x134	$N_{b,y,Rd}$	*4100*	*4100*	*4100*	*4100*	*4080*	*4050*	*4020*	*3980*	*3940*	*3910*	*3870*	*3820*	*3780*
	$N_{b,z,Rd}$	*3790*	*3410*	*2940*	2440	2000	1570	1260	1020	848	713	607	523	455
	$N_{b,T,Rd}$	*3910*	*3650*	*3360*	*3050*	*2730*	2430	2180	1970	1800	1670	1560	1470	1390

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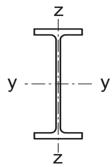
* Section may be Class 4 under axial compression.

Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 686x254x170	$N_{b,y,Rd}$	*5540*	*5540*	*5540*	*5540*	*5490*	*5440*	*5390*	*5340*	*5280*	*5220*	5170	5170	5170
	$N_{b,z,Rd}$	5170	4770	4100	3350	2670	2120	1710	1390	1160	975	831	717	624
	$N_{b,T,Rd}$	*5280*	4950	4610	4270	3950	3680	3450	3260	3100	2980	2880	2800	2730
* 686x254x152	$N_{b,y,Rd}$	*4840*	*4840*	*4840*	*4840*	*4800*	*4750*	*4710*	*4660*	*4610*	*4560*	*4510*	*4450*	*4390*
	$N_{b,z,Rd}$	*4470*	*4040*	3630	2950	2340	1860	1490	1220	1010	851	726	626	545
	$N_{b,T,Rd}$	*4600*	*4310*	*4000*	3680	3380	3110	2880	2690	2540	2410	2320	2230	2170
* 686x254x140	$N_{b,y,Rd}$	*4360*	*4360*	*4360*	*4360*	*4320*	*4280*	*4240*	*4200*	*4160*	*4110*	*4060*	*4010*	*3960*
	$N_{b,z,Rd}$	*4030*	*3640*	3280	2670	2110	1670	1340	1090	907	763	650	561	488
	$N_{b,T,Rd}$	*4150*	*3880*	*3590*	*3290*	2990	2730	2510	2320	2170	2050	1960	1880	1810
* 686x254x125	$N_{b,y,Rd}$	*3810*	*3810*	*3810*	*3810*	*3780*	*3750*	*3710*	*3680*	*3640*	*3600*	*3550*	*3510*	*3460*
	$N_{b,z,Rd}$	*3510*	*3160*	*2710*	2310	1810	1430	1140	930	770	647	551	475	413
	$N_{b,T,Rd}$	*3620*	*3380*	*3110*	*2830*	2550	2290	2080	1900	1760	1650	1550	1480	1420
610x305x238	$N_{b,y,Rd}$	8030	8030	8030	8000	7930	7850	7760	7680	7590	7490	7380	7270	7140
	$N_{b,z,Rd}$	7700	7210	6620	5910	5110	4320	3620	3040	2570	2190	1880	1630	1430
	$N_{b,T,Rd}$	7830	7470	7140	6840	6570	6330	6130	5960	5820	5700	5610	5530	5460
610x305x179	$N_{b,y,Rd}$	6040	6040	6040	6020	5960	5900	5830	5770	5700	5620	5540	5450	5350
	$N_{b,z,Rd}$	5780	5400	4930	4380	3760	3160	2640	2210	1860	1580	1360	1180	1030
	$N_{b,T,Rd}$	5870	5580	5280	4990	4700	4430	4190	3990	3810	3670	3540	3440	3350
* 610x305x149	$N_{b,y,Rd}$	*4810*	*4810*	*4810*	*4800*	*4750*	*4700*	*4650*	*4600*	*4550*	*4490*	*4420*	*4350*	*4280*
	$N_{b,z,Rd}$	*4610*	*4310*	4010	3620	3100	2600	2170	1810	1530	1300	1110	966	845
	$N_{b,T,Rd}$	*4680*	*4440*	*4190*	3930	3670	3430	3200	3000	2820	2680	2560	2460	2370
* 610x229x140	$N_{b,y,Rd}$	*4560*	*4560*	*4560*	*4540*	*4500*	*4450*	*4400*	*4350*	4340	4340	4290	4220	4140
	$N_{b,z,Rd}$	4270	3760	3120	2460	1910	1490	1190	968	800	672	572	493	428
	$N_{b,T,Rd}$	4290	3990	3690	3400	3140	2930	2760	2620	2510	2430	2360	2300	2260
* 610x229x125	$N_{b,y,Rd}$	*3980*	*3980*	*3980*	*3960*	*3920*	*3880*	*3840*	*3800*	*3750*	*3700*	*3640*	*3580*	*3510*
	$N_{b,z,Rd}$	*3620*	3330	2760	2160	1670	1310	1040	846	699	587	500	430	374
	$N_{b,T,Rd}$	*3740*	*3470*	3190	2910	2650	2440	2270	2130	2030	1940	1870	1820	1770
* 610x229x113	$N_{b,y,Rd}$	*3540*	*3540*	*3540*	*3520*	*3480*	*3450*	*3410*	*3370*	*3330*	*3280*	*3230*	*3180*	*3120*
	$N_{b,z,Rd}$	*3210*	*2830*	2460	1910	1470	1150	914	742	613	514	437	376	327
	$N_{b,T,Rd}$	*3320*	*3070*	*2800*	2540	2290	2080	1910	1780	1670	1590	1520	1460	1420
* 610x229x101	$N_{b,y,Rd}$	*3210*	*3210*	*3210*	*3190*	*3150*	*3120*	*3090*	*3050*	*3010*	*2970*	*2920*	*2870*	*2810*
	$N_{b,z,Rd}$	*2890*	*2530*	2190	1670	1270	989	784	635	524	439	373	321	279
	$N_{b,T,Rd}$	*3000*	*2760*	*2500*	*2230*	1980	1760	1600	1460	1360	1280	1210	1160	1120

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* Section may be Class 4 under axial compression.

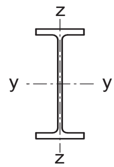
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 610x178x100 +	$N_{b,y,Rd}$	*3120*	*3120*	*3120*	*3100*	*3070*	*3040*	*3000*	*2970*	*2930*	*2880*	*2840*	*2790*	*2730*
	$N_{b,z,Rd}$	*2610*	2150	1520	1080	789	599	469	377	309	258	219	188	163
	$N_{b,T,Rd}$	*2800*	*2510*	2210	1940	1740	1590	1470	1390	1330	1280	1240	1210	1190
* 610x178x92 +	$N_{b,y,Rd}$	*2900*	*2900*	*2900*	*2880*	*2850*	*2810*	*2780*	*2740*	*2710*	*2670*	*2620*	*2570*	*2520*
	$N_{b,z,Rd}$	*2390*	1950	1350	945	689	522	408	328	269	224	190	163	141
	$N_{b,T,Rd}$	*2590*	*2290*	1980	1720	1510	1360	1250	1170	1110	1060	1030	997	973
* 610x178x82 +	$N_{b,y,Rd}$	*2490*	*2490*	*2490*	*2480*	*2450*	*2420*	*2390*	*2360*	*2330*	*2300*	*2260*	*2220*	*2170*
	$N_{b,z,Rd}$	*2050*	1610	1150	800	582	440	344	276	226	188	160	137	119
	$N_{b,T,Rd}$	*2220*	*1950*	*1670*	1420	1230	1090	985	910	854	811	778	751	730
533x312x272 +	$N_{b,y,Rd}$	9220	9220	9220	9150	9050	8950	8840	8720	8600	8460	8320	8150	7970
	$N_{b,z,Rd}$	8910	8390	7770	7040	6200	5330	4530	3830	3260	2790	2410	2090	1830
	$N_{b,T,Rd}$	9040	8690	8390	8140	7930	7770	7640	7530	7450	7380	7330	7280	7250
533x312x219 +	$N_{b,y,Rd}$	7390	7390	7390	7320	7240	7160	7070	6970	6870	6750	6630	6490	6340
	$N_{b,z,Rd}$	7120	6690	6170	5550	4850	4140	3500	2950	2500	2130	1840	1600	1400
	$N_{b,T,Rd}$	7220	6900	6610	6350	6110	5910	5750	5610	5490	5400	5320	5250	5190
533x312x182 +	$N_{b,y,Rd}$	6120	6120	6120	6060	5990	5920	5850	5770	5680	5580	5480	5360	5230
	$N_{b,z,Rd}$	5890	5520	5090	4570	3980	3390	2850	2400	2030	1730	1490	1300	1140
	$N_{b,T,Rd}$	5960	5680	5410	5150	4910	4690	4490	4330	4190	4080	3980	3900	3830
533x312x150 +	$N_{b,y,Rd}$	5090	5090	5090	5040	4980	4920	4850	4790	4710	4630	4540	4440	4330
	$N_{b,z,Rd}$	4890	4580	4210	3770	3280	2780	2340	1960	1660	1420	1220	1060	926
	$N_{b,T,Rd}$	4950	4700	4450	4200	3950	3720	3510	3330	3170	3040	2930	2840	2760
533x210x138 +	$N_{b,y,Rd}$	4660	4660	4660	4610	4550	4490	4430	4370	4290	4210	4130	4030	3920
	$N_{b,z,Rd}$	4160	3590	2880	2210	1690	1310	1040	841	694	582	494	425	370
	$N_{b,T,Rd}$	4340	4040	3760	3520	3330	3180	3060	2970	2900	2840	2800	2760	2730
533x210x122	$N_{b,y,Rd}$	4110	4110	4100	4060	4010	3960	3900	3850	3780	3710	3630	3550	3450
	$N_{b,z,Rd}$	3660	3160	2530	1940	1480	1150	910	737	608	510	434	373	324
	$N_{b,T,Rd}$	3810	3530	3250	3000	2800	2630	2510	2410	2340	2280	2230	2190	2160
* 533x210x109	$N_{b,y,Rd}$	*3580*	*3580*	*3580*	*3540*	*3490*	3480	3480	3440	3390	3320	3250	3170	3080
	$N_{b,z,Rd}$	3270	2810	2240	1700	1290	1000	795	643	531	445	378	325	282
	$N_{b,T,Rd}$	3320	3060	2790	2550	2340	2180	2050	1950	1870	1810	1770	1730	1700
* 533x210x101	$N_{b,y,Rd}$	*3270*	*3270*	*3270*	*3230*	*3190*	*3150*	*3110*	*3060*	*3010*	*2960*	*2900*	2890	2860
	$N_{b,z,Rd}$	*2910*	2600	2060	1570	1190	921	729	590	487	408	346	298	259
	$N_{b,T,Rd}$	*3020*	2780	2520	2280	2080	1920	1790	1690	1610	1550	1510	1470	1440
* 533x210x92	$N_{b,y,Rd}$	*3010*	*3010*	*3000*	*2970*	*2930*	*2900*	*2860*	*2810*	*2770*	*2710*	*2660*	*2590*	*2520*
	$N_{b,z,Rd}$	*2670*	2360	1880	1410	1060	820	649	524	432	362	307	264	229
	$N_{b,T,Rd}$	*2780*	*2540*	2280	2040	1830	1660	1530	1430	1360	1300	1250	1210	1180
* 533x210x82	$N_{b,y,Rd}$	*2650*	*2650*	*2650*	*2620*	*2580*	*2550*	*2520*	*2480*	*2430*	*2390*	*2340*	*2280*	*2210*
	$N_{b,z,Rd}$	*2340*	*1990*	1630	1210	910	700	552	446	367	307	261	224	195
	$N_{b,T,Rd}$	*2440*	*2220*	*1980*	1740	1530	1370	1240	1150	1070	1020	972	936	907

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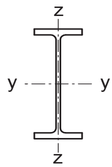
* Section may be Class 4 under axial compression.
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.
For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.
FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 533x165x85 +	$N_{b,y,Rd}$	*2680*	*2680*	*2680*	*2650*	*2620*	*2580*	*2550*	*2510*	*2470*	*2420*	*2370*	*2310*	*2240*
	$N_{b,z,Rd}$	2240	1730	1200	842	614	465	364	292	239	200	169	145	126
	$N_{b,T,Rd}$	*2380*	2110	1860	1650	1490	1380	1300	1240	1190	1160	1130	1110	1090
* 533x165x74 +	$N_{b,y,Rd}$	*2390*	*2390*	*2380*	*2350*	*2320*	*2290*	*2260*	*2220*	*2180*	*2140*	*2090*	*2040*	*1980*
	$N_{b,z,Rd}$	*1910*	1490	1000	696	505	381	298	239	195	163	138	118	102
	$N_{b,T,Rd}$	*2090*	*1830*	1560	1350	1190	1080	1000	941	898	865	839	818	802
* 533x165x66 +	$N_{b,y,Rd}$	*2030*	*2030*	*2030*	*2000*	*1980*	*1950*	*1920*	*1890*	*1860*	*1820*	*1780*	*1740*	*1680*
	$N_{b,z,Rd}$	*1620*	1260	841	580	420	317	247	198	162	135	114	98.0	84.9
	$N_{b,T,Rd}$	*1780*	*1540*	1290	1090	946	843	770	716	677	646	623	604	590
457x191x161 +	$N_{b,y,Rd}$	5460	5460	5420	5350	5280	5200	5110	5020	4910	4790	4660	4500	4330
	$N_{b,z,Rd}$	4830	4130	3280	2490	1890	1460	1160	935	771	646	549	472	410
	$N_{b,T,Rd}$	5110	4850	4670	4550	4460	4400	4350	4320	4300	4280	4260	4250	4240
457x191x133 +	$N_{b,y,Rd}$	4510	4510	4470	4410	4350	4280	4210	4130	4040	3940	3820	3690	3540
	$N_{b,z,Rd}$	3960	3360	2640	1980	1500	1150	913	738	608	509	432	372	323
	$N_{b,T,Rd}$	4180	3920	3720	3570	3450	3370	3310	3270	3230	3210	3190	3170	3160
457x191x106 +	$N_{b,y,Rd}$	3580	3580	3550	3500	3450	3390	3330	3270	3190	3110	3010	2900	2780
	$N_{b,z,Rd}$	3130	2620	2030	1510	1140	874	690	557	459	384	326	280	243
	$N_{b,T,Rd}$	3290	3040	2820	2640	2500	2390	2310	2250	2200	2170	2140	2120	2100
457x191x98	$N_{b,y,Rd}$	3310	3310	3290	3240	3190	3140	3090	3030	2960	2880	2790	2690	2580
	$N_{b,z,Rd}$	2900	2430	1880	1400	1060	813	642	518	427	357	303	261	226
	$N_{b,T,Rd}$	3040	2800	2570	2390	2240	2130	2050	1980	1940	1900	1870	1840	1830
457x191x89	$N_{b,y,Rd}$	3020	3020	3000	2950	2910	2860	2810	2760	2690	2620	2540	2450	2340
	$N_{b,z,Rd}$	2630	2210	1700	1260	948	729	576	465	383	320	272	234	203
	$N_{b,T,Rd}$	2760	2520	2290	2100	1940	1830	1740	1670	1620	1580	1550	1520	1500
* 457x191x82	$N_{b,y,Rd}$	*2770*	*2770*	*2740*	*2710*	*2660*	*2620*	2620	2600	2530	2460	2380	2280	2180
	$N_{b,z,Rd}$	2470	2040	1550	1140	850	652	514	414	341	285	242	208	180
	$N_{b,T,Rd}$	2520	2290	2060	1860	1700	1580	1490	1420	1370	1330	1300	1270	1250
* 457x191x74	$N_{b,y,Rd}$	*2460*	*2460*	*2440*	*2410*	*2370*	*2340*	*2290*	*2250*	*2200*	*2140*	*2070*	2040	1980
	$N_{b,z,Rd}$	*2140*	1850	1400	1020	764	586	461	372	306	256	217	187	162
	$N_{b,T,Rd}$	*2240*	2020	1810	1610	1450	1330	1240	1170	1120	1080	1040	1020	999
* 457x191x67	$N_{b,y,Rd}$	*2190*	*2190*	*2170*	*2140*	*2110*	*2070*	*2040*	*2000*	*1950*	*1900*	*1830*	*1770*	*1690*
	$N_{b,z,Rd}$	*1900*	1650	1230	899	669	512	403	324	267	223	189	163	141
	$N_{b,T,Rd}$	*1990*	*1790*	1580	1390	1230	1110	1020	956	905	866	836	811	791

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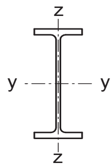
+ These sections are in addition to the range of BS 4 sections.
* Section may be Class 4 under axial compression.
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.
For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.
FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
457x152x82	$N_{b,y,Rd}$	2780	2780	2780	2780	2780	2780	2760	2720	2680	2630	2590	2530	2470
	$N_{b,z,Rd}$	2650	2460	2230	1950	1650	1370	1130	791	576	436	341	273	224
	$N_{b,T,Rd}$	2700	2570	2440	2310	2190	2080	1980	1820	1710	1630	1570	1530	1500
* 457x152x74	$N_{b,y,Rd}$	*2410*	*2410*	*2410*	*2410*	*2410*	*2410*	*2390*	*2360*	*2320*	*2290*	2250	2250	2220
	$N_{b,z,Rd}$	*2300*	2200	1990	1740	1470	1210	1000	698	507	384	300	240	197
	$N_{b,T,Rd}$	*2350*	2230	2110	2000	1880	1770	1680	1520	1410	1330	1280	1240	1210
* 457x152x67	$N_{b,y,Rd}$	*2220*	*2220*	*2220*	*2220*	*2220*	*2210*	*2200*	*2160*	*2130*	*2100*	*2060*	*2010*	*1970*
	$N_{b,z,Rd}$	*2100*	*1950*	1840	1590	1320	1080	889	616	447	337	263	211	173
	$N_{b,T,Rd}$	*2150*	*2040*	*1920*	1810	1690	1570	1470	1310	1190	1110	1050	1010	976
* 457x152x60	$N_{b,y,Rd}$	*1920*	*1920*	*1920*	*1920*	*1920*	*1910*	*1900*	*1870*	*1850*	*1820*	*1780*	*1750*	*1700*
	$N_{b,z,Rd}$	*1820*	*1690*	*1520*	1380	1160	948	777	537	389	293	229	183	150
	$N_{b,T,Rd}$	*1860*	*1760*	*1660*	*1550*	*1440*	1340	1240	1080	964	885	828	788	757
* 457x152x52	$N_{b,y,Rd}$	*1630*	*1630*	*1630*	*1630*	*1630*	*1630*	*1620*	*1600*	*1570*	*1550*	*1520*	*1490*	*1450*
	$N_{b,z,Rd}$	*1540*	*1430*	*1280*	*1110*	968	785	639	439	317	239	186	149	122
	$N_{b,T,Rd}$	*1580*	*1500*	*1410*	*1310*	*1200*	*1100*	1010	856	748	673	621	583	555
406x178x85 +	$N_{b,y,Rd}$	2890	2890	2890	2890	2890	2870	2850	2800	2750	2700	2640	2580	2500
	$N_{b,z,Rd}$	2810	2660	2490	2280	2050	1790	1540	1130	844	647	509	411	338
	$N_{b,T,Rd}$	2850	2740	2620	2510	2410	2310	2220	2070	1960	1880	1810	1770	1730
406x178x74	$N_{b,y,Rd}$	2600	2600	2600	2600	2600	2580	2560	2520	2470	2420	2370	2300	2230
	$N_{b,z,Rd}$	2520	2380	2210	2020	1790	1550	1330	964	715	546	429	346	284
	$N_{b,T,Rd}$	2560	2450	2340	2230	2110	2010	1910	1740	1610	1520	1450	1400	1360
* 406x178x67	$N_{b,y,Rd}$	*2280*	*2280*	*2280*	*2280*	*2280*	*2260*	*2250*	*2210*	*2170*	2170	2140	2080	2010
	$N_{b,z,Rd}$	*2210*	2150	1990	1810	1610	1390	1180	855	633	483	380	306	251
	$N_{b,T,Rd}$	*2240*	2150	2050	1950	1840	1740	1650	1480	1350	1260	1190	1140	1100
* 406x178x60	$N_{b,y,Rd}$	*1990*	*1990*	*1990*	*1990*	*1990*	*1980*	*1960*	*1930*	*1900*	*1860*	*1820*	*1770*	*1720*
	$N_{b,z,Rd}$	*1930*	*1830*	*1700*	1620	1430	1240	1050	759	562	429	337	271	223
	$N_{b,T,Rd}$	*1960*	*1880*	*1790*	*1700*	1600	1510	1410	1250	1130	1030	965	914	876
* 406x178x54	$N_{b,y,Rd}$	*1780*	*1780*	*1780*	*1780*	*1780*	*1760*	*1750*	*1720*	*1690*	*1660*	*1620*	*1580*	*1530*
	$N_{b,z,Rd}$	*1720*	*1620*	*1510*	1410	1260	1080	910	652	480	366	287	231	190
	$N_{b,T,Rd}$	*1750*	*1670*	*1590*	*1500*	1410	1320	1220	1060	938	847	780	731	694

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* Section may be Class 4 under axial compression.

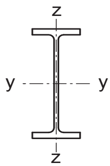
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 406x140x53 +	$N_{b,y,Rd}$	*1760*	*1760*	*1760*	*1760*	*1760*	*1740*	*1730*	*1700*	*1670*	*1640*	*1600*	*1550*	*1500*
	$N_{b,z,Rd}$	*1650*	*1520*	1410	1190	967	781	635	435	314	237	184	148	121
	$N_{b,T,Rd}$	*1690*	*1600*	*1500*	1390	1290	1200	1120	987	899	838	795	765	742
* 406x140x46	$N_{b,y,Rd}$	*1460*	*1460*	*1460*	*1460*	*1460*	*1450*	*1440*	*1410*	*1390*	*1360*	*1330*	*1300*	*1260*
	$N_{b,z,Rd}$	*1370*	*1260*	*1120*	965	824	665	539	369	266	200	156	125	102
	$N_{b,T,Rd}$	*1410*	*1330*	*1240*	*1150*	*1060*	*967*	889	766	682	625	584	556	534
* 406x140x39	$N_{b,y,Rd}$	*1200*	*1200*	*1200*	*1200*	*1200*	*1190*	*1180*	*1160*	*1140*	*1120*	*1090*	*1060*	*1030*
	$N_{b,z,Rd}$	*1120*	*1030*	*905*	*763*	650	519	418	284	204	154	120	95.6	78.2
	$N_{b,T,Rd}$	*1160*	*1090*	*1010*	*927*	*840*	*757*	684	569	493	441	405	379	360
356x171x67	$N_{b,y,Rd}$	2350	2350	2350	2350	2340	2320	2300	2250	2200	2150	2080	2010	1920
	$N_{b,z,Rd}$	2280	2150	1990	1810	1610	1390	1180	855	633	483	380	306	251
	$N_{b,T,Rd}$	2310	2210	2110	2010	1920	1830	1760	1630	1530	1470	1420	1380	1350
356x171x57	$N_{b,y,Rd}$	2000	2000	2000	2000	1980	1970	1950	1910	1870	1820	1760	1700	1620
	$N_{b,z,Rd}$	1930	1810	1680	1520	1340	1150	978	703	519	396	311	250	205
	$N_{b,T,Rd}$	1960	1870	1770	1680	1590	1500	1420	1280	1170	1100	1040	1000	972
* 356x171x51	$N_{b,y,Rd}$	*1720*	*1720*	*1720*	*1720*	*1710*	*1700*	*1680*	*1650*	*1610*	1580	1570	1510	1440
	$N_{b,z,Rd}$	*1670*	1580	1500	1350	1190	1020	859	616	454	346	271	218	179
	$N_{b,T,Rd}$	*1690*	*1610*	1530	1450	1360	1280	1200	1060	961	888	834	794	765
* 356x171x45	$N_{b,y,Rd}$	*1500*	*1500*	*1500*	*1500*	*1490*	*1480*	*1460*	*1430*	*1400*	*1370*	*1320*	1270	1260
	$N_{b,z,Rd}$	*1450*	*1360*	1270	1170	1020	870	732	521	383	291	228	183	151
	$N_{b,T,Rd}$	*1470*	*1400*	1330	1250	1170	1090	1010	877	777	705	652	614	585
* 356x127x39	$N_{b,y,Rd}$	*1280*	*1280*	*1280*	*1280*	*1270*	*1260*	*1250*	*1220*	*1190*	*1160*	*1130*	*1080*	*1030*
	$N_{b,z,Rd}$	*1180*	*1060*	941	754	592	466	373	252	181	135	105	84.0	68.7
	$N_{b,T,Rd}$	*1210*	*1130*	*1050*	959	876	804	744	656	599	561	535	517	503
* 356x127x33	$N_{b,y,Rd}$	*1050*	*1050*	*1050*	*1050*	*1040*	*1030*	*1020*	*1000*	*978*	*952*	*922*	*886*	*844*
	$N_{b,z,Rd}$	*960*	*857*	*727*	608	473	371	296	199	142	107	82.7	66.1	54.0
	$N_{b,T,Rd}$	*991*	*922*	*846*	*765*	687	619	562	479	426	391	367	350	338

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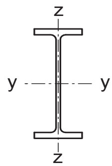
FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL BEAMS
Advance® UKB

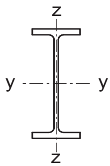


Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
305x165x54	$N_{b,y,Rd}$	1890	1890	1890	1880	1860	1840	1820	1780	1730	1670	1600	1510	1410
	$N_{b,z,Rd}$	1830	1720	1600	1450	1280	1100	933	672	496	379	297	239	196
	$N_{b,T,Rd}$	1850	1770	1690	1610	1530	1460	1400	1300	1230	1180	1140	1120	1090
* 305x165x46	$N_{b,y,Rd}$	*1580*	*1580*	*1580*	*1580*	1570	1570	1560	1520	1480	1420	1360	1290	1200
	$N_{b,z,Rd}$	1560	1470	1360	1230	1080	929	788	566	418	319	250	201	165
	$N_{b,T,Rd}$	1550	1480	1400	1330	1260	1190	1130	1020	945	891	851	821	799
* 305x165x40	$N_{b,y,Rd}$	*1360*	*1360*	*1360*	*1350*	*1340*	*1320*	*1310*	*1280*	*1240*	*1200*	1150	1120	1040
	$N_{b,z,Rd}$	*1310*	*1240*	1150	1070	937	803	679	487	359	273	214	173	142
	$N_{b,T,Rd}$	*1330*	*1260*	*1200*	1130	1060	993	930	825	747	692	651	622	600
305x127x48	$N_{b,y,Rd}$	1680	1680	1680	1670	1650	1640	1620	1580	1530	1470	1400	1310	1210
	$N_{b,z,Rd}$	1540	1380	1180	951	751	594	477	322	231	173	135	108	88.0
	$N_{b,T,Rd}$	1600	1500	1420	1340	1270	1220	1180	1110	1080	1050	1030	1020	1010
305x127x42	$N_{b,y,Rd}$	1470	1470	1470	1460	1440	1430	1410	1370	1330	1280	1210	1140	1050
	$N_{b,z,Rd}$	1340	1200	1010	816	641	506	406	274	196	147	114	91.4	74.7
	$N_{b,T,Rd}$	1390	1300	1210	1130	1060	1000	953	885	841	812	792	778	767
305x127x37	$N_{b,y,Rd}$	1300	1300	1300	1290	1270	1260	1250	1210	1170	1130	1070	1000	921
	$N_{b,z,Rd}$	1190	1050	889	711	558	439	352	237	170	127	99.0	79.1	64.6
	$N_{b,T,Rd}$	1220	1140	1060	975	902	840	790	718	672	642	621	606	596
* 305x102x33	$N_{b,y,Rd}$	*1100*	*1100*	*1100*	*1100*	*1090*	*1070*	*1060*	*1040*	1030	1000	954	895	827
	$N_{b,z,Rd}$	998	830	635	469	351	270	213	141	100	74.8	57.9	46.2	37.7
	$N_{b,T,Rd}$	1010	928	842	764	700	651	612	561	530	510	496	487	480
* 305x102x28	$N_{b,y,Rd}$	*921*	*921*	*921*	*916*	*906*	*896*	*886*	*864*	*837*	*806*	*768*	756	695
	$N_{b,z,Rd}$	*800*	696	524	383	285	219	172	114	80.9	60.3	46.7	37.2	30.3
	$N_{b,T,Rd}$	*844*	*767*	687	611	548	499	461	411	381	361	348	339	332
* 305x102x25	$N_{b,y,Rd}$	*797*	*797*	*797*	*791*	*783*	*774*	*765*	*745*	*722*	*694*	*659*	629	598
	$N_{b,z,Rd}$	*683*	587	430	310	229	175	137	90.7	64.2	47.9	37.0	29.5	24.0
	$N_{b,T,Rd}$	*726*	*654*	576	502	441	394	359	312	284	266	255	246	240

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
* Section may be Class 4 under axial compression.
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.
For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.
FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
254x146x43	$N_{b,y,Rd}$	1510	1510	1500	1490	1470	1450	1430	1380	1320	1250	1160	1050	943
	$N_{b,z,Rd}$	1440	1340	1220	1070	917	766	637	447	326	247	193	155	127
	$N_{b,T,Rd}$	1460	1390	1320	1260	1200	1150	1110	1050	1010	983	963	949	938
254x146x37	$N_{b,y,Rd}$	1300	1300	1290	1280	1260	1250	1230	1190	1130	1070	991	900	803
	$N_{b,z,Rd}$	1240	1150	1040	918	781	650	539	378	275	208	163	131	107
	$N_{b,T,Rd}$	1250	1190	1120	1060	1000	949	905	836	789	756	734	717	705
254x146x31	$N_{b,y,Rd}$	1090	1090	1090	1070	1060	1040	1030	992	946	888	817	736	653
	$N_{b,z,Rd}$	1040	958	864	752	632	522	430	299	217	164	128	103	84.3
	$N_{b,T,Rd}$	1050	992	931	869	808	752	703	627	576	540	515	497	484
254x102x28	$N_{b,y,Rd}$	993	993	989	976	964	950	935	902	860	808	743	669	594
	$N_{b,z,Rd}$	869	732	569	425	320	246	195	129	92.0	68.7	53.2	42.4	34.6
	$N_{b,T,Rd}$	913	839	768	707	658	620	591	551	528	512	502	495	489
254x102x25	$N_{b,y,Rd}$	880	880	875	864	853	840	827	796	758	709	649	582	513
	$N_{b,z,Rd}$	764	635	486	359	269	207	163	108	76.8	57.3	44.4	35.4	28.8
	$N_{b,T,Rd}$	805	733	662	598	546	505	475	434	410	394	383	376	371
* 254x102x22	$N_{b,y,Rd}$	750	750	750	750	745	734	722	694	658	613	559	498	438
	$N_{b,z,Rd}$	660	539	404	295	219	168	132	87.4	62.0	46.2	35.7	28.5	23.2
	$N_{b,T,Rd}$	681	616	548	485	434	395	366	327	304	289	279	272	267
203x133x30	$N_{b,y,Rd}$	1050	1050	1040	1020	1000	983	961	909	840	753	657	563	481
	$N_{b,z,Rd}$	988	907	807	689	568	463	378	260	188	142	111	88.7	72.6
	$N_{b,T,Rd}$	1000	947	894	847	805	771	743	702	675	658	645	636	630
203x133x25	$N_{b,y,Rd}$	880	880	866	853	838	821	803	757	696	621	539	460	392
	$N_{b,z,Rd}$	825	755	668	565	463	375	306	210	152	114	89.0	71.3	58.3
	$N_{b,T,Rd}$	838	786	735	686	641	603	571	524	493	472	458	448	440
203x102x23	$N_{b,y,Rd}$	809	808	795	783	769	753	736	693	635	564	488	416	353
	$N_{b,z,Rd}$	719	619	495	378	288	223	177	118	84.1	62.9	48.7	38.9	31.7
	$N_{b,T,Rd}$	746	692	644	605	574	551	534	510	495	486	480	475	472
178x102x19	$N_{b,y,Rd}$	668	664	652	639	625	609	591	543	480	408	341	284	238
	$N_{b,z,Rd}$	595	513	411	314	239	186	147	98.3	70.1	52.4	40.6	32.4	26.4
	$N_{b,T,Rd}$	615	569	528	494	468	448	433	412	400	392	387	383	380
152x89x16	$N_{b,y,Rd}$	558	550	538	524	509	491	468	410	341	276	223	183	151
	$N_{b,z,Rd}$	481	396	300	220	164	126	99.0	65.6	46.6	34.7	26.9	21.4	17.5
	$N_{b,T,Rd}$	506	469	440	419	404	393	386	376	370	366	363	362	360
127x76x13	$N_{b,y,Rd}$	452	441	429	414	396	373	344	278	215	168	133	107	88.2
	$N_{b,z,Rd}$	374	289	204	145	106	80.7	63.2	41.6	29.5	21.9	16.9	13.5	11.0
	$N_{b,T,Rd}$	406	382	366	356	349	345	342	338	336	334	333	333	332

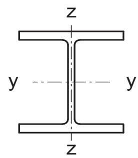
Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

* Section may be Class 4 under axial compression.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL COLUMNS
Advance® UKC

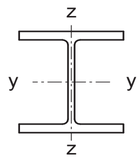


Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
356x406x634	$N_{b,y,Rd}$	19800	19800	19500	19100	18700	18200	17700	17200	16700	16100	15400	14700	14000
	$N_{b,z,Rd}$	19800	18800	17800	16800	15600	14400	13200	12000	10800	9720	8720	7820	7030
	$N_{b,T,Rd}$	19800	19700	19400	19300	19200	19100	19100	19000	19000	19000	19000	19000	19000
356x406x551	$N_{b,y,Rd}$	17200	17200	16900	16600	16200	15800	15300	14900	14400	13800	13200	12600	12000
	$N_{b,z,Rd}$	17200	16300	15400	14500	13500	12500	11400	10300	9310	8350	7480	6710	6030
	$N_{b,T,Rd}$	17200	17000	16700	16500	16400	16400	16300	16300	16300	16200	16200	16200	16200
356x406x467	$N_{b,y,Rd}$	15200	15200	14900	14500	14200	13800	13400	12900	12400	11900	11400	10800	10200
	$N_{b,z,Rd}$	15100	14300	13500	12600	11700	10800	9770	8790	7870	7030	6270	5600	5020
	$N_{b,T,Rd}$	15200	14800	14500	14300	14200	14100	14100	14000	14000	14000	14000	14000	13900
356x406x393	$N_{b,y,Rd}$	12800	12800	12500	12200	11900	11500	11200	10800	10400	9910	9420	8910	8380
	$N_{b,z,Rd}$	12700	12000	11300	10600	9770	8940	8100	7270	6490	5780	5140	4590	4110
	$N_{b,T,Rd}$	12800	12300	12100	11900	11700	11600	11600	11500	11500	11500	11400	11400	11400
356x406x340	$N_{b,y,Rd}$	11000	11000	10800	10500	10200	9940	9620	9270	8900	8490	8050	7590	7130
	$N_{b,z,Rd}$	11000	10400	9750	9100	8410	7680	6940	6220	5550	4930	4390	3910	3500
	$N_{b,T,Rd}$	11000	10600	10300	10100	9950	9840	9770	9710	9660	9630	9600	9580	9560
356x406x287	$N_{b,y,Rd}$	9700	9680	9440	9200	8940	8660	8360	8040	7680	7300	6890	6470	6040
	$N_{b,z,Rd}$	9600	9060	8500	7910	7270	6610	5950	5300	4710	4170	3700	3290	2940
	$N_{b,T,Rd}$	9600	9190	8880	8650	8480	8350	8260	8190	8130	8090	8050	8020	8000
356x406x235	$N_{b,y,Rd}$	7920	7900	7700	7500	7290	7060	6810	6530	6240	5920	5580	5230	4880
	$N_{b,z,Rd}$	7840	7390	6930	6430	5910	5370	4820	4290	3800	3360	2980	2650	2360
	$N_{b,T,Rd}$	7810	7440	7140	6900	6710	6560	6450	6360	6290	6230	6190	6150	6120
356x368x202	$N_{b,y,Rd}$	6810	6780	6610	6440	6250	6050	5830	5590	5330	5050	4750	4450	4140
	$N_{b,z,Rd}$	6690	6280	5850	5390	4910	4400	3910	3440	3030	2660	2340	2070	1840
	$N_{b,T,Rd}$	6670	6330	6050	5820	5640	5490	5380	5290	5220	5160	5110	5080	5040
356x368x177	$N_{b,y,Rd}$	5990	5960	5810	5650	5480	5300	5100	4890	4660	4400	4140	3860	3590
	$N_{b,z,Rd}$	5880	5510	5130	4730	4300	3850	3420	3010	2640	2320	2040	1810	1610
	$N_{b,T,Rd}$	5860	5540	5270	5040	4850	4690	4570	4460	4380	4310	4260	4210	4180
356x368x153	$N_{b,y,Rd}$	5170	5140	5010	4870	4720	4570	4400	4210	4000	3780	3550	3320	3080
	$N_{b,z,Rd}$	5070	4750	4420	4070	3700	3310	2930	2580	2260	1990	1750	1550	1370
	$N_{b,T,Rd}$	5040	4750	4500	4270	4080	3910	3780	3660	3570	3490	3430	3380	3330
356x368x129	$N_{b,y,Rd}$	4350	4320	4210	4090	3960	3830	3680	3520	3340	3160	2960	2750	2550
	$N_{b,z,Rd}$	4260	3990	3710	3410	3100	2770	2450	2150	1890	1660	1460	1290	1140
	$N_{b,T,Rd}$	4230	3980	3750	3530	3340	3170	3020	2900	2800	2710	2640	2580	2530

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.
FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL COLUMNS
Advance® UKC

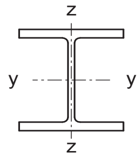


Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
305x305x283	$N_{b,y,Rd}$	9180	9100	8850	8590	8320	8020	7690	7320	6930	6510	6070	5630	5200
	$N_{b,z,Rd}$	8860	8230	7550	6820	6050	5290	4580	3950	3410	2960	2580	2270	2000
	$N_{b,T,Rd}$	9030	8750	8590	8480	8420	8370	8340	8320	8310	8290	8290	8280	8270
305x305x240	$N_{b,y,Rd}$	8110	8010	7780	7540	7280	7000	6690	6350	5970	5580	5170	4770	4380
	$N_{b,z,Rd}$	7790	7210	6580	5910	5200	4510	3880	3330	2870	2480	2160	1890	1670
	$N_{b,T,Rd}$	7910	7610	7420	7300	7220	7170	7130	7100	7080	7060	7050	7040	7030
305x305x198	$N_{b,y,Rd}$	6680	6590	6390	6190	5970	5730	5460	5170	4850	4520	4180	3840	3510
	$N_{b,z,Rd}$	6400	5910	5390	4830	4240	3670	3150	2690	2320	2000	1740	1530	1350
	$N_{b,T,Rd}$	6470	6180	5980	5850	5750	5690	5640	5600	5580	5560	5540	5530	5520
305x305x158	$N_{b,y,Rd}$	5330	5240	5090	4920	4740	4540	4320	4080	3810	3540	3260	2990	2730
	$N_{b,z,Rd}$	5090	4700	4270	3810	3330	2870	2450	2100	1800	1550	1350	1180	1040
	$N_{b,T,Rd}$	5120	4850	4640	4490	4380	4290	4230	4180	4150	4120	4100	4080	4070
305x305x137	$N_{b,y,Rd}$	4610	4530	4390	4250	4090	3910	3710	3500	3270	3020	2780	2540	2320
	$N_{b,z,Rd}$	4400	4060	3680	3280	2860	2460	2100	1790	1540	1330	1150	1010	888
	$N_{b,T,Rd}$	4420	4160	3950	3790	3670	3580	3510	3450	3410	3370	3350	3320	3310
305x305x118	$N_{b,y,Rd}$	3980	3910	3780	3660	3520	3360	3190	3000	2800	2590	2380	2170	1980
	$N_{b,z,Rd}$	3790	3490	3160	2810	2450	2100	1790	1530	1310	1130	980	857	755
	$N_{b,T,Rd}$	3790	3550	3350	3180	3050	2940	2860	2800	2740	2700	2670	2640	2620
305x305x97	$N_{b,y,Rd}$	3380	3310	3210	3090	2970	2830	2670	2500	2320	2140	1950	1770	1610
	$N_{b,z,Rd}$	3210	2950	2660	2350	2030	1730	1470	1250	1070	917	795	695	611
	$N_{b,T,Rd}$	3210	2980	2770	2590	2450	2320	2230	2150	2090	2040	1990	1960	1930
254x254x167	$N_{b,y,Rd}$	5640	5470	5270	5050	4810	4530	4230	3890	3550	3210	2890	2590	2330
	$N_{b,z,Rd}$	5260	4760	4210	3630	3060	2550	2130	1790	1510	1290	1110	970	851
	$N_{b,T,Rd}$	5410	5220	5110	5040	5000	4980	4960	4940	4930	4930	4920	4920	4910
254x254x132	$N_{b,y,Rd}$	4450	4300	4140	3960	3760	3530	3280	3010	2730	2460	2200	1970	1770
	$N_{b,z,Rd}$	4140	3740	3290	2820	2370	1970	1640	1370	1160	989	852	742	650
	$N_{b,T,Rd}$	4220	4020	3900	3820	3770	3730	3710	3690	3670	3660	3650	3650	3640
254x254x107	$N_{b,y,Rd}$	3600	3470	3340	3190	3020	2820	2610	2380	2150	1930	1720	1540	1370
	$N_{b,z,Rd}$	3340	3010	2640	2260	1880	1560	1300	1080	915	780	672	585	513
	$N_{b,T,Rd}$	3380	3190	3060	2960	2900	2850	2820	2790	2780	2760	2750	2740	2730
254x254x89	$N_{b,y,Rd}$	2990	2880	2770	2640	2500	2340	2150	1960	1770	1580	1410	1260	1130
	$N_{b,z,Rd}$	2770	2490	2190	1860	1560	1290	1070	891	752	642	553	481	421
	$N_{b,T,Rd}$	2790	2600	2460	2360	2280	2230	2190	2160	2130	2110	2100	2090	2080
254x254x73	$N_{b,y,Rd}$	2550	2460	2360	2240	2110	1970	1810	1640	1470	1310	1160	1030	922
	$N_{b,z,Rd}$	2360	2110	1840	1550	1290	1060	873	728	613	522	449	390	342
	$N_{b,T,Rd}$	2360	2170	2020	1900	1800	1730	1680	1640	1610	1590	1570	1550	1540

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.
FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL COLUMNS
Advance® UKC

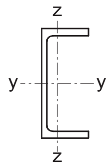


Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
203x203x127 +	$N_{b,y,Rd}$	4290	4290	4240	4150	4060	3970	3860	3640	3370	3080	2760	2440	2150
	$N_{b,z,Rd}$	4280	4060	3830	3590	3330	3060	2780	2250	1790	1440	1170	961	803
	$N_{b,T,Rd}$	4290	4180	4090	4030	3990	3960	3940	3920	3900	3890	3890	3880	3880
203x203x113 +	$N_{b,y,Rd}$	3840	3840	3790	3710	3630	3540	3440	3240	2990	2720	2430	2150	1880
	$N_{b,z,Rd}$	3830	3630	3420	3200	2970	2720	2470	1990	1590	1270	1030	847	707
	$N_{b,T,Rd}$	3840	3720	3630	3560	3520	3490	3470	3440	3420	3410	3400	3400	3390
203x203x100 +	$N_{b,y,Rd}$	3370	3370	3320	3250	3170	3090	3010	2820	2600	2360	2100	1850	1610
	$N_{b,z,Rd}$	3350	3170	2980	2790	2580	2370	2150	1720	1370	1090	886	728	608
	$N_{b,T,Rd}$	3360	3240	3150	3080	3030	3000	2970	2940	2920	2910	2900	2890	2890
203x203x86	$N_{b,y,Rd}$	2920	2920	2870	2810	2740	2670	2590	2430	2230	2010	1790	1570	1360
	$N_{b,z,Rd}$	2900	2740	2580	2410	2230	2040	1840	1480	1170	934	755	621	518
	$N_{b,T,Rd}$	2900	2780	2690	2630	2570	2540	2510	2470	2440	2430	2420	2410	2400
203x203x71	$N_{b,y,Rd}$	2400	2400	2360	2300	2250	2190	2130	1990	1820	1640	1450	1270	1100
	$N_{b,z,Rd}$	2380	2250	2120	1970	1820	1670	1510	1200	952	758	613	504	420
	$N_{b,T,Rd}$	2380	2270	2180	2120	2060	2020	1980	1940	1910	1880	1870	1860	1850
203x203x60	$N_{b,y,Rd}$	2100	2100	2060	2010	1960	1900	1840	1710	1560	1390	1220	1050	911
	$N_{b,z,Rd}$	2080	1960	1840	1710	1570	1420	1280	1010	791	627	506	414	345
	$N_{b,T,Rd}$	2070	1970	1880	1810	1750	1700	1660	1600	1550	1530	1510	1490	1480
203x203x52	$N_{b,y,Rd}$	1820	1820	1790	1740	1700	1650	1600	1480	1350	1200	1050	908	785
	$N_{b,z,Rd}$	1800	1700	1590	1480	1360	1230	1110	871	683	541	436	357	297
	$N_{b,T,Rd}$	1800	1700	1620	1550	1490	1430	1390	1320	1280	1240	1220	1200	1190
203x203x46	$N_{b,y,Rd}$	1610	1610	1580	1540	1500	1460	1410	1310	1190	1050	918	794	684
	$N_{b,z,Rd}$	1590	1500	1410	1300	1200	1080	970	762	596	472	380	311	259
	$N_{b,T,Rd}$	1590	1500	1430	1350	1290	1240	1190	1120	1070	1030	1010	986	971
152x152x51 +	$N_{b,y,Rd}$	1790	1760	1710	1650	1590	1520	1450	1280	1090	912	758	632	532
	$N_{b,z,Rd}$	1710	1570	1430	1270	1110	949	809	591	442	341	270	219	180
	$N_{b,T,Rd}$	1730	1660	1600	1570	1540	1530	1510	1500	1490	1480	1480	1480	1470
152x152x44 +	$N_{b,y,Rd}$	1540	1520	1470	1420	1370	1310	1240	1090	925	770	638	531	447
	$N_{b,z,Rd}$	1470	1350	1220	1080	943	808	687	501	374	288	228	185	152
	$N_{b,T,Rd}$	1480	1410	1350	1320	1290	1270	1250	1240	1220	1220	1210	1210	1210
152x152x37	$N_{b,y,Rd}$	1300	1270	1230	1190	1140	1090	1030	905	766	635	525	437	367
	$N_{b,z,Rd}$	1230	1130	1020	903	782	668	568	412	308	237	187	151	125
	$N_{b,T,Rd}$	1240	1170	1110	1070	1040	1020	1000	976	962	952	946	941	938
152x152x30	$N_{b,y,Rd}$	1050	1030	999	964	926	883	836	729	614	508	419	348	292
	$N_{b,z,Rd}$	999	916	826	729	630	537	455	330	246	189	149	121	99.7
	$N_{b,T,Rd}$	1000	937	882	838	803	775	754	724	706	693	685	679	674
152x152x23	$N_{b,y,Rd}$	803	785	759	731	700	665	627	541	451	370	303	251	210
	$N_{b,z,Rd}$	758	692	620	543	465	393	331	238	177	136	107	86.5	71.3
	$N_{b,T,Rd}$	759	703	652	607	569	538	514	478	454	439	428	420	415

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections.
For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.
FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

PARALLEL FLANGE CHANNELS
Advance® UKPFC



Subject to concentric axial compression

Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
430x100x64	$N_{b,y,Rd}$	2180	2180	2180	2180	2170	2130	2090	2010	1930	1850	1770	1680	1590
	$N_{b,z,Rd}$	1970	1750	1490	1240	1010	817	668	464	338	257	201	162	133
	$N_{b,T,Rd}$	2000	1820	1660	1530	1430	1350	1280	1200	1140	1100	1070	1050	1030
380x100x54	$N_{b,y,Rd}$	1820	1820	1820	1820	1790	1760	1720	1650	1580	1500	1420	1330	1250
	$N_{b,z,Rd}$	1660	1480	1270	1070	873	713	586	409	298	227	178	143	118
	$N_{b,T,Rd}$	1660	1510	1380	1270	1180	1110	1060	989	942	909	883	860	838
300x100x46	$N_{b,y,Rd}$	1540	1540	1540	1510	1470	1430	1400	1320	1230	1150	1060	964	875
	$N_{b,z,Rd}$	1410	1260	1090	919	758	621	512	358	262	199	156	126	104
	$N_{b,T,Rd}$	1390	1270	1170	1090	1030	982	946	894	855	819	783	743	700
300x90x41	$N_{b,y,Rd}$	1450	1450	1450	1420	1380	1340	1310	1230	1150	1060	971	882	795
	$N_{b,z,Rd}$	1290	1120	931	750	597	477	387	266	193	146	114	91.4	74.9
	$N_{b,T,Rd}$	1290	1160	1060	983	926	884	853	807	773	743	713	679	640
260x90x35	$N_{b,y,Rd}$	1220	1220	1210	1170	1140	1100	1060	988	907	822	736	655	579
	$N_{b,z,Rd}$	1090	950	795	644	515	413	336	231	168	127	99.1	79.6	65.3
	$N_{b,T,Rd}$	1070	963	878	813	766	731	704	662	628	594	558	518	477
260x75x28	$N_{b,y,Rd}$	965	965	951	923	895	867	837	775	709	640	572	506	447
	$N_{b,z,Rd}$	813	669	520	395	303	237	189	127	91.5	68.8	53.5	42.8	35.1
	$N_{b,T,Rd}$	820	722	647	593	555	528	508	479	458	438	416	392	364
230x90x32	$N_{b,y,Rd}$	1130	1130	1100	1060	1030	991	952	871	785	697	613	535	467
	$N_{b,z,Rd}$	1010	883	743	604	485	390	317	219	159	120	94.0	75.5	61.9
	$N_{b,T,Rd}$	980	882	808	755	716	685	661	619	578	536	490	444	399
230x75x26	$N_{b,y,Rd}$	899	899	876	847	818	788	757	691	622	551	483	421	367
	$N_{b,z,Rd}$	763	632	496	379	292	228	182	123	88.7	66.7	51.9	41.6	34.0
	$N_{b,T,Rd}$	759	674	613	570	541	519	501	473	447	419	387	352	317

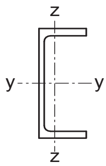
Advance® and UKPFC are trademarks of of Tata Steel. A fuller description of the relationship between Parallel Flange Channels and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$N_{b,T,Rd}$ is the lower of the torsional and the torsional-flexural buckling resiatance.

For values of the compression cross-sectional resistance, $N_{c,Rd}$, see values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

PARALLEL FLANGE CHANNELS
Advance® UKPFC



Subject to concentric axial compression

Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
200x90x30	$N_{b,y,Rd}$	1040	1040	999	961	922	882	840	751	659	570	489	418	359
	$N_{b,z,Rd}$	935	819	690	563	452	364	296	204	149	112	88.0	70.7	58.0
	$N_{b,T,Rd}$	894	807	745	700	667	639	614	565	514	461	409	360	317
200x75x23	$N_{b,y,Rd}$	822	817	787	757	726	694	661	591	518	447	383	327	281
	$N_{b,z,Rd}$	701	584	461	355	274	215	172	116	83.6	62.9	49.0	39.2	32.1
	$N_{b,T,Rd}$	687	615	566	532	508	488	471	439	403	364	324	286	251
180x90x26	$N_{b,y,Rd}$	913	897	861	824	786	746	705	617	529	447	377	318	271
	$N_{b,z,Rd}$	820	718	606	495	398	320	261	180	131	99.1	77.6	62.3	51.1
	$N_{b,T,Rd}$	769	687	629	586	554	527	502	454	405	358	313	273	238
180x75x20	$N_{b,y,Rd}$	712	699	670	641	610	578	545	475	405	341	287	242	206
	$N_{b,z,Rd}$	607	505	398	306	235	185	148	100.0	71.9	54.1	42.1	33.7	27.6
	$N_{b,T,Rd}$	587	520	472	440	416	397	380	347	312	276	242	211	184
150x90x24	$N_{b,y,Rd}$	836	802	762	720	677	630	582	485	397	323	265	220	185
	$N_{b,z,Rd}$	751	658	555	453	364	293	239	165	120	90.8	71.0	57.1	46.8
	$N_{b,T,Rd}$	686	612	561	523	491	461	432	374	320	271	230	195	167
150x75x18	$N_{b,y,Rd}$	627	601	571	540	506	471	435	362	296	241	198	164	138
	$N_{b,z,Rd}$	536	447	353	272	210	165	132	89.3	64.3	48.3	37.7	30.2	24.7
	$N_{b,T,Rd}$	504	446	407	379	357	336	317	277	238	203	172	146	125
125x65x15	$N_{b,y,Rd}$	510	480	449	416	381	344	307	241	188	148	119	97.6	81.2
	$N_{b,z,Rd}$	418	330	245	181	136	105	83.5	55.9	40.0	30.0	23.3	18.6	15.2
	$N_{b,T,Rd}$	407	368	341	319	297	274	251	205	166	135	111	91.9	77.3
100x50x10	$N_{b,y,Rd}$	342	315	286	255	222	191	163	120	89.7	69.2	54.8	44.4	36.6
	$N_{b,z,Rd}$	253	174	117	82.1	60.0	45.6	35.8	23.7	16.8	12.5	9.70	7.73	6.30
	$N_{b,T,Rd}$	275	253	234	213	190	167	146	110	84.5	66.1	52.9	43.1	35.8

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$N_{b,T,Rd}$ is the lower of the torsional and the torsional-flexural buckling resiatance.

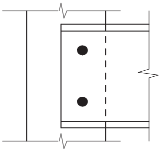
For values of the compression cross-sectional resistance, $N_{c,Rd}$, see values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

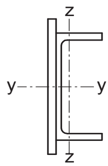
BS EN 1993-1-1:2005 BS 4-1:2005

COMPRESSION

S275 / Advance® 275



PARALLEL FLANGE CHANNELS
Advance UKPFC



Connected through web

One row of fasteners with
two or more fasteners across the web

Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Length between intersections, L (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
430x100x64	$N_{b,y,Rd}$	2180	2180	2180	2180	2170	2130	2090	2010	1930	1850	1770	1680	1590
	$N_{b,z,Rd}$	1490	1310	1130	979	846	734	640	464	338	257	201	162	133
	$N_{b,T,Rd}$	2000	1820	1660	1530	1430	1350	1280	1200	1140	1100	1070	1050	1030
380x100x54	$N_{b,y,Rd}$	1820	1820	1820	1820	1790	1760	1720	1650	1580	1500	1420	1330	1250
	$N_{b,z,Rd}$	1250	1110	965	837	727	632	553	409	298	227	178	143	118
	$N_{b,T,Rd}$	1660	1510	1380	1270	1180	1110	1060	989	942	909	883	860	838
300x100x46	$N_{b,y,Rd}$	1540	1540	1540	1510	1470	1430	1400	1320	1230	1150	1060	964	875
	$N_{b,z,Rd}$	1060	941	825	718	625	545	478	358	262	199	156	126	104
	$N_{b,T,Rd}$	1390	1270	1170	1090	1030	982	946	894	855	819	783	743	700
300x90x41	$N_{b,y,Rd}$	1450	1450	1450	1420	1380	1340	1310	1230	1150	1060	971	882	795
	$N_{b,z,Rd}$	968	837	716	610	521	447	387	266	193	146	114	91.4	74.9
	$N_{b,T,Rd}$	1290	1160	1060	983	926	884	853	807	773	743	713	679	640
260x90x35	$N_{b,y,Rd}$	1220	1220	1210	1170	1140	1100	1060	988	907	822	736	655	579
	$N_{b,z,Rd}$	819	711	610	521	446	384	332	231	168	127	99.1	79.6	65.3
	$N_{b,T,Rd}$	1070	963	878	813	766	731	704	662	628	594	558	518	477
260x75x28	$N_{b,y,Rd}$	965	965	951	923	895	867	837	775	709	640	572	506	447
	$N_{b,z,Rd}$	609	507	418	346	288	237	189	127	91.5	68.8	53.5	42.8	35.1
	$N_{b,T,Rd}$	820	722	647	593	555	528	508	479	458	438	416	392	364
230x90x32	$N_{b,y,Rd}$	1130	1130	1100	1060	1030	991	952	871	785	697	613	535	467
	$N_{b,z,Rd}$	759	660	568	486	417	359	312	219	159	120	94.0	75.5	61.9
	$N_{b,T,Rd}$	980	882	808	755	716	685	661	619	578	536	490	444	399
230x75x26	$N_{b,y,Rd}$	899	899	876	847	818	788	757	691	622	551	483	421	367
	$N_{b,z,Rd}$	571	478	396	328	274	228	182	123	88.7	66.7	51.9	41.6	34.0
	$N_{b,T,Rd}$	759	674	613	570	541	519	501	473	447	419	387	352	317

Advance® and UKPFC are trademarks of of Tata Steel. A fuller description of the relationship between Parallel Flange Channels and the Advance® range of sections manufactured by Tata Steel is given in note 12.

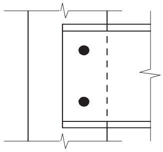
$N_{b,T,Rd}$ is the lower of the torsional and the torsional-flexural buckling resiatance.

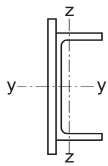
For values of the compression cross-sectional resistance, $N_{c,Rd}$, see values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

PARALLEL FLANGE CHANNELS
Advance UKPFC





Connected through web

One row of fasteners with
two or more fasteners across the web

Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Length between intersections, L (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
200x90x30	$N_{b,y,Rd}$	1040	1040	999	961	922	882	840	751	659	570	489	418	359
	$N_{b,z,Rd}$	703	612	527	452	388	335	290	204	149	112	88.0	70.7	58.0
	$N_{b,T,Rd}$	894	807	745	700	667	639	614	565	514	461	409	360	317
200x75x23	$N_{b,y,Rd}$	822	817	787	757	726	694	661	591	518	447	383	327	281
	$N_{b,z,Rd}$	525	441	367	305	255	215	172	116	83.6	62.9	49.0	39.2	32.1
	$N_{b,T,Rd}$	687	615	566	532	508	488	471	439	403	364	324	286	251
180x90x26	$N_{b,y,Rd}$	913	897	861	824	786	746	705	617	529	447	377	318	271
	$N_{b,z,Rd}$	617	537	463	397	341	294	255	180	131	99.1	77.6	62.3	51.1
	$N_{b,T,Rd}$	769	687	629	586	554	527	502	454	405	358	313	273	238
180x75x20	$N_{b,y,Rd}$	712	699	670	641	610	578	545	475	405	341	287	242	206
	$N_{b,z,Rd}$	454	381	317	263	220	185	148	100.0	71.9	54.1	42.1	33.7	27.6
	$N_{b,T,Rd}$	587	520	472	440	416	397	380	347	312	276	242	211	184
150x90x24	$N_{b,y,Rd}$	836	802	762	720	677	630	582	485	397	323	265	220	185
	$N_{b,z,Rd}$	565	492	424	364	312	269	234	165	120	90.8	71.0	57.1	46.8
	$N_{b,T,Rd}$	686	612	561	523	491	461	432	374	320	271	230	195	167
150x75x18	$N_{b,y,Rd}$	627	601	571	540	506	471	435	362	296	241	198	164	138
	$N_{b,z,Rd}$	401	337	280	233	196	165	132	89.3	64.3	48.3	37.7	30.2	24.7
	$N_{b,T,Rd}$	504	446	407	379	357	336	317	277	238	203	172	146	125
125x65x15	$N_{b,y,Rd}$	510	480	449	416	381	344	307	241	188	148	119	97.6	81.2
	$N_{b,z,Rd}$	313	254	205	166	136	105	83.5	55.9	40.0	30.0	23.3	18.6	15.2
	$N_{b,T,Rd}$	407	368	341	319	297	274	251	205	166	135	111	91.9	77.3
100x50x10	$N_{b,y,Rd}$	342	315	286	255	222	191	163	120	89.7	69.2	54.8	44.4	36.6
	$N_{b,z,Rd}$	191	144	110	82.1	60.0	45.6	35.8	23.7	16.8	12.5	9.70	7.73	6.30
	$N_{b,T,Rd}$	275	253	234	213	190	167	146	110	84.5	66.1	52.9	43.1	35.8

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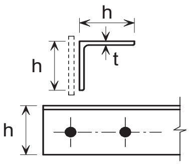
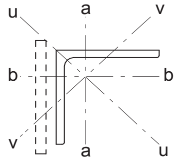
$N_{b,T,Rd}$ is the lower of the torsional and the torsional-flexural buckling resiatance.
For values of the compression cross-sectional resistance, $N_{c,Rd}$, see values of $N_{pl,Rd}$ in the tables for axial force and bending.
FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

EQUAL ANGLES
Advance® UKA - Equal Angles





Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
			Axis a-a	Axis b-b	Axis v-v														
h x h mm	t mm	cm^2	cm	cm	cm		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
200x200	24	90.6	6.06	6.06	3.90	F	1970	1890	1800	1650	1500	1340	1200	953	764	622	515	432	367
						T	2190	2190	2190	2190	2190	2190	2190	2190	2190	2190	2190	2190	2190
	20	76.3	6.11	6.11	3.92	F	1660	1590	1520	1400	1260	1140	1010	807	648	528	437	367	312
						T	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760
	* 18	69.1	6.13	6.13	3.90	F	*1510*	*1440*	*1370*	*1260*	*1140*	*1020*	*914*	*727*	*583*	*475*	*393*	*329*	*280*
						T	*1550*	*1550*	*1550*	*1550*	*1550*	*1550*	*1550*	*1550*	*1550*	*1550*	*1550*	*1550*	*1550*
	* 16	61.8	6.16	6.16	3.94	F	*1400*	*1340*	*1270*	*1170*	*1050*	*944*	*842*	*668*	*535*	*436*	*360*	*302*	*257*
						T	*1360*	*1360*	*1360*	*1360*	*1360*	*1360*	*1360*	*1360*	*1360*	*1360*	*1360*	*1360*	*1360*
150x150	18 +	51.2	4.55	4.55	2.93	F	1080	1020	905	788	678	582	501	377	292	232	188	155	131
						T	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240
	15	43.0	4.57	4.57	2.93	F	942	882	781	678	581	497	427	320	247	196	159	131	110
						T	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030
	* 12	34.8	4.60	4.60	2.95	F	*763*	*715*	*635*	*551*	*473*	*405*	*348*	*262*	*202*	*160*	*130*	*108*	*90.4*
						T	*771*	*771*	*771*	*771*	*771*	*771*	*771*	*771*	*771*	*771*	*771*	*771*	*771*
	* 10	29.3	4.62	4.62	2.97	F	*581*	*547*	*495*	*435*	*378*	*327*	*283*	*215*	*167*	*133*	*108*	*89.7*	*75.5*
						T	*547*	*547*	*547*	*547*	*547*	*547*	*547*	*547*	*547*	*547*	*547*	*547*	*547*
120x120	15 +	34.0	3.63	3.63	2.34	F	721	638	535	441	363	301	253	184	139	109	87.0	71.3	59.5
						T	857	857	857	857	857	857	857	857	857	857	857	857	857
	12	27.5	3.65	3.65	2.35	F	584	517	434	358	295	245	206	150	113	88.4	70.9	58.1	48.5
						T	659	659	659	659	659	659	659	659	659	659	659	659	659
	* 10	23.2	3.67	3.67	2.36	F	*493*	*437*	*367*	*304*	*250*	*208*	*174*	*127*	*96.1*	*75.1*	*60.2*	*49.4*	*41.2*
						T	*523*	*523*	*523*	*523*	*523*	*523*	*523*	*523*	*523*	*523*	*523*	*523*	*523*
	* 8 +	18.8	3.71	3.71	2.38	F	*362*	*327*	*279*	*234*	*195*	*163*	*138*	*101*	*77.0*	*60.4*	*48.6*	*39.9*	*33.4*
						T	*350*	*350*	*350*	*350*	*350*	*350*	*350*	*350*	*350*	*350*	*350*	*350*	*350*
100x100	15 +	28.0	2.99	2.99	1.94	F	572	473	376	297	238	193	159	113	84.6	65.5	52.1	42.5	35.2
						T	729	729	729	729	729	729	729	729	729	729	729	729	729
	12	22.7	3.02	3.02	1.94	F	465	383	305	241	193	157	129	92.0	68.6	53.1	42.2	34.4	28.6
						T	569	569	569	569	569	569	569	569	569	569	569	569	569
	10	19.2	3.04	3.04	1.95	F	394	325	259	205	164	133	110	78.4	58.5	45.3	36.1	29.4	24.4
						T	461	461	461	461	461	461	461	461	461	461	461	461	461
	* 8	15.5	3.06	3.06	1.96	F	*318*	*263*	*210*	*167*	*133*	*108*	*89.6*	*63.8*	*47.6*	*36.9*	*29.4*	*23.9*	*19.9*
						T	*345*	*345*	*345*	*345*	*345*	*345*	*345*	*345*	*345*	*345*	*345*	*345*	*345*

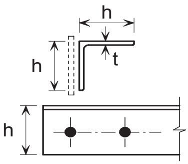
Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance® range of sections manufactured by Tata Steel is given in note 12

+ These sections are in addition to the range of BS EN 10056-1 sections.

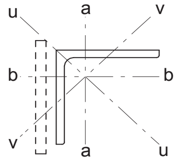
* Section is Class 4 under axial compression.

Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

FOR EXPLANATION OF TABLES SEE NOTE 8.



EQUAL ANGLES
Advance® UKA - Equal Angles



Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
			Axis a-a	Axis b-b	Axis v-v														
h x h mm	t mm	cm²	cm	cm	cm		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
90x90	12 +	20.3	2.71	2.71	1.75	F	401	319	246	191	150	121	99.1	69.8	51.7	39.8	31.6	25.7	21.3
						T	519	519	519	519	519	519	519	519	519	519	519	519	519
	10	17.1	2.72	2.72	1.75	F	338	269	207	161	127	102	83.5	58.8	43.6	33.5	26.6	21.6	17.9
						T	422	422	422	422	422	422	422	422	422	422	422	422	422
	* 8	13.9	2.74	2.74	1.76	F	*275*	*219*	*169*	*131*	*104*	*83.5*	*68.4*	*48.2*	*35.7*	*27.5*	*21.8*	*17.7*	*14.7*
						T	*322*	*322*	*322*	*322*	*322*	*322*	*322*	*322*	*322*	*322*	*322*	*322*	*322*
	* 7	12.2	2.75	2.75	1.77	F	*242*	*193*	*150*	*116*	*91.7*	*73.9*	*60.6*	*42.7*	*31.7*	*24.4*	*19.4*	*15.7*	*13.0*
						T	*269*	*269*	*269*	*269*	*269*	*269*	*269*	*269*	*269*	*269*	*269*	*269*	*269*
80x80	10	15.1	2.41	2.41	1.55	F	282	215	160	121	94.3	75.1	61.1	42.6	31.3	24.0	19.0	15.4	12.7
						T	382	382	382	382	382	382	382	382	382	382	382	382	382
	8	12.3	2.43	2.43	1.56	F	231	176	131	99.7	77.5	61.8	50.3	35.1	25.8	19.8	15.6	12.7	10.5
						T	296	296	296	296	296	296	296	296	296	296	296	296	296
75x75	8	11.4	2.27	2.27	1.46	F	207	154	113	84.5	65.3	51.7	41.9	29.1	21.3	16.3	12.9	10.4	8.59
						T	279	279	279	279	279	279	279	279	279	279	279	279	279
	* 6	8.73	2.29	2.29	1.47	F	*159*	*118*	*87.0*	*65.3*	*50.5*	*40.0*	*32.5*	*22.5*	*16.5*	*12.6*	*9.98*	*8.07*	*6.66*
						T	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*
70x70	7	9.40	2.12	2.12	1.36	F	164	118	85.1	63.2	48.4	38.2	30.8	21.3	15.6	11.9	9.34	7.55	6.22
						T	226	226	226	226	226	226	226	226	226	226	226	226	226
	* 6	8.13	2.13	2.13	1.37	F	*142*	*103*	*74.3*	*55.2*	*42.3*	*33.4*	*27.0*	*18.6*	*13.6*	*10.4*	*8.19*	*6.61*	*5.45*
						T	*187*	*187*	*187*	*187*	*187*	*187*	*187*	*187*	*187*	*187*	*187*	*187*	*187*
65x65	7	8.73	1.96	1.96	1.26	F	145	101	71.7	52.6	40.0	31.4	25.3	17.4	12.6	9.61	7.56	6.09	5.02
						T	212	212	212	212	212	212	212	212	212	212	212	212	212
60x60	8	9.03	1.80	1.80	1.16	F	141	95.5	66.3	48.2	36.4	28.4	22.8	15.6	11.3	8.57	6.72	5.41	4.45
						T	231	231	231	231	231	231	231	231	231	231	231	231	231
	6	6.91	1.82	1.82	1.17	F	109	73.8	51.4	37.3	28.2	22.1	17.7	12.1	8.78	6.66	5.23	4.21	3.46
						T	167	167	167	167	167	167	167	167	167	167	167	167	167
	* 5	5.82	1.82	1.82	1.17	F	*91.6*	*62.2*	*43.3*	*31.4*	*23.8*	*18.6*	*14.9*	*10.2*	*7.39*	*5.61*	*4.40*	*3.54*	*2.92*
						T	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*
50x50	6	5.69	1.50	1.50	0.968	F	76.3	48.2	32.3	23.0	17.1	13.3	10.6	7.14	5.14	3.88	3.03	2.44	2.00
						T	143	143	143	143	143	143	143	143	143	143	143	143	143
	5	4.80	1.51	1.51	0.973	F	64.6	40.9	27.5	19.5	14.6	11.3	8.98	6.08	4.38	3.31	2.58	2.08	1.70
						T	116	116	116	116	116	116	116	116	116	116	116	116	116
	* 4	3.89	1.52	1.52	0.979	F	*52.7*	*33.4*	*22.5*	*16.0*	*11.9*	*9.24*	*7.36*	*4.98*	*3.59*	*2.71*	*2.12*	*1.70*	*1.40*
						T	*87.6*	*87.6*	*87.6*	*87.6*	*87.6*	*87.6*	*87.6*	*87.6*	*87.6*	*87.6*	*87.6*	*87.6*	*87.6*

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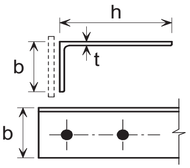
+ These sections are in addition to the range of BS EN 10056-1 sections.

* Section is Class 4 under axial compression.

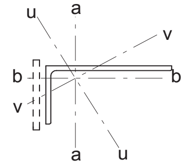
Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION



UNEQUAL ANGLES
Advance® UKA - Unequal Angles



Short leg attached

Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
			Axis	Axis	Axis														
h x b	t		a-a	b-b	v-v		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
mm	mm	cm^2	cm	cm	cm														
200x150	18 +	60.1	6.30	4.38	3.22	F	1270	1180	1090	987	864	752	655	501	392	313	256	213	179
						T	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380
	* 15	50.5	6.33	4.40	3.23	F	*1080*	*1010*	*930*	*839*	*734*	*639*	*555*	*425*	*332*	*266*	*217*	*180*	*152*
						T	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*
	* 12	40.8	6.36	4.44	3.25	F	*745*	*702*	*655*	*605*	*538*	*475*	*418*	*325*	*257*	*207*	*170*	*142*	*120*
						T	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*
200x100	15	43.0	6.40	2.64	2.12	F	853	738	625	504	409	335	278	200	150	117	93.2	76.1	63.3
						T	964	964	964	964	964	964	964	964	964	964	964	964	964
	* 12	34.8	6.43	2.67	2.14	F	*585*	*517*	*448*	*375*	*309*	*257*	*216*	*157*	*119*	*92.7*	*74.4*	*60.9*	*50.8*
						T	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*
	* 10	29.2	6.46	2.68	2.15	F	*431*	*386*	*339*	*293*	*244*	*205*	*173*	*127*	*97.0*	*76.2*	*61.3*	*50.4*	*42.1*
						T	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*
150x90	15	33.9	4.74	2.46	1.93	F	659	561	453	358	286	232	192	136	102	78.6	62.5	50.9	42.3
						T	833	833	833	833	833	833	833	833	833	833	833	833	833
	12	27.5	4.77	2.49	1.94	F	537	458	369	292	234	190	157	111	83.1	64.3	51.2	41.7	34.6
						T	632	632	632	632	632	632	632	632	632	632	632	632	632
	* 10	23.2	4.80	2.51	1.95	F	*413*	*357*	*295*	*236*	*191*	*156*	*129*	*92.5*	*69.3*	*53.8*	*42.9*	*35.0*	*29.1*
						T	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*
150x75	15	31.7	4.75	1.94	1.58	F	568	454	344	261	203	162	132	92.3	68.0	52.1	41.2	33.4	27.6
						T	780	780	780	780	780	780	780	780	780	780	780	780	780
	12	25.7	4.78	1.97	1.59	F	463	372	281	214	166	133	108	75.6	55.7	42.7	33.8	27.4	22.6
						T	591	591	591	591	591	591	591	591	591	591	591	591	591
	* 10	21.7	4.81	1.99	1.60	F	*359*	*294*	*227*	*175*	*137*	*110*	*90.0*	*63.2*	*46.7*	*35.9*	*28.5*	*23.1*	*19.1*
						T	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*
125x75	12	22.7	3.95	2.05	1.61	F	415	334	251	192	150	120	97.4	68.1	50.2	38.5	30.5	24.7	20.4
						T	552	552	552	552	552	552	552	552	552	552	552	552	552
	10	19.1	3.97	2.07	1.61	F	351	281	212	161	126	101	82.0	57.3	42.3	32.4	25.7	20.8	17.2
						T	439	439	439	439	439	439	439	439	439	439	439	439	439
	* 8	15.5	4.00	2.09	1.63	F	*255*	*211*	*163*	*126*	*99.6*	*80.1*	*65.7*	*46.3*	*34.3*	*26.4*	*20.9*	*17.0*	*14.1*
						T	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*

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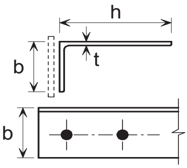
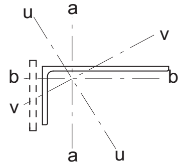
FOR EXPLANATION OF TABLES SEE NOTE 8.



UNEQUAL ANGLES
Advance® UKA - Unequal Angles



Short leg attached

Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
h x b mm	t mm	cm^2	Axis a-a cm	Axis b-b cm	Axis v-v cm		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
100x75	12	19.7	3.10	2.14	1.59	F	366	286	215	164	128	102	82.9	57.9	42.7	32.7	25.9	21.0	17.3
						T	500	500	500	500	500	500	500	500	500	500	500	500	500
	10	16.6	3.12	2.16	1.59	F	310	241	181	138	108	85.8	69.9	48.8	36.0	27.6	21.8	17.7	14.6
						T	405	405	405	405	405	405	405	405	405	405	405	405	405
	* 8	13.5	3.14	2.18	1.60	F	*253*	*197*	*148*	*113*	*88.2*	*70.4*	*57.4*	*40.1*	*29.6*	*22.7*	*17.9*	*14.5*	*12.0*
						T	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*
100x65	10 +	15.6	3.14	1.81	1.39	F	271	200	145	108	83.0	65.6	53.0	36.7	26.8	20.5	16.1	13.0	10.7
						T	383	383	383	383	383	383	383	383	383	383	383	383	383
	8 +	12.7	3.16	1.83	1.40	F	222	164	119	88.9	68.3	54.0	43.7	30.2	22.1	16.9	13.3	10.7	8.87
						T	292	292	292	292	292	292	292	292	292	292	292	292	292
	* 7 +	11.2	3.17	1.83	1.40	F	*185*	*140*	*102*	*76.6*	*59.1*	*46.8*	*38.0*	*26.3*	*19.3*	*14.8*	*11.6*	*9.41*	*7.77*
						T	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*
100x50	8	11.4	3.19	1.31	1.06	F	165	108	73.8	53.0	39.8	30.9	24.7	16.8	12.1	9.19	7.19	5.78	4.75
						T	262	262	262	262	262	262	262	262	262	262	262	262	262
	* 6	8.71	3.21	1.33	1.07	F	*112*	*77.5*	*53.9*	*39.2*	*29.7*	*23.2*	*18.6*	*12.7*	*9.24*	*7.01*	*5.50*	*4.43*	*3.65*
						T	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*
80x60	7	9.38	2.51	1.74	1.28	F	157	111	78.6	57.8	44.1	34.6	27.9	19.2	14.0	10.6	8.35	6.74	5.55
						T	220	220	220	220	220	220	220	220	220	220	220	220	220
80x40	8	9.01	2.53	1.03	0.838	F	104	62.8	41.2	28.9	21.3	16.4	13.0	8.73	6.26	4.71	3.67	2.94	2.41
						T	222	222	222	222	222	222	222	222	222	222	222	222	222
	6	6.89	2.55	1.05	0.845	F	80.5	48.6	31.9	22.4	16.6	12.7	10.1	6.77	4.86	3.66	2.85	2.29	1.87
						T	155	155	155	155	155	155	155	155	155	155	155	155	155
75x50	8	9.41	2.35	1.40	1.07	F	138	90.4	61.8	44.4	33.4	25.9	20.7	14.1	10.2	7.71	6.04	4.86	3.99
						T	234	234	234	234	234	234	234	234	234	234	234	234	234
	6	7.19	2.37	1.42	1.08	F	106	69.9	47.8	34.4	25.9	20.1	16.1	10.9	7.92	5.99	4.69	3.78	3.10
						T	165	165	165	165	165	165	165	165	165	165	165	165	165
70x50	6	6.89	2.20	1.43	1.07	F	101	66.2	45.2	32.5	24.4	19.0	15.2	10.3	7.46	5.65	4.42	3.56	2.92
						T	161	161	161	161	161	161	161	161	161	161	161	161	161
65x50	* 5	5.54	2.05	1.47	1.07	F	*80.9*	*53.1*	*36.3*	*26.1*	*19.6*	*15.2*	*12.2*	*8.29*	*6.00*	*4.54*	*3.55*	*2.86*	*2.35*
						T	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*
60x40	6	5.68	1.88	1.12	0.855	F	67.2	40.7	26.8	18.8	13.9	10.7	8.49	5.70	4.10	3.08	2.40	1.93	1.58
						T	139	139	139	139	139	139	139	139	139	139	139	139	139
	5	4.79	1.89	1.13	0.860	F	57.0	34.6	22.8	16.0	11.9	9.12	7.23	4.86	3.49	2.63	2.05	1.64	1.35
						T	111	111	111	111	111	111	111	111	111	111	111	111	111

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance® range of sections manufactured by Tata Steel is given in note 12

+ These sections are in addition to the range of BS EN 10056-1 sections.

* Section is Class 4 under axial compression.

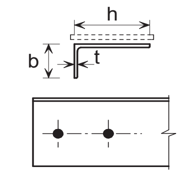
Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

FOR EXPLANATION OF TABLES SEE NOTE 8.

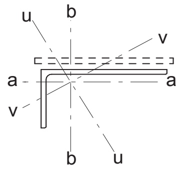
BS EN 1993-1-1:2005
BS EN 10056-1:1999

COMPRESSION

S275 / Advance® 275



UNEQUAL ANGLES
Advance® UKA - Unequal Angles



Long leg attached

Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
			Axis	Axis	Axis														
h x b	t		a-a	b-b	v-v		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
mm	mm	cm²	cm	cm	cm														
200x150	18 +	60.1	4.38	6.30	3.22	F	1270	1180	1090	987	864	752	655	501	392	313	256	213	179
						T	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380
	* 15	50.5	4.40	6.33	3.23	F	*1080*	*1010*	*930*	*839*	*734*	*639*	*555*	*425*	*332*	*266*	*217*	*180*	*152*
						T	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*	*1090*
	* 12	40.8	4.44	6.36	3.25	F	*745*	*702*	*655*	*605*	*538*	*475*	*418*	*325*	*257*	*207*	*170*	*142*	*120*
						T	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*	*693*
200x100	15	43.0	2.64	6.40	2.12	F	853	738	625	504	409	335	278	200	150	117	93.2	76.1	63.3
						T	964	964	964	964	964	964	964	964	964	964	964	964	964
	* 12	34.8	2.67	6.43	2.14	F	*585*	*517*	*448*	*375*	*309*	*257*	*216*	*157*	*119*	*92.7*	*74.4*	*60.9*	*50.8*
						T	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*	*604*
	* 10	29.2	2.68	6.46	2.15	F	*431*	*386*	*339*	*293*	*244*	*205*	*173*	*127*	*97.0*	*76.2*	*61.3*	*50.4*	*42.1*
						T	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*	*408*
150x90	15	33.9	2.46	4.74	1.93	F	659	561	453	358	286	232	192	136	102	78.6	62.5	50.9	42.3
						T	833	833	833	833	833	833	833	833	833	833	833	833	833
	12	27.5	2.49	4.77	1.94	F	537	458	369	292	234	190	157	111	83.1	64.3	51.2	41.7	34.6
						T	632	632	632	632	632	632	632	632	632	632	632	632	632
	* 10	23.2	2.51	4.80	1.95	F	*413*	*357*	*295*	*236*	*191*	*156*	*129*	*92.5*	*69.3*	*53.8*	*42.9*	*35.0*	*29.1*
						T	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*	*452*
150x75	15	31.7	1.94	4.75	1.58	F	568	454	344	261	203	162	132	92.3	68.0	52.1	41.2	33.4	27.6
						T	780	780	780	780	780	780	780	780	780	780	780	780	780
	12	25.7	1.97	4.78	1.59	F	463	372	281	214	166	133	108	75.6	55.7	42.7	33.8	27.4	22.6
						T	591	591	591	591	591	591	591	591	591	591	591	591	591
	* 10	21.7	1.99	4.81	1.60	F	*359*	*294*	*227*	*175*	*137*	*110*	*90.0*	*63.2*	*46.7*	*35.9*	*28.5*	*23.1*	*19.1*
						T	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*	*423*
125x75	12	22.7	2.05	3.95	1.61	F	415	334	251	192	150	120	97.4	68.1	50.2	38.5	30.5	24.7	20.4
						T	552	552	552	552	552	552	552	552	552	552	552	552	552
	10	19.1	2.07	3.97	1.61	F	351	281	212	161	126	101	82.0	57.3	42.3	32.4	25.7	20.8	17.2
						T	439	439	439	439	439	439	439	439	439	439	439	439	439
	* 8	15.5	2.09	4.00	1.63	F	*255*	*211*	*163*	*126*	*99.6*	*80.1*	*65.7*	*46.3*	*34.3*	*26.4*	*20.9*	*17.0*	*14.1*
						T	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*	*289*

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance® range of sections manufactured by Tata Steel is given in note 12

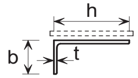
+ These sections are in addition to the range of BS EN 10056-1 sections.

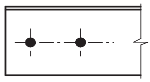
* Section is Class 4 under axial compression.

Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

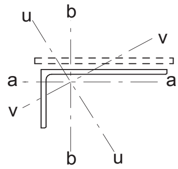
FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION





UNEQUAL ANGLES
Advance® UKA - Unequal Angles



Long leg attached

Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
			Axis a-a	Axis b-b	Axis v-v														
h x b mm	t mm	cm^2	cm	cm	cm		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
100x75	12	19.7	2.14	3.10	1.59	F	366	286	215	164	128	102	82.9	57.9	42.7	32.7	25.9	21.0	17.3
						T	500	500	500	500	500	500	500	500	500	500	500	500	500
	10	16.6	2.16	3.12	1.59	F	310	241	181	138	108	85.8	69.9	48.8	36.0	27.6	21.8	17.7	14.6
						T	405	405	405	405	405	405	405	405	405	405	405	405	405
	* 8	13.5	2.18	3.14	1.60	F	*253*	*197*	*148*	*113*	*88.2*	*70.4*	*57.4*	*40.1*	*29.6*	*22.7*	*17.9*	*14.5*	*12.0*
						T	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*	*307*
100x65	10 +	15.6	1.81	3.14	1.39	F	271	200	145	108	83.0	65.6	53.0	36.7	26.8	20.5	16.1	13.0	10.7
						T	383	383	383	383	383	383	383	383	383	383	383	383	383
	8 +	12.7	1.83	3.16	1.40	F	222	164	119	88.9	68.3	54.0	43.7	30.2	22.1	16.9	13.3	10.7	8.87
						T	292	292	292	292	292	292	292	292	292	292	292	292	292
	* 7 +	11.2	1.83	3.17	1.40	F	*185*	*140*	*102*	*76.6*	*59.1*	*46.8*	*38.0*	*26.3*	*19.3*	*14.8*	*11.6*	*9.41*	*7.77*
						T	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*	*230*
100x50	8	11.4	1.31	3.19	1.06	F	165	108	73.8	53.0	39.8	30.9	24.7	16.8	12.1	9.19	7.19	5.78	4.75
						T	262	262	262	262	262	262	262	262	262	262	262	262	262
	* 6	8.71	1.33	3.21	1.07	F	*112*	*77.5*	*53.9*	*39.2*	*29.7*	*23.2*	*18.6*	*12.7*	*9.24*	*7.01*	*5.50*	*4.43*	*3.65*
						T	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*	*151*
80x60	7	9.38	1.74	2.51	1.28	F	157	111	78.6	57.8	44.1	34.6	27.9	19.2	14.0	10.6	8.35	6.74	5.55
						T	220	220	220	220	220	220	220	220	220	220	220	220	220
80x40	8	9.01	1.03	2.53	0.838	F	104	62.8	41.2	28.9	21.3	16.4	13.0	8.73	6.26	4.71	3.67	2.94	2.41
						T	222	222	222	222	222	222	222	222	222	222	222	222	222
	6	6.89	1.05	2.55	0.845	F	80.5	48.6	31.9	22.4	16.6	12.7	10.1	6.77	4.86	3.66	2.85	2.29	1.87
						T	155	155	155	155	155	155	155	155	155	155	155	155	155
75x50	8	9.41	1.40	2.35	1.07	F	138	90.4	61.8	44.4	33.4	25.9	20.7	14.1	10.2	7.71	6.04	4.86	3.99
						T	234	234	234	234	234	234	234	234	234	234	234	234	234
	6	7.19	1.42	2.37	1.08	F	106	69.9	47.8	34.4	25.9	20.1	16.1	10.9	7.92	5.99	4.69	3.78	3.10
						T	165	165	165	165	165	165	165	165	165	165	165	165	165
70x50	6	6.89	1.43	2.20	1.07	F	101	66.2	45.2	32.5	24.4	19.0	15.2	10.3	7.46	5.65	4.42	3.56	2.92
						T	161	161	161	161	161	161	161	161	161	161	161	161	161
65x50	* 5	5.54	1.47	2.05	1.07	F	*80.9*	*53.1*	*36.3*	*26.1*	*19.6*	*15.2*	*12.2*	*8.29*	*6.00*	*4.54*	*3.55*	*2.86*	*2.35*
						T	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*	*123*
60x40	6	5.68	1.12	1.88	0.855	F	67.2	40.7	26.8	18.8	13.9	10.7	8.49	5.70	4.10	3.08	2.40	1.93	1.58
						T	139	139	139	139	139	139	139	139	139	139	139	139	139
	5	4.79	1.13	1.89	0.860	F	57.0	34.6	22.8	16.0	11.9	9.12	7.23	4.86	3.49	2.63	2.05	1.64	1.35
						T	111	111	111	111	111	111	111	111	111	111	111	111	111

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance® range of sections manufactured by Tata Steel is given in note 12

+ These sections are in addition to the range of BS EN 10056-1 sections.

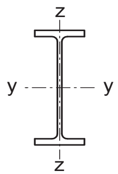
* Section is Class 4 under axial compression.

Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

FOR EXPLANATION OF TABLES SEE NOTE 8.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1016x305x487 +		$M_{c,y,Rd}$	5920	5920	5920	5920	5920	5920	5920	5920	5920	5920	5920
$N_{pl,Rd}$ = 15800	n/a	$M_{c,z,Rd}$	714	714	714	714	714	714	714	714	714	714	714
	1.00	$M_{N,y,Rd}$	5920	5920	5920	5390	4620	3850	3080	2310	1540	769	0
		$M_{N,z,Rd}$	714	714	714	714	714	710	667	574	432	241	0
1016x305x437 +		$M_{c,y,Rd}$	5300	5300	5300	5300	5300	5300	5300	5300	5300	5300	5300
$N_{pl,Rd}$ = 14200	n/a	$M_{c,z,Rd}$	629	629	629	629	629	629	629	629	629	629	629
	1.00	$M_{N,y,Rd}$	5300	5300	5300	4820	4130	3440	2760	2070	1380	689	0
		$M_{N,z,Rd}$	629	629	629	629	629	626	588	506	381	212	0
1016x305x393 +		$M_{c,y,Rd}$	4730	4730	4730	4730	4730	4730	4730	4730	4730	4730	4730
$N_{pl,Rd}$ = 12800	n/a	$M_{c,z,Rd}$	553	553	553	553	553	553	553	553	553	553	553
	1.00	$M_{N,y,Rd}$	4730	4730	4730	4320	3700	3090	2470	1850	1230	617	0
		$M_{N,z,Rd}$	553	553	553	553	553	551	519	447	337	188	0
1016x305x349 +		$M_{c,y,Rd}$	4400	4400	4400	4400	3800	3800	3800	3800	3800	3800	$
$N_{pl,Rd}$ = 11800	0.942	$M_{c,z,Rd}$	514	514	514	514	324	324	324	324	324	324	$
	0.313	$M_{N,y,Rd}$	4400	4400	4400	3990	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	514	514	514	514	-	-	-	-	-	-	-
1016x305x314 +		$M_{c,y,Rd}$	3940	3940	3940	3410	3410	3410	3410	3410	3410	✖	$
$N_{pl,Rd}$ = 10600	0.805	$M_{c,z,Rd}$	454	454	454	287	287	287	287	287	287	✖	$
	0.252	$M_{N,y,Rd}$	3940	3940	3940	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	454	454	454	-	-	-	-	-	-	-	-
1016x305x272 +		$M_{c,y,Rd}$	3400	3400	2970	2970	2970	2970	2970	✖	✖	✖	$
$N_{pl,Rd}$ = 9200	0.628	$M_{c,z,Rd}$	389	389	248	248	248	248	248	✖	✖	✖	$
	0.169	$M_{N,y,Rd}$	3400	3400	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	389	389	-	-	-	-	-	-	-	-	-
1016x305x249 +		$M_{c,y,Rd}$	3010	3010	2600	2600	2600	2600	2600	✖	✖	✖	$
$N_{pl,Rd}$ = 8400	0.628	$M_{c,z,Rd}$	330	330	208	208	208	208	208	✖	✖	✖	$
	0.185	$M_{N,y,Rd}$	3010	3010	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	330	330	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

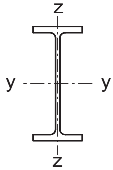
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



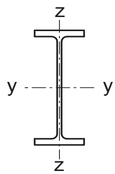
Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
1016x305x487 +	1.00	$N_{b,y,Rd}$	15800	15800	15800	15800	15800	15800	15700	15600	15400	15200	15100	14900	14700
$N_{pl,Rd}$ = 15800		$N_{b,z,Rd}$	14700	13300	11700	10000	8420	7000	5820	4870	4120	3520	3030	2640	2310
$f_y W_{el,y}$ = 5030	**1.00**	$M_{b,Rd}$	5920	5820	5220	4710	4280	3900	3590	3310	3080	2870	2700	2540	2400
$f_y W_{el,z}$ = 442															
1016x305x437 +	1.00	$N_{b,y,Rd}$	14200	14200	14200	14200	14200	14200	14100	14000	13800	13700	13500	13400	13200
$N_{pl,Rd}$ = 14200		$N_{b,z,Rd}$	13200	11900	10400	8920	7460	6180	5140	4300	3630	3100	2670	2320	2030
$f_y W_{el,y}$ = 4520	**1.00**	$M_{b,Rd}$	5300	5170	4620	4150	3740	3390	3100	2850	2630	2450	2290	2150	2020
$f_y W_{el,z}$ = 391															
1016x305x393 +	1.00	$N_{b,y,Rd}$	12800	12800	12800	12800	12800	12800	12700	12500	12400	12300	12100	12000	11900
$N_{pl,Rd}$ = 12800		$N_{b,z,Rd}$	11800	10600	9290	7910	6590	5450	4520	3770	3180	2710	2340	2030	1780
$f_y W_{el,y}$ = 4050	**1.00**	$M_{b,Rd}$	4730	4580	4070	3640	3260	2940	2660	2430	2240	2070	1930	1800	1690
$f_y W_{el,z}$ = 345															
* 1016x305x349 +	0.942	$N_{b,y,Rd}$	11800	11800	11800	11800	11800	11800	11700	11700	11600	11500	11400	11300	11300
$N_{pl,Rd}$ = 11800		$N_{b,z,Rd}$	11100	10300	9230	7960	6640	5450	4480	3710	3100	2630	2250	1950	1700
$f_y W_{el,y}$ = 3800	0.942	$M_{b,Rd}$	3800	3750	3350	3000	2700	2430	2210	2020	1850	1710	1590	1490	1400
$f_y W_{el,z}$ = 324	**0.313**	$M_{b,Rd}$	4400	4220	3730	3310	2940	2630	2370	2150	1960	1810	1670	1560	1460
* 1016x305x314 +	0.805	$N_{b,y,Rd}$	10600	10600	10600	10600	10600	10600	10500	10500	10400	10300	10300	10200	10100
$N_{pl,Rd}$ = 10600		$N_{b,z,Rd}$	10000	9220	8250	7090	5900	4830	3960	3270	2740	2320	1980	1710	1500
$f_y W_{el,y}$ = 3410	0.805	$M_{b,Rd}$	3410	3350	2980	2650	2370	2130	1920	1740	1590	1460	1350	1260	1180
$f_y W_{el,z}$ = 287	**0.252**	$M_{b,Rd}$	3940	3750	3310	2910	2580	2290	2050	1850	1680	1540	1420	1320	1230
* 1016x305x272 +	0.628	$N_{b,y,Rd}$	9200	9200	9200	9200	9200	9200	9140	9080	9030	8960	8900	8840	8770
$N_{pl,Rd}$ = 9200		$N_{b,z,Rd}$	8670	7990	7140	6140	5100	4170	3420	2820	2360	2000	1710	1480	1290
$f_y W_{el,y}$ = 2970	0.628	$M_{b,Rd}$	2970	2890	2570	2280	2020	1800	1610	1450	1320	1200	1110	1020	954
$f_y W_{el,z}$ = 248	**0.169**	$M_{b,Rd}$	3400	3230	2840	2490	2180	1920	1710	1530	1380	1260	1150	1070	989
* 1016x305x249 +	0.628	$N_{b,y,Rd}$	8400	8400	8400	8400	8400	8400	8340	8290	8230	8170	8110	8050	7990
$N_{pl,Rd}$ = 8400		$N_{b,z,Rd}$	7870	7210	6380	5400	4430	3590	2920	2400	2010	1690	1450	1250	1090
$f_y W_{el,y}$ = 2600	0.628	$M_{b,Rd}$	2600	2510	2220	1950	1720	1520	1350	1210	1090	990	906	836	775
$f_y W_{el,z}$ = 208	**0.185**	$M_{b,Rd}$	3010	2820	2460	2140	1860	1630	1430	1280	1140	1040	945	868	803

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
$n = N_{Ed} / N_{pl,Rd}$
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.
For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

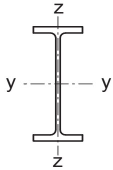
Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1016x305x222 +		$M_{c,y,Rd}$	2600	2600	2230	2230	2230	2230	✖	✖	✖	$	$
$N_{pl,Rd}$ = 7500	0.593	$M_{c,z,Rd}$	270	270	169	169	169	169	✖	✖	✖	$	$
	0.182	$M_{N,y,Rd}$	2600	2600	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	270	270	-	-	-	-	-	-	-	-	-
914x419x388		$M_{c,y,Rd}$	4680	4680	4680	4680	4140	4140	4140	4140	4140	4140	4140
$N_{pl,Rd}$ = 13100	1.00	$M_{c,z,Rd}$	885	885	885	885	573	573	573	573	573	573	573
	0.319	$M_{N,y,Rd}$	4680	4680	4610	4040	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	885	885	885	885	-	-	-	-	-	-	-
914x419x343		$M_{c,y,Rd}$	4100	4100	4100	3640	3640	3640	3640	3640	3640	3640	$
$N_{pl,Rd}$ = 11600	0.939	$M_{c,z,Rd}$	766	766	766	496	496	496	496	496	496	496	$
	0.269	$M_{N,y,Rd}$	4100	4100	4070	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	766	766	766	-	-	-	-	-	-	-	-
914x305x289		$M_{c,y,Rd}$	3330	3330	3330	3330	2880	2880	2880	2880	2880	2880	$
$N_{pl,Rd}$ = 9750	0.903	$M_{c,z,Rd}$	424	424	424	424	269	269	269	269	269	269	$
	0.313	$M_{N,y,Rd}$	3330	3330	3330	3040	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	424	424	424	424	-	-	-	-	-	-	-
914x305x253		$M_{c,y,Rd}$	2900	2900	2900	2520	2520	2520	2520	2520	✖	✖	$
$N_{pl,Rd}$ = 8560	0.745	$M_{c,z,Rd}$	363	363	363	231	231	231	231	231	✖	✖	$
	0.239	$M_{N,y,Rd}$	2900	2900	2900	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	363	363	363	-	-	-	-	-	-	-	-
914x305x224		$M_{c,y,Rd}$	2530	2530	2190	2190	2190	2190	2190	✖	✖	✖	$
$N_{pl,Rd}$ = 7580	0.644	$M_{c,z,Rd}$	308	308	196	196	196	196	196	✖	✖	✖	$
	0.196	$M_{N,y,Rd}$	2530	2530	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	308	308	-	-	-	-	-	-	-	-	-
914x305x201		$M_{c,y,Rd}$	2210	2210	1910	1910	1910	1910	✖	✖	✖	$	$
$N_{pl,Rd}$ = 6780	0.587	$M_{c,z,Rd}$	260	260	165	165	165	165	✖	✖	✖	$	$
	0.177	$M_{N,y,Rd}$	2210	2210	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	260	260	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

S275 / Advance® 275

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 1016x305x222 +	0.593	$N_{b,y,Rd}$	7500	7500	7500	7500	7500	7490	7440	7390	7330	7280	7230	7170	7110
$N_{pl,Rd}$ = 7500		$N_{b,z,Rd}$	6980	6340	5530	4610	3720	2980	2410	1980	1650	1390	1190	1020	893
$f_y W_{el,y}$ = 2230	0.593	$M_{b,Rd}$	2230	2120	1860	1630	1420	1250	1100	976	875	790	720	660	610
$f_y W_{el,z}$ = 169	**0.182**	$M_{b,Rd}$	2600	2400	2080	1790	1540	1340	1170	1030	919	826	750	686	632
914x419x388	1.00	$N_{b,y,Rd}$	13100	13100	13100	13100	13100	13100	13000	12900	12800	12700	12600	12500	12400
$N_{pl,Rd}$ = 13100		$N_{b,z,Rd}$	12900	12400	11700	11000	10200	9280	8290	7310	6410	5610	4910	4320	3820
$f_y W_{el,y}$ = 4140	1.00	$M_{b,Rd}$	4140	4140	4140	3960	3760	3560	3360	3170	2990	2820	2660	2510	2380
$f_y W_{el,z}$ = 573	**0.319**	$M_{b,Rd}$	4680	4680	4650	4400	4150	3910	3670	3440	3220	3020	2830	2660	2500
* 914x419x343	0.939	$N_{b,y,Rd}$	11600	11600	11600	11600	11600	11600	11500	11400	11300	11200	11200	11100	11000
$N_{pl,Rd}$ = 11600		$N_{b,z,Rd}$	11400	10900	10400	9710	8960	8120	7240	6370	5570	4860	4260	3740	3310
$f_y W_{el,y}$ = 3640	0.939	$M_{b,Rd}$	3640	3640	3640	3460	3270	3090	2910	2730	2560	2400	2250	2110	1990
$f_y W_{el,z}$ = 496	**0.269**	$M_{b,Rd}$	4100	4100	4060	3830	3610	3380	3160	2950	2740	2560	2380	2230	2090
* 914x305x289	0.903	$N_{b,y,Rd}$	9750	9750	9750	9750	9750	9720	9660	9590	9520	9450	9370	9300	9220
$N_{pl,Rd}$ = 9750		$N_{b,z,Rd}$	9230	8530	7670	6640	5560	4580	3760	3120	2610	2210	1900	1640	1430
$f_y W_{el,y}$ = 2880	0.903	$M_{b,Rd}$	2880	2860	2650	2450	2240	2050	1870	1710	1570	1440	1330	1240	1150
$f_y W_{el,z}$ = 269	**0.313**	$M_{b,Rd}$	3330	3250	2990	2730	2470	2230	2010	1820	1660	1520	1390	1290	1200
* 914x305x253	0.745	$N_{b,y,Rd}$	8560	8560	8560	8560	8560	8530	8470	8410	8350	8290	8220	8160	8090
$N_{pl,Rd}$ = 8560		$N_{b,z,Rd}$	8090	7460	6690	5770	4810	3940	3230	2680	2240	1900	1620	1400	1230
$f_y W_{el,y}$ = 2520	0.745	$M_{b,Rd}$	2520	2490	2300	2110	1920	1740	1580	1430	1300	1190	1090	1010	935
$f_y W_{el,z}$ = 231	**0.239**	$M_{b,Rd}$	2900	2820	2580	2340	2110	1890	1690	1520	1370	1240	1140	1050	967
* 914x305x224	0.644	$N_{b,y,Rd}$	7580	7580	7580	7580	7580	7550	7500	7440	7390	7330	7270	7210	7150
$N_{pl,Rd}$ = 7580		$N_{b,z,Rd}$	7130	6560	5850	5000	4140	3380	2760	2280	1900	1610	1380	1190	1040
$f_y W_{el,y}$ = 2190	0.644	$M_{b,Rd}$	2190	2150	1980	1810	1640	1480	1330	1190	1070	975	889	816	754
$f_y W_{el,z}$ = 196	**0.196**	$M_{b,Rd}$	2530	2440	2230	2010	1800	1590	1420	1260	1130	1020	924	845	778
* 914x305x201	0.587	$N_{b,y,Rd}$	6780	6780	6780	6780	6780	6750	6700	6650	6600	6550	6500	6440	6380
$N_{pl,Rd}$ = 6780		$N_{b,z,Rd}$	6360	5810	5140	4350	3560	2880	2350	1930	1610	1360	1160	1000	876
$f_y W_{el,y}$ = 1910	0.587	$M_{b,Rd}$	1910	1870	1710	1560	1400	1250	1110	992	889	801	727	664	610
$f_y W_{el,z}$ = 165	**0.177**	$M_{b,Rd}$	2210	2120	1930	1730	1530	1350	1190	1050	931	834	754	686	628

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+ These sections are in addition to the range of BS 4 sections

$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

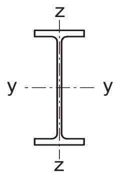
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance n = N_{Ed} / $N_{pl,Rd}$										
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
838x292x226		$M_{c,y,Rd}$	2430	2430	2430	2120	2120	2120	2120	2120	✖	✖	$
$N_{pl,Rd}$ = 7660	0.754	$M_{c,z,Rd}$	321	321	321	205	205	205	205	205	✖	✖	$
	0.233	$M_{N,y,Rd}$	2430	2430	2430	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	321	321	321	-	-	-	-	-	-	-	-
838x292x194		$M_{c,y,Rd}$	2020	2020	1760	1760	1760	1760	1760	✖	✖	✖	$
$N_{pl,Rd}$ = 6550	0.645	$M_{c,z,Rd}$	258	258	164	164	164	164	164	✖	✖	✖	$
	0.194	$M_{N,y,Rd}$	2020	2020	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	258	258	-	-	-	-	-	-	-	-	-
838x292x176		$M_{c,y,Rd}$	1800	1800	1560	1560	1560	1560	✖	✖	✖	$	$
$N_{pl,Rd}$ = 5940	0.590	$M_{c,z,Rd}$	223	223	142	142	142	142	✖	✖	✖	$	$
	0.175	$M_{N,y,Rd}$	1800	1800	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	223	223	-	-	-	-	-	-	-	-	-
762x267x197		$M_{c,y,Rd}$	1900	1900	1900	1650	1650	1650	1650	1650	1650	✖	$
$N_{pl,Rd}$ = 6650	0.849	$M_{c,z,Rd}$	254	254	254	162	162	162	162	162	162	✖	$
	0.280	$M_{N,y,Rd}$	1900	1900	1900	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	254	254	254	-	-	-	-	-	-	-	-
762x267x173		$M_{c,y,Rd}$	1640	1640	1640	1430	1430	1430	1430	1430	✖	✖	$
$N_{pl,Rd}$ = 5830	0.737	$M_{c,z,Rd}$	214	214	214	136	136	136	136	136	✖	✖	$
	0.237	$M_{N,y,Rd}$	1640	1640	1640	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	214	214	214	-	-	-	-	-	-	-	-
762x267x147		$M_{c,y,Rd}$	1370	1370	1180	1180	1180	1180	1180	✖	✖	$	$
$N_{pl,Rd}$ = 4960	0.607	$M_{c,z,Rd}$	171	171	109	109	109	109	109	✖	✖	$	$
	0.181	$M_{N,y,Rd}$	1370	1370	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	171	171	-	-	-	-	-	-	-	-	-
762x267x134		$M_{c,y,Rd}$	1280	1280	1100	1100	1100	1100	✖	✖	✖	$	$
$N_{pl,Rd}$ = 4700	0.519	$M_{c,z,Rd}$	157	157	99.6	99.6	99.6	99.6	✖	✖	✖	$	$
	0.139	$M_{N,y,Rd}$	1280	1280	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	157	157	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

N_{Ed} = Design value of the axial force.

n = N_{Ed} / $N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

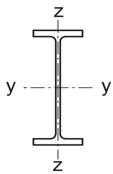
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 838x292x226	0.754	$N_{b,y,Rd}$	7660	7660	7660	7660	7660	7610	7550	7490	7430	7370	7310	7240	7170
$N_{pl,Rd}$ = 7660		$N_{b,z,Rd}$	7210	6630	5910	5050	4180	3410	2790	2300	1920	1630	1390	1200	1050
$f_y W_{el,y}$ = 2120	0.754	$M_{b,Rd}$	2120	2080	1910	1750	1590	1440	1300	1180	1070	979	900	831	772
$f_y W_{el,z}$ = 205	**0.233**	$M_{b,Rd}$	2430	2340	2140	1930	1740	1550	1390	1250	1120	1020	935	861	798
* 838x292x194	0.645	$N_{b,y,Rd}$	6550	6550	6550	6550	6540	6490	6440	6390	6340	6290	6230	6170	6110
$N_{pl,Rd}$ = 6550		$N_{b,z,Rd}$	6130	5610	4950	4190	3430	2770	2260	1860	1550	1310	1120	966	843
$f_y W_{el,y}$ = 1760	0.645	$M_{b,Rd}$	1760	1710	1570	1430	1290	1150	1030	920	828	750	683	627	578
$f_y W_{el,z}$ = 164	**0.194**	$M_{b,Rd}$	2020	1940	1760	1580	1400	1240	1090	970	866	780	708	647	596
* 838x292x176	0.590	$N_{b,y,Rd}$	5940	5940	5940	5940	5930	5880	5840	5790	5740	5690	5640	5580	5530
$N_{pl,Rd}$ = 5940		$N_{b,z,Rd}$	5540	5040	4420	3700	3000	2420	1960	1610	1340	1130	966	834	727
$f_y W_{el,y}$ = 1560	0.590	$M_{b,Rd}$	1560	1510	1380	1250	1120	995	882	785	702	632	573	523	481
$f_y W_{el,z}$ = 142	**0.175**	$M_{b,Rd}$	1800	1710	1550	1380	1220	1070	937	825	733	656	593	539	494
* 762x267x197	0.849	$N_{b,y,Rd}$	6650	6650	6650	6650	6620	6570	6510	6460	6400	6330	6270	6200	6120
$N_{pl,Rd}$ = 6650		$N_{b,z,Rd}$	6170	5590	4850	4010	3220	2580	2080	1710	1420	1190	1020	880	767
$f_y W_{el,y}$ = 1650	0.849	$M_{b,Rd}$	1650	1590	1450	1310	1180	1060	954	861	783	715	658	609	567
$f_y W_{el,z}$ = 162	**0.280**	$M_{b,Rd}$	1900	1790	1610	1440	1280	1140	1010	907	819	745	683	630	584
* 762x267x173	0.737	$N_{b,y,Rd}$	5830	5830	5830	5830	5800	5750	5700	5650	5600	5540	5480	5420	5350
$N_{pl,Rd}$ = 5830		$N_{b,z,Rd}$	5390	4860	4190	3430	2740	2180	1760	1440	1190	1000	857	739	644
$f_y W_{el,y}$ = 1430	0.737	$M_{b,Rd}$	1430	1360	1240	1110	992	882	785	703	633	575	525	483	448
$f_y W_{el,z}$ = 136	**0.237**	$M_{b,Rd}$	1640	1530	1380	1220	1070	943	831	737	660	596	543	498	460
* 762x267x147	0.607	$N_{b,y,Rd}$	4960	4960	4960	4960	4930	4890	4840	4800	4750	4700	4650	4600	4540
$N_{pl,Rd}$ = 4960		$N_{b,z,Rd}$	4550	4080	3470	2810	2220	1760	1410	1150	956	804	686	591	514
$f_y W_{el,y}$ = 1180	0.607	$M_{b,Rd}$	1180	1120	1010	902	795	698	614	544	485	436	395	361	333
$f_y W_{el,z}$ = 109	**0.181**	$M_{b,Rd}$	1370	1260	1130	989	859	744	647	568	504	451	408	371	341
* 762x267x134	0.519	$N_{b,y,Rd}$	4700	4700	4700	4700	4670	4630	4590	4540	4500	4450	4400	4340	4280
$N_{pl,Rd}$ = 4700		$N_{b,z,Rd}$	4290	3810	3200	2550	2000	1570	1260	1020	848	713	607	523	455
$f_y W_{el,y}$ = 1100	0.519	$M_{b,Rd}$	1100	1030	927	819	715	622	542	476	421	377	340	309	283
$f_y W_{el,z}$ = 99.6	**0.139**	$M_{b,Rd}$	1280	1170	1030	897	770	660	569	496	437	389	350	317	289

$n = N_{Ed} / N_{pl,Rd}$

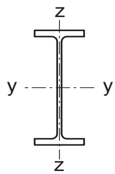
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
686x254x170		$M_{c,y,Rd}$	1490	1490	1490	1300	1300	1300	1300	1300	1300	✖	$
$N_{pl,Rd}$ = 5750	0.899	$M_{c,z,Rd}$	215	215	215	137	137	137	137	137	137	✖	$
	0.292	$M_{N,y,Rd}$	1490	1490	1490	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	215	215	215	-	-	-	-	-	-	-	-
686x254x152		$M_{c,y,Rd}$	1330	1330	1330	1160	1160	1160	1160	1160	✖	✖	$
$N_{pl,Rd}$ = 5140	0.773	$M_{c,z,Rd}$	188	188	188	121	121	121	121	121	✖	✖	$
	0.239	$M_{N,y,Rd}$	1330	1330	1330	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	188	188	188	-	-	-	-	-	-	-	-
686x254x140		$M_{c,y,Rd}$	1210	1210	1210	1060	1060	1060	1060	✖	✖	✖	$
$N_{pl,Rd}$ = 4720	0.696	$M_{c,z,Rd}$	169	169	169	108	108	108	108	✖	✖	✖	$
	0.208	$M_{N,y,Rd}$	1210	1210	1210	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	169	169	169	-	-	-	-	-	-	-	-
686x254x125		$M_{c,y,Rd}$	1060	1060	922	922	922	922	922	✖	✖	✖	$
$N_{pl,Rd}$ = 4210	0.628	$M_{c,z,Rd}$	144	144	91.7	91.7	91.7	91.7	91.7	✖	✖	✖	$
	0.186	$M_{N,y,Rd}$	1060	1060	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	144	144	-	-	-	-	-	-	-	-	-
610x305x238		$M_{c,y,Rd}$	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980
$N_{pl,Rd}$ = 8030	n/a	$M_{c,z,Rd}$	417	417	417	417	417	417	417	417	417	417	417
	1.00	$M_{N,y,Rd}$	1980	1980	1930	1690	1450	1210	965	723	482	241	0
		$M_{N,z,Rd}$	417	417	417	417	415	396	357	298	218	119	0
610x305x179		$M_{c,y,Rd}$	1470	1470	1470	1310	1310	1310	1310	1310	1310	1310	1310
$N_{pl,Rd}$ = 6040	1.00	$M_{c,z,Rd}$	303	303	303	197	197	197	197	197	197	197	197
	0.293	$M_{N,y,Rd}$	1470	1470	1440	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	303	303	303	-	-	-	-	-	-	-	-
610x305x149		$M_{c,y,Rd}$	1220	1220	1220	1090	1090	1090	1090	1090	✖	✖	$
$N_{pl,Rd}$ = 5040	0.796	$M_{c,z,Rd}$	248	248	248	162	162	162	162	162	✖	✖	$
	0.200	$M_{N,y,Rd}$	1220	1220	1190	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	248	248	248	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

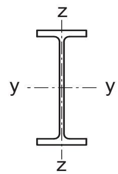
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 686x254x170	0.899	$N_{b,y,Rd}$	5750	5750	5750	5750	5700	5640	5590	5530	5470	5410	5340	5270	5190
$N_{pl,Rd}$ = 5750		$N_{b,z,Rd}$	5300	4770	4100	3350	2670	2120	1710	1390	1160	975	831	717	624
$f_y W_{el,y}$ = 1300	0.899	$M_{b,Rd}$	1300	1240	1130	1020	913	818	735	664	604	553	509	472	440
$f_y W_{el,z}$ = 137	**0.292**	$M_{b,Rd}$	1490	1390	1250	1110	987	874	778	697	630	574	527	487	453
* 686x254x152	0.773	$N_{b,y,Rd}$	5140	5140	5140	5140	5090	5040	4990	4940	4890	4830	4770	4700	4630
$N_{pl,Rd}$ = 5140		$N_{b,z,Rd}$	4730	4250	3630	2950	2340	1860	1490	1220	1010	851	726	626	545
$f_y W_{el,y}$ = 1160	0.773	$M_{b,Rd}$	1160	1100	993	891	793	705	628	563	509	463	424	391	363
$f_y W_{el,z}$ = 121	**0.239**	$M_{b,Rd}$	1330	1230	1100	973	854	750	662	589	529	479	438	403	373
* 686x254x140	0.696	$N_{b,y,Rd}$	4720	4720	4720	4710	4670	4630	4580	4530	4480	4430	4370	4310	4240
$N_{pl,Rd}$ = 4720		$N_{b,z,Rd}$	4330	3880	3300	2670	2110	1670	1340	1090	907	763	650	561	488
$f_y W_{el,y}$ = 1060	0.696	$M_{b,Rd}$	1060	995	898	802	710	627	555	495	444	403	367	338	312
$f_y W_{el,z}$ = 108	**0.208**	$M_{b,Rd}$	1210	1110	993	874	763	666	584	516	461	416	379	347	320
* 686x254x125	0.628	$N_{b,y,Rd}$	4210	4210	4210	4210	4170	4130	4090	4040	4000	3950	3900	3840	3780
$N_{pl,Rd}$ = 4210		$N_{b,z,Rd}$	3850	3420	2880	2310	1810	1430	1140	930	770	647	551	475	413
$f_y W_{el,y}$ = 922	0.628	$M_{b,Rd}$	922	863	775	687	602	527	463	409	365	328	298	272	251
$f_y W_{el,z}$ = 91.7	**0.186**	$M_{b,Rd}$	1060	968	858	749	647	559	485	426	378	339	306	280	257
610x305x238	1.00	$N_{b,y,Rd}$	8030	8030	8030	8000	7930	7850	7760	7680	7590	7490	7380	7270	7140
$N_{pl,Rd}$ = 8030		$N_{b,z,Rd}$	7700	7210	6620	5910	5110	4320	3620	3040	2570	2190	1880	1630	1430
$f_y W_{el,y}$ = 1750	**1.00**	$M_{b,Rd}$	1980	1980	1840	1720	1590	1480	1370	1280	1190	1110	1050	983	928
$f_y W_{el,z}$ = 270															
610x305x179	1.00	$N_{b,y,Rd}$	6040	6040	6040	6020	5960	5900	5830	5770	5700	5620	5540	5450	5350
$N_{pl,Rd}$ = 6040		$N_{b,z,Rd}$	5780	5400	4930	4380	3760	3160	2640	2210	1860	1580	1360	1180	1030
$f_y W_{el,y}$ = 1310	1.00	$M_{b,Rd}$	1310	1310	1220	1130	1050	964	888	818	755	699	650	607	569
$f_y W_{el,z}$ = 197	**0.293**	$M_{b,Rd}$	1470	1450	1350	1240	1140	1040	947	866	794	732	677	630	588
* 610x305x149	0.796	$N_{b,y,Rd}$	5040	5040	5040	5010	4960	4910	4860	4800	4740	4680	4610	4530	4450
$N_{pl,Rd}$ = 5040		$N_{b,z,Rd}$	4810	4490	4090	3620	3100	2600	2170	1810	1530	1300	1110	966	845
$f_y W_{el,y}$ = 1090	0.796	$M_{b,Rd}$	1090	1090	1010	930	853	779	709	646	591	542	499	462	430
$f_y W_{el,z}$ = 162	**0.200**	$M_{b,Rd}$	1220	1200	1100	1010	920	832	751	680	617	563	517	477	443

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$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

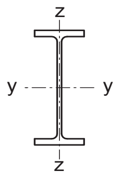
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
610x229x140		$M_{c,y,Rd}$	1100	1100	1100	960	960	960	960	960	960	960	$
$N_{pl,Rd}$ = 4720	0.919	$M_{c,z,Rd}$	162	162	162	104	104	104	104	104	104	104	$
	0.296	$M_{N,y,Rd}$	1100	1100	1100	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	162	162	162	-	-	-	-	-	-	-	-
610x229x125		$M_{c,y,Rd}$	974	974	974	854	854	854	854	854	✖	✖	$
$N_{pl,Rd}$ = 4210	0.789	$M_{c,z,Rd}$	142	142	142	90.9	90.9	90.9	90.9	90.9	✖	✖	$
	0.242	$M_{N,y,Rd}$	974	974	974	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	142	142	142	-	-	-	-	-	-	-	-
610x229x113		$M_{c,y,Rd}$	869	869	869	762	762	762	762	✖	✖	✖	$
$N_{pl,Rd}$ = 3820	0.703	$M_{c,z,Rd}$	124	124	124	79.8	79.8	79.8	79.8	✖	✖	✖	$
	0.208	$M_{N,y,Rd}$	869	869	869	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	124	124	124	-	-	-	-	-	-	-	-
610x229x101		$M_{c,y,Rd}$	792	792	692	692	692	692	692	✖	✖	✖	$
$N_{pl,Rd}$ = 3550	0.617	$M_{c,z,Rd}$	110	110	70.4	70.4	70.4	70.4	70.4	✖	✖	✖	$
	0.177	$M_{N,y,Rd}$	792	792	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	110	110	-	-	-	-	-	-	-	-	-
610x178x100 +		$M_{c,y,Rd}$	738	738	738	633	633	633	633	633	✖	✖	$
$N_{pl,Rd}$ = 3390	0.724	$M_{c,z,Rd}$	78.4	78.4	78.4	49.0	49.0	49.0	49.0	49.0	✖	✖	$
	0.250	$M_{N,y,Rd}$	738	738	738	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	78.4	78.4	78.4	-	-	-	-	-	-	-	-
610x178x92 +		$M_{c,y,Rd}$	691	691	691	589	589	589	589	✖	✖	✖	$
$N_{pl,Rd}$ = 3220	0.659	$M_{c,z,Rd}$	71.0	71.0	71.0	44.3	44.3	44.3	44.3	✖	✖	✖	$
	0.227	$M_{N,y,Rd}$	691	691	691	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	71.0	71.0	71.0	-	-	-	-	-	-	-	-
610x178x82 +		$M_{c,y,Rd}$	603	603	513	513	513	513	✖	✖	✖	$	$
$N_{pl,Rd}$ = 2860	0.564	$M_{c,z,Rd}$	60.0	60.0	37.4	37.4	37.4	37.4	✖	✖	✖	$	$
	0.178	$M_{N,y,Rd}$	603	603	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	60.0	60.0	-	-	-	-	-	-	-	-	-

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+ These sections are in addition to the range of BS 4 sections

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

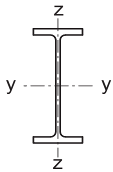
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 610x229x140	0.919	$N_{b,y,Rd}$	4720	4720	4720	4690	4640	4590	4540	4490	4430	4360	4290	4220	4140
$N_{pl,Rd}$ = 4720		$N_{b,z,Rd}$	4270	3760	3120	2460	1910	1490	1190	968	800	672	572	493	428
$f_y W_{el,y}$ = 960	0.919	$M_{b,Rd}$	960	887	798	711	632	563	503	454	412	377	348	323	301
$f_y W_{el,z}$ = 104	**0.296**	$M_{b,Rd}$	1100	991	880	774	678	597	529	474	429	391	359	332	309
* 610x229x125	0.789	$N_{b,y,Rd}$	4210	4210	4210	4190	4150	4100	4050	4000	3950	3890	3830	3770	3690
$N_{pl,Rd}$ = 4210		$N_{b,z,Rd}$	3810	3340	2760	2160	1670	1310	1040	846	699	587	500	430	374
$f_y W_{el,y}$ = 854	0.789	$M_{b,Rd}$	854	784	701	620	546	481	427	382	345	314	288	266	247
$f_y W_{el,z}$ = 90.9	**0.242**	$M_{b,Rd}$	974	874	771	672	583	509	447	398	357	324	296	273	253
* 610x229x113	0.703	$N_{b,y,Rd}$	3820	3820	3820	3790	3750	3710	3670	3620	3570	3520	3460	3400	3330
$N_{pl,Rd}$ = 3820		$N_{b,z,Rd}$	3430	3000	2460	1910	1470	1150	914	742	613	514	437	376	327
$f_y W_{el,y}$ = 762	0.703	$M_{b,Rd}$	762	695	618	543	473	414	364	323	290	262	240	221	204
$f_y W_{el,z}$ = 79.8	**0.208**	$M_{b,Rd}$	869	774	679	587	505	436	380	336	300	270	246	226	209
* 610x229x101	0.617	$N_{b,y,Rd}$	3550	3550	3550	3520	3480	3440	3400	3350	3300	3250	3190	3130	3060
$N_{pl,Rd}$ = 3550		$N_{b,z,Rd}$	3160	2720	2190	1670	1270	989	784	635	524	439	373	321	279
$f_y W_{el,y}$ = 692	0.617	$M_{b,Rd}$	692	622	547	474	408	352	306	269	239	215	195	179	165
$f_y W_{el,z}$ = 70.4	**0.177**	$M_{b,Rd}$	785	694	601	511	433	369	319	279	247	221	200	182	165
* 610x178x100 +	0.724	$N_{b,y,Rd}$	3390	3390	3390	3360	3330	3290	3250	3210	3160	3110	3060	3000	2930
$N_{pl,Rd}$ = 3390		$N_{b,z,Rd}$	2790	2150	1520	1080	789	599	469	377	309	258	219	188	163
$f_y W_{el,y}$ = 633	0.724	$M_{b,Rd}$	586	475	386	318	268	230	201	179	161	147	135	125	116
$f_y W_{el,z}$ = 49.0	**0.250**	$M_{b,Rd}$	660	524	417	339	282	241	209	186	167	151	139	128	119
* 610x178x92 +	0.659	$N_{b,y,Rd}$	3220	3220	3220	3180	3150	3110	3070	3030	2980	2930	2870	2810	2740
$N_{pl,Rd}$ = 3220		$N_{b,z,Rd}$	2600	1950	1350	945	689	522	408	328	269	224	190	163	141
$f_y W_{el,y}$ = 589	0.659	$M_{b,Rd}$	536	429	343	279	232	198	172	152	136	123	113	104	96.9
$f_y W_{el,z}$ = 44.3	**0.227**	$M_{b,Rd}$	604	472	370	297	244	206	179	157	141	127	116	107	99.4
* 610x178x82 +	0.564	$N_{b,y,Rd}$	2860	2860	2860	2830	2800	2760	2730	2690	2650	2600	2550	2490	2430
$N_{pl,Rd}$ = 2860		$N_{b,z,Rd}$	2280	1680	1150	800	582	440	344	276	226	188	160	137	119
$f_y W_{el,y}$ = 513	0.564	$M_{b,Rd}$	462	366	290	233	192	162	140	123	109	98.6	89.9	82.7	76.6
$f_y W_{el,z}$ = 37.4	**0.178**	$M_{b,Rd}$	522	403	312	247	201	169	145	127	113	101	92.4	84.8	78.5

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+ These sections are in addition to the range of BS 4 sections
n = N_{Ed} / $N_{pl,Rd}$
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.
For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

BS EN 1993-1-1:2005
BS 4-1:2005

AXIAL FORCE & BENDING

S275 / Advance® 275

UNIVERSAL BEAMS
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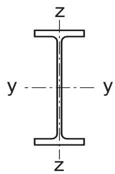

Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
533x312x272 +		$M_{c,y,Rd}$	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080
$N_{pl,Rd}$ = 9220	n/a	$M_{c,z,Rd}$	526	526	526	526	526	526	526	526	526	526	526
	1.00	$M_{N,y,Rd}$	2080	2080	1970	1730	1480	1230	986	739	493	246	0
		$M_{N,z,Rd}$	526	526	526	526	517	486	432	357	260	141	0
533x312x219 +		$M_{c,y,Rd}$	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620
$N_{pl,Rd}$ = 7390	n/a	$M_{c,z,Rd}$	401	401	401	401	401	401	401	401	401	401	401
	1.00	$M_{N,y,Rd}$	1620	1620	1560	1360	1170	974	779	584	390	195	0
		$M_{N,z,Rd}$	401	401	401	401	397	377	338	281	205	112	0
533x312x182 +		$M_{c,y,Rd}$	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330
$N_{pl,Rd}$ = 6120	n/a	$M_{c,z,Rd}$	328	328	328	328	328	328	328	328	328	328	328
	1.00	$M_{N,y,Rd}$	1330	1330	1280	1120	962	802	641	481	321	160	0
		$M_{N,z,Rd}$	328	328	328	328	325	308	276	229	168	91.3	0
533x312x150 +		$M_{c,y,Rd}$	1100	1100	1100	984	984	984	984	984	984	984	984
$N_{pl,Rd}$ = 5090	1.00	$M_{c,z,Rd}$	267	267	267	175	175	175	175	175	175	175	175
	0.288	$M_{N,y,Rd}$	1100	1100	1060	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	267	267	267	-	-	-	-	-	-	-	-
533x210x138 +		$M_{c,y,Rd}$	957	957	957	957	957	957	957	957	957	957	957
$N_{pl,Rd}$ = 4660	n/a	$M_{c,z,Rd}$	151	151	151	151	151	151	151	151	151	151	151
	1.00	$M_{N,y,Rd}$	957	957	957	852	730	608	487	365	243	122	0
		$M_{N,z,Rd}$	151	151	151	151	151	148	137	116	86.7	47.9	0
533x210x122		$M_{c,y,Rd}$	847	847	847	847	740	740	740	740	740	740	740
$N_{pl,Rd}$ = 4110	1.00	$M_{c,z,Rd}$	133	133	133	133	84.8	84.8	84.8	84.8	84.8	84.8	84.8
	0.357	$M_{N,y,Rd}$	847	847	847	749	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	133	133	133	133	-	-	-	-	-	-	-
533x210x109		$M_{c,y,Rd}$	750	750	750	750	656	656	656	656	656	656	$
$N_{pl,Rd}$ = 3680	0.944	$M_{c,z,Rd}$	116	116	116	116	73.9	73.9	73.9	73.9	73.9	73.9	$
	0.303	$M_{N,y,Rd}$	750	750	750	668	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	116	116	116	116	-	-	-	-	-	-	-

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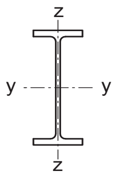
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
533x312x272 +	1.00	$N_{b,y,Rd}$	9220	9220	9220	9150	9050	8950	8840	8720	8600	8460	8320	8150	7970
$N_{pl,Rd}$ = 9220		$N_{b,z,Rd}$	8910	8390	7770	7040	6200	5330	4530	3830	3260	2790	2410	2090	1830
$f_y W_{el,y}$ = 1830	**1.00**	$M_{b,Rd}$	2080	2080	2020	1930	1850	1770	1690	1620	1550	1480	1410	1350	1290
$f_y W_{el,z}$ = 341															
533x312x219 +	1.00	$N_{b,y,Rd}$	7390	7390	7390	7320	7240	7160	7070	6970	6870	6750	6630	6490	6340
$N_{pl,Rd}$ = 7390		$N_{b,z,Rd}$	7120	6690	6170	5550	4850	4140	3500	2950	2500	2130	1840	1600	1400
$f_y W_{el,y}$ = 1430	**1.00**	$M_{b,Rd}$	1620	1620	1550	1480	1400	1330	1250	1180	1110	1050	989	935	885
$f_y W_{el,z}$ = 260															
533x312x182 +	1.00	$N_{b,y,Rd}$	6120	6120	6120	6060	5990	5920	5850	5770	5680	5580	5480	5360	5230
$N_{pl,Rd}$ = 6120		$N_{b,z,Rd}$	5890	5520	5090	4570	3980	3390	2850	2400	2030	1730	1490	1300	1140
$f_y W_{el,y}$ = 1190	**1.00**	$M_{b,Rd}$	1330	1330	1270	1200	1130	1060	992	925	862	803	751	703	661
$f_y W_{el,z}$ = 214															
533x312x150 +	1.00	$N_{b,y,Rd}$	5090	5090	5090	5040	4980	4920	4850	4790	4710	4630	4540	4440	4330
$N_{pl,Rd}$ = 5090		$N_{b,z,Rd}$	4890	4580	4210	3770	3280	2780	2340	1960	1660	1420	1220	1060	926
$f_y W_{el,y}$ = 984	1.00	$M_{b,Rd}$	984	984	941	893	841	788	735	683	634	588	547	510	477
$f_y W_{el,z}$ = 175	**0.288**	$M_{b,Rd}$	1100	1090	1040	978	916	851	786	724	666	615	569	528	492
533x210x138 +	1.00	$N_{b,y,Rd}$	4660	4660	4660	4610	4550	4490	4430	4370	4290	4210	4130	4030	3920
$N_{pl,Rd}$ = 4660		$N_{b,z,Rd}$	4160	3590	2880	2210	1690	1310	1040	841	694	582	494	425	370
$f_y W_{el,y}$ = 831	**1.00**	$M_{b,Rd}$	951	850	755	667	590	526	472	427	390	359	333	310	290
$f_y W_{el,z}$ = 95.7															
533x210x122	1.00	$N_{b,y,Rd}$	4110	4110	4100	4060	4010	3960	3900	3850	3780	3710	3630	3550	3450
$N_{pl,Rd}$ = 4110		$N_{b,z,Rd}$	3660	3160	2530	1940	1480	1150	910	737	608	510	434	373	324
$f_y W_{el,y}$ = 740	1.00	$M_{b,Rd}$	740	670	598	531	472	420	377	342	312	286	265	246	230
$f_y W_{el,z}$ = 84.8	**0.357**	$M_{b,Rd}$	839	747	658	576	504	445	396	356	324	296	273	254	237
* 533x210x109	0.944	$N_{b,y,Rd}$	3680	3680	3680	3640	3590	3550	3500	3440	3390	3320	3250	3170	3080
$N_{pl,Rd}$ = 3680		$N_{b,z,Rd}$	3270	2810	2240	1700	1290	1000	795	643	531	445	378	325	282
$f_y W_{el,y}$ = 656	0.944	$M_{b,Rd}$	656	589	522	459	403	356	317	284	258	236	217	201	188
$f_y W_{el,z}$ = 73.9	**0.303**	$M_{b,Rd}$	739	655	572	496	429	375	331	295	267	243	223	206	192

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+ These sections are in addition to the range of BS 4 sections

n = N_{Ed} / $N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.

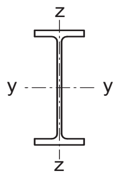
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
533x210x101		$M_{c,y,Rd}$	692	692	692	607	607	607	607	607	607	✖	$
$N_{pl,Rd}$ = 3420	0.845	$M_{c,z,Rd}$	106	106	106	67.8	67.8	67.8	67.8	67.8	67.8	✖	$
	0.260	$M_{N,y,Rd}$	692	692	692	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	106	106	106	-	-	-	-	-	-	-	-
533x210x92		$M_{c,y,Rd}$	649	649	649	570	570	570	570	570	✖	✖	$
$N_{pl,Rd}$ = 3220	0.734	$M_{c,z,Rd}$	97.6	97.6	97.6	62.7	62.7	62.7	62.7	62.7	✖	✖	$
	0.217	$M_{N,y,Rd}$	649	649	649	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	97.6	97.6	97.6	-	-	-	-	-	-	-	-
533x210x82		$M_{c,y,Rd}$	566	566	566	495	495	495	495	✖	✖	✖	$
$N_{pl,Rd}$ = 2890	0.673	$M_{c,z,Rd}$	82.5	82.5	82.5	52.8	52.8	52.8	52.8	✖	✖	✖	$
	0.201	$M_{N,y,Rd}$	566	566	566	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	82.5	82.5	82.5	-	-	-	-	-	-	-	-
533x165x85 +		$M_{c,y,Rd}$	558	558	558	481	481	481	481	481	✖	✖	$
$N_{pl,Rd}$ = 2860	0.782	$M_{c,z,Rd}$	64.4	64.4	64.4	40.5	40.5	40.5	40.5	40.5	✖	✖	$
	0.264	$M_{N,y,Rd}$	558	558	558	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	64.4	64.4	64.4	-	-	-	-	-	-	-	-
533x165x74 +		$M_{c,y,Rd}$	497	497	497	427	427	427	427	✖	✖	✖	$
$N_{pl,Rd}$ = 2620	0.686	$M_{c,z,Rd}$	55.0	55.0	55.0	34.4	34.4	34.4	34.4	✖	✖	✖	$
	0.230	$M_{N,y,Rd}$	497	497	497	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	55.0	55.0	55.0	-	-	-	-	-	-	-	-
533x165x66 +		$M_{c,y,Rd}$	429	429	367	367	367	367	✖	✖	✖	$	$
$N_{pl,Rd}$ = 2300	0.588	$M_{c,z,Rd}$	45.7	45.7	28.6	28.6	28.6	28.6	✖	✖	✖	$	$
	0.185	$M_{N,y,Rd}$	429	429	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	45.7	45.7	-	-	-	-	-	-	-	-	-
457x191x161 +		$M_{c,y,Rd}$	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
$N_{pl,Rd}$ = 5460	n/a	$M_{c,z,Rd}$	178	178	178	178	178	178	178	178	178	178	178
	1.00	$M_{N,y,Rd}$	1000	1000	989	865	742	618	495	371	247	124	0
		$M_{N,z,Rd}$	178	178	178	178	178	171	156	131	96.4	52.9	0

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✖ Section becomes Class 4, see note 10.
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- Not applicable for Class 3 and Class 4 sections.
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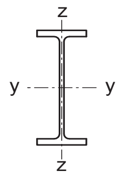
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



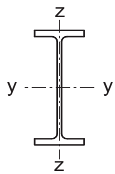
Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 533x210x101	0.845	$N_{b,y,Rd}$	3420	3420	3410	3370	3330	3290	3250	3200	3140	3080	3020	2940	2860
$N_{pl,Rd}$ = 3420		$N_{b,z,Rd}$	3030	2600	2060	1570	1190	921	729	590	487	408	346	298	259
$f_y W_{el,y}$ = 607	0.845	$M_{b,Rd}$	607	542	479	418	365	320	283	253	228	208	191	177	164
$f_y W_{el,z}$ = 67.8	**0.260**	$M_{b,Rd}$	681	602	523	450	387	336	295	262	236	214	196	181	168
* 533x210x92	0.734	$N_{b,y,Rd}$	3220	3220	3210	3170	3130	3090	3040	3000	2940	2880	2820	2740	2660
$N_{pl,Rd}$ = 3220		$N_{b,z,Rd}$	2830	2400	1880	1410	1060	820	649	524	432	362	307	264	229
$f_y W_{el,y}$ = 570	0.734	$M_{b,Rd}$	565	502	438	378	326	282	248	220	197	178	163	150	139
$f_y W_{el,z}$ = 62.7	**0.217**	$M_{b,Rd}$	634	556	478	406	344	296	257	227	203	183	167	154	140
* 533x210x82	0.673	$N_{b,y,Rd}$	2890	2890	2880	2840	2810	2770	2730	2680	2630	2580	2510	2440	2370
$N_{pl,Rd}$ = 2890		$N_{b,z,Rd}$	2520	2110	1630	1210	910	700	552	446	367	307	261	224	195
$f_y W_{el,y}$ = 495	0.673	$M_{b,Rd}$	488	431	373	319	271	232	202	177	158	142	130	119	109
$f_y W_{el,z}$ = 52.8	**0.201**	$M_{b,Rd}$	549	479	407	341	286	243	209	183	163	146	132	119	109
* 533x165x85 +	0.782	$N_{b,y,Rd}$	2860	2860	2850	2820	2780	2750	2710	2660	2610	2560	2500	2430	2360
$N_{pl,Rd}$ = 2860		$N_{b,z,Rd}$	2310	1730	1200	842	614	465	364	292	239	200	169	145	126
$f_y W_{el,y}$ = 481	0.782	$M_{b,Rd}$	435	350	283	233	197	170	150	134	121	110	102	94.4	88.1
$f_y W_{el,z}$ = 40.5	**0.264**	$M_{b,Rd}$	487	383	304	247	207	178	155	138	125	114	105	97.0	90.4
* 533x165x74 +	0.686	$N_{b,y,Rd}$	2620	2620	2610	2570	2540	2500	2460	2420	2370	2320	2260	2190	2120
$N_{pl,Rd}$ = 2620		$N_{b,z,Rd}$	2050	1490	1000	696	505	381	298	239	195	163	138	118	102
$f_y W_{el,y}$ = 427	0.686	$M_{b,Rd}$	377	297	236	191	159	135	118	104	93.8	85.2	78.2	72.2	67.2
$f_y W_{el,z}$ = 34.4	**0.230**	$M_{b,Rd}$	422	325	253	202	166	141	122	108	96.6	87.6	80.2	74.1	68.8
* 533x165x66 +	0.588	$N_{b,y,Rd}$	2300	2300	2290	2260	2230	2200	2160	2120	2080	2030	1980	1920	1850
$N_{pl,Rd}$ = 2300		$N_{b,z,Rd}$	1780	1260	841	580	420	317	247	198	162	135	114	98.0	84.9
$f_y W_{el,y}$ = 367	0.588	$M_{b,Rd}$	320	249	195	156	128	108	93.4	82.2	73.4	66.4	60.7	55.9	51.9
$f_y W_{el,z}$ = 28.6	**0.185**	$M_{b,Rd}$	359	272	209	164	134	112	96.6	84.8	75.6	68.2	62.2	57.3	53.1
457x191x161 +	1.00	$N_{b,y,Rd}$	5460	5460	5420	5350	5280	5200	5110	5020	4910	4790	4660	4500	4330
$N_{pl,Rd}$ = 5460		$N_{b,z,Rd}$	4830	4130	3280	2490	1890	1460	1160	935	771	646	549	472	410
$f_y W_{el,y}$ = 859	**1.00**	$M_{b,Rd}$	995	901	819	746	682	627	578	536	499	466	437	412	389
$f_y W_{el,z}$ = 113															

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
n = N_{Ed} / $N_{pl,Rd}$
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.
For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



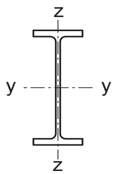
Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
457x191x133 +		$M_{c,y,Rd}$	814	814	814	814	814	814	814	814	814	814	814
$N_{pl,Rd}$ = 4510	n/a	$M_{c,z,Rd}$	142	142	142	142	142	142	142	142	142	142	142
	1.00	$M_{N,y,Rd}$	814	814	809	708	607	506	405	303	202	101	0
		$M_{N,z,Rd}$	142	142	142	142	142	137	125	105	77.9	42.8	0
457x191x106 +		$M_{c,y,Rd}$	633	633	633	633	633	633	633	633	633	633	633
$N_{pl,Rd}$ = 3580	n/a	$M_{c,z,Rd}$	107	107	107	107	107	107	107	107	107	107	107
	1.00	$M_{N,y,Rd}$	633	633	633	557	477	398	318	239	159	79.5	0
		$M_{N,z,Rd}$	107	107	107	107	107	105	96.0	81.2	60.3	33.2	0
457x191x98		$M_{c,y,Rd}$	591	591	591	591	591	591	591	591	591	591	591
$N_{pl,Rd}$ = 3310	n/a	$M_{c,z,Rd}$	100	100	100	100	100	100	100	100	100	100	100
	1.00	$M_{N,y,Rd}$	591	591	590	516	442	369	295	221	147	73.7	0
		$M_{N,z,Rd}$	100	100	100	100	100	97.4	88.9	74.9	55.5	30.5	0
457x191x89		$M_{c,y,Rd}$	534	534	534	534	469	469	469	469	469	469	469
$N_{pl,Rd}$ = 3020	1.00	$M_{c,z,Rd}$	89.6	89.6	89.6	89.6	57.8	57.8	57.8	57.8	57.8	57.8	57.8
	0.321	$M_{N,y,Rd}$	534	534	534	468	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	89.6	89.6	89.6	89.6	-	-	-	-	-	-	-
457x191x82		$M_{c,y,Rd}$	504	504	504	443	443	443	443	443	443	443	$
$N_{pl,Rd}$ = 2860	0.915	$M_{c,z,Rd}$	83.6	83.6	83.6	53.9	53.9	53.9	53.9	53.9	53.9	53.9	$
	0.283	$M_{N,y,Rd}$	504	504	504	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	83.6	83.6	83.6	-	-	-	-	-	-	-	-
457x191x74		$M_{c,y,Rd}$	455	455	455	401	401	401	401	401	✖	✖	$
$N_{pl,Rd}$ = 2600	0.786	$M_{c,z,Rd}$	74.8	74.8	74.8	48.4	48.4	48.4	48.4	48.4	✖	✖	$
	0.227	$M_{N,y,Rd}$	455	455	455	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	74.8	74.8	74.8	-	-	-	-	-	-	-	-
457x191x67		$M_{c,y,Rd}$	405	405	405	356	356	356	356	356	✖	✖	$
$N_{pl,Rd}$ = 2350	0.714	$M_{c,z,Rd}$	65.2	65.2	65.2	42.1	42.1	42.1	42.1	42.1	✖	✖	$
	0.205	$M_{N,y,Rd}$	405	405	405	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	65.2	65.2	65.2	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
457x191x133 +	1.00	$N_{b,y,Rd}$	4510	4510	4470	4410	4350	4280	4210	4130	4040	3940	3820	3690	3540
$N_{pl,Rd}$ = 4510		$N_{b,z,Rd}$	3960	3360	2640	1980	1500	1150	913	738	608	509	432	372	323
$f_y W_{el,y}$ = 704	**1.00**	$M_{b,Rd}$	801	718	642	575	517	468	426	391	360	335	312	292	275
$f_y W_{el,z}$ = 90.4															
457x191x106 +	1.00	$N_{b,y,Rd}$	3580	3580	3550	3500	3450	3390	3330	3270	3190	3110	3010	2900	2780
$N_{pl,Rd}$ = 3580		$N_{b,z,Rd}$	3130	2620	2030	1510	1140	874	690	557	459	384	326	280	243
$f_y W_{el,y}$ = 552	**1.00**	$M_{b,Rd}$	617	545	479	419	368	327	293	265	242	222	206	192	180
$f_y W_{el,z}$ = 68.6															
457x191x98	1.00	$N_{b,y,Rd}$	3310	3310	3290	3240	3190	3140	3090	3030	2960	2880	2790	2690	2580
$N_{pl,Rd}$ = 3310		$N_{b,z,Rd}$	2900	2430	1880	1400	1060	813	642	518	427	357	303	261	226
$f_y W_{el,y}$ = 519	**1.00**	$M_{b,Rd}$	575	507	443	386	337	297	265	239	218	200	185	172	161
$f_y W_{el,z}$ = 64.4															
457x191x89	1.00	$N_{b,y,Rd}$	3020	3020	3000	2950	2910	2860	2810	2760	2690	2620	2540	2450	2340
$N_{pl,Rd}$ = 3020		$N_{b,z,Rd}$	2630	2210	1700	1260	948	729	576	465	383	320	272	234	203
$f_y W_{el,y}$ = 469	1.00	$M_{b,Rd}$	462	410	361	316	277	244	218	197	179	164	151	141	131
$f_y W_{el,z}$ = 57.8	**0.321**	$M_{b,Rd}$	517	454	393	339	293	256	227	204	185	169	155	144	135
* 457x191x82	0.915	$N_{b,y,Rd}$	2860	2860	2830	2790	2750	2700	2650	2600	2530	2460	2380	2280	2180
$N_{pl,Rd}$ = 2860		$N_{b,z,Rd}$	2470	2040	1550	1140	850	652	514	414	341	285	242	208	180
$f_y W_{el,y}$ = 443	0.915	$M_{b,Rd}$	433	381	332	286	248	216	191	171	155	141	130	120	112
$f_y W_{el,z}$ = 53.9	**0.283**	$M_{b,Rd}$	484	421	360	305	261	226	199	177	159	145	133	123	114
* 457x191x74	0.786	$N_{b,y,Rd}$	2600	2600	2580	2540	2500	2460	2410	2360	2300	2240	2160	2080	1980
$N_{pl,Rd}$ = 2600		$N_{b,z,Rd}$	2240	1850	1400	1020	764	586	461	372	306	256	217	187	162
$f_y W_{el,y}$ = 401	0.786	$M_{b,Rd}$	390	343	296	253	217	188	165	147	132	120	110	102	94.4
$f_y W_{el,z}$ = 48.4	**0.227**	$M_{b,Rd}$	435	377	320	269	228	195	171	151	135	123	112	103	94.5
* 457x191x67	0.714	$N_{b,y,Rd}$	2350	2350	2330	2290	2260	2220	2170	2130	2070	2010	1940	1860	1770
$N_{pl,Rd}$ = 2350		$N_{b,z,Rd}$	2020	1650	1230	899	669	512	403	324	267	223	189	163	141
$f_y W_{el,y}$ = 356	0.714	$M_{b,Rd}$	346	302	258	218	185	159	138	122	109	98.8	90.2	82.9	75.8
$f_y W_{el,z}$ = 42.1	**0.205**	$M_{b,Rd}$	385	331	278	231	194	165	143	125	112	101	91.6	82.9	75.8

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+ These sections are in addition to the range of BS 4 sections

n = N_{Ed} / $N_{pl,Rd}$

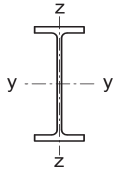
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.

Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
457x152x82		$M_{c,y,Rd}$	480	480	480	480	416	416	416	416	416	416	416
$N_{pl,Rd}$ = 2780	1.00	$M_{c,z,Rd}$	63.6	63.6	63.6	63.6	40.5	40.5	40.5	40.5	40.5	40.5	40.5
	0.349	$M_{N,y,Rd}$	480	480	480	431	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	63.6	63.6	63.6	63.6	-	-	-	-	-	-	-
457x152x74		$M_{c,y,Rd}$	431	431	431	375	375	375	375	375	375	✖	$
$N_{pl,Rd}$ = 2500	0.897	$M_{c,z,Rd}$	56.4	56.4	56.4	36.0	36.0	36.0	36.0	36.0	36.0	✖	$
	0.294	$M_{N,y,Rd}$	431	431	431	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	56.4	56.4	56.4	-	-	-	-	-	-	-	-
457x152x67		$M_{c,y,Rd}$	400	400	400	347	347	347	347	347	✖	✖	$
$N_{pl,Rd}$ = 2350	0.786	$M_{c,z,Rd}$	51.4	51.4	51.4	32.7	32.7	32.7	32.7	32.7	✖	✖	$
	0.251	$M_{N,y,Rd}$	400	400	400	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	51.4	51.4	51.4	-	-	-	-	-	-	-	-
457x152x60		$M_{c,y,Rd}$	354	354	309	309	309	309	309	✖	✖	✖	$
$N_{pl,Rd}$ = 2100	0.657	$M_{c,z,Rd}$	44.8	44.8	28.6	28.6	28.6	28.6	28.6	✖	✖	✖	$
	0.192	$M_{N,y,Rd}$	354	354	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	44.8	44.8	-	-	-	-	-	-	-	-	-
457x152x52		$M_{c,y,Rd}$	301	301	261	261	261	261	✖	✖	✖	$	$
$N_{pl,Rd}$ = 1830	0.586	$M_{c,z,Rd}$	36.6	36.6	23.4	23.4	23.4	23.4	✖	✖	✖	$	$
	0.169	$M_{N,y,Rd}$	301	301	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	36.6	36.6	-	-	-	-	-	-	-	-	-
406x178x85 +		$M_{c,y,Rd}$	459	459	459	459	459	459	459	459	459	459	459
$N_{pl,Rd}$ = 2890	n/a	$M_{c,z,Rd}$	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9
	1.00	$M_{N,y,Rd}$	459	459	457	400	343	286	229	171	114	57.1	0
		$M_{N,z,Rd}$	82.9	82.9	82.9	82.9	82.9	80.3	73.3	61.7	45.6	25.1	0
406x178x74		$M_{c,y,Rd}$	413	413	413	413	364	364	364	364	364	364	364
$N_{pl,Rd}$ = 2600	1.00	$M_{c,z,Rd}$	73.4	73.4	73.4	73.4	47.3	47.3	47.3	47.3	47.3	47.3	47.3
	0.313	$M_{N,y,Rd}$	413	413	411	359	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	73.4	73.4	73.4	73.4	-	-	-	-	-	-	-

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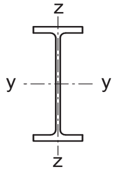
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
457x152x82	1.00	$N_{b,y,Rd}$	2780	2780	2780	2780	2780	2780	2760	2720	2680	2630	2590	2530	2470
$N_{pl,Rd}$ = 2780		$N_{b,z,Rd}$	2650	2460	2230	1950	1650	1370	1130	791	576	436	341	273	224
$f_y W_{el,y}$ = 416	1.00	$M_{b,Rd}$	416	416	388	360	333	307	283	242	209	183	163	147	134
$f_y W_{el,z}$ = 40.5	**0.349**	$M_{b,Rd}$	480	472	436	401	367	335	306	257	220	191	169	152	138
* 457x152x74	0.897	$N_{b,y,Rd}$	2500	2500	2500	2500	2500	2500	2480	2450	2410	2370	2330	2280	2220
$N_{pl,Rd}$ = 2500		$N_{b,z,Rd}$	2380	2200	1990	1740	1470	1210	1000	698	507	384	300	240	197
$f_y W_{el,y}$ = 375	0.897	$M_{b,Rd}$	375	373	347	321	295	271	248	209	179	156	138	123	112
$f_y W_{el,z}$ = 36.0	**0.294**	$M_{b,Rd}$	431	422	389	356	325	294	267	221	187	162	142	127	115
* 457x152x67	0.786	$N_{b,y,Rd}$	2350	2350	2350	2350	2350	2340	2330	2290	2260	2220	2180	2130	2070
$N_{pl,Rd}$ = 2350		$N_{b,z,Rd}$	2220	2050	1840	1590	1320	1080	889	616	447	337	263	211	173
$f_y W_{el,y}$ = 347	0.786	$M_{b,Rd}$	347	343	317	291	266	241	219	181	153	132	115	103	92.7
$f_y W_{el,z}$ = 32.7	**0.251**	$M_{b,Rd}$	400	388	355	323	291	261	235	191	159	136	119	106	94.9
* 457x152x60	0.657	$N_{b,y,Rd}$	2100	2100	2100	2100	2100	2090	2070	2040	2010	1970	1930	1890	1840
$N_{pl,Rd}$ = 2100		$N_{b,z,Rd}$	1980	1820	1630	1400	1160	948	777	537	389	293	229	183	150
$f_y W_{el,y}$ = 309	0.657	$M_{b,Rd}$	309	304	280	256	232	210	189	154	128	109	95.3	84.3	75.6
$f_y W_{el,z}$ = 28.6	**0.192**	$M_{b,Rd}$	354	342	313	283	253	226	201	162	133	113	97.9	86.3	76.3
* 457x152x52	0.586	$N_{b,y,Rd}$	1830	1830	1830	1830	1830	1820	1810	1780	1750	1720	1680	1640	1600
$N_{pl,Rd}$ = 1830		$N_{b,z,Rd}$	1720	1570	1390	1180	968	785	639	439	317	239	186	149	122
$f_y W_{el,y}$ = 261	0.586	$M_{b,Rd}$	261	255	234	213	192	171	153	123	101	84.6	72.9	64.0	56.3
$f_y W_{el,z}$ = 23.4	**0.169**	$M_{b,Rd}$	301	289	263	236	209	185	163	128	104	87.1	74.8	64.5	56.3
406x178x85 +	1.00	$N_{b,y,Rd}$	2890	2890	2890	2890	2890	2870	2850	2800	2750	2700	2640	2580	2500
$N_{pl,Rd}$ = 2890		$N_{b,z,Rd}$	2810	2660	2490	2280	2050	1790	1540	1130	844	647	509	411	338
$f_y W_{el,y}$ = 403	**1.00**	$M_{b,Rd}$	459	459	441	413	387	361	336	292	255	225	202	182	166
$f_y W_{el,z}$ = 53.3															
406x178x74	1.00	$N_{b,y,Rd}$	2600	2600	2600	2600	2600	2580	2560	2520	2470	2420	2370	2300	2230
$N_{pl,Rd}$ = 2600		$N_{b,z,Rd}$	2520	2380	2210	2020	1790	1550	1330	964	715	546	429	346	284
$f_y W_{el,y}$ = 364	1.00	$M_{b,Rd}$	364	364	351	330	308	287	267	231	201	177	157	142	129
$f_y W_{el,z}$ = 47.3	**0.313**	$M_{b,Rd}$	413	413	392	365	339	313	289	246	212	185	163	146	133

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

\+ These sections are in addition to the range of BS 4 sections

n = N_{Ed} / $N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.

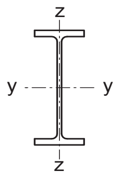
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB

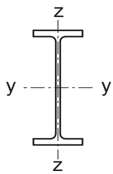


Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
406x178x67		$M_{c,y,Rd}$	370	370	370	327	327	327	327	327	327	327	$
$N_{pl,Rd}$ = 2350	0.922	$M_{c,z,Rd}$	65.2	65.2	65.2	42.1	42.1	42.1	42.1	42.1	42.1	42.1	$
	0.274	$M_{N,y,Rd}$	370	370	370	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	65.2	65.2	65.2	-	-	-	-	-	-	-	-
406x178x60		$M_{c,y,Rd}$	330	330	330	292	292	292	292	292	✖	✖	$
$N_{pl,Rd}$ = 2100	0.777	$M_{c,z,Rd}$	57.5	57.5	57.5	37.1	37.1	37.1	37.1	37.1	✖	✖	$
	0.214	$M_{N,y,Rd}$	330	330	330	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	57.5	57.5	57.5	-	-	-	-	-	-	-	-
406x178x54		$M_{c,y,Rd}$	290	290	290	256	256	256	256	256	✖	✖	$
$N_{pl,Rd}$ = 1900	0.744	$M_{c,z,Rd}$	49.0	49.0	49.0	31.6	31.6	31.6	31.6	31.6	✖	✖	$
	0.217	$M_{N,y,Rd}$	290	290	290	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	49.0	49.0	49.0	-	-	-	-	-	-	-	-
406x140x53 +		$M_{c,y,Rd}$	284	284	284	247	247	247	247	247	✖	✖	$
$N_{pl,Rd}$ = 1870	0.777	$M_{c,z,Rd}$	38.2	38.2	38.2	24.5	24.5	24.5	24.5	24.5	✖	✖	$
	0.241	$M_{N,y,Rd}$	284	284	284	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	38.2	38.2	38.2	-	-	-	-	-	-	-	-
406x140x46		$M_{c,y,Rd}$	244	244	214	214	214	214	✖	✖	✖	✖	$
$N_{pl,Rd}$ = 1610	0.599	$M_{c,z,Rd}$	32.5	32.5	20.9	20.9	20.9	20.9	✖	✖	✖	✖	$
	0.158	$M_{N,y,Rd}$	244	244	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	32.5	32.5	-	-	-	-	-	-	-	-	-
406x140x39		$M_{c,y,Rd}$	199	199	173	173	173	173	✖	✖	✖	$	$
$N_{pl,Rd}$ = 1370	0.534	$M_{c,z,Rd}$	25.0	25.0	16.0	16.0	16.0	16.0	✖	✖	✖	$	$
	0.142	$M_{N,y,Rd}$	199	199	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	25.0	25.0	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 406x178x67	0.922	$N_{b,y,Rd}$	2350	2350	2350	2350	2350	2330	2310	2280	2230	2190	2140	2080	2010
$N_{pl,Rd}$ = 2350		$N_{b,z,Rd}$	2280	2150	1990	1810	1610	1390	1180	855	633	483	380	306	251
$f_y W_{el,y}$ = 327	0.922	$M_{b,Rd}$	327	327	314	294	274	255	236	202	173	151	133	119	108
$f_y W_{el,z}$ = 42.1	**0.274**	$M_{b,Rd}$	370	370	350	325	301	277	254	214	182	157	138	123	111
* 406x178x60	0.777	$N_{b,y,Rd}$	2100	2100	2100	2100	2100	2090	2070	2030	2000	1960	1910	1860	1800
$N_{pl,Rd}$ = 2100		$N_{b,z,Rd}$	2040	1920	1780	1620	1430	1240	1050	759	562	429	337	271	223
$f_y W_{el,y}$ = 292	0.777	$M_{b,Rd}$	292	292	280	261	243	224	207	175	149	128	112	99.9	89.9
$f_y W_{el,z}$ = 37.1	**0.214**	$M_{b,Rd}$	330	330	310	288	265	243	222	185	155	133	116	103	92.1
* 406x178x54	0.744	$N_{b,y,Rd}$	1900	1900	1900	1900	1890	1880	1860	1830	1800	1760	1720	1670	1610
$N_{pl,Rd}$ = 1900		$N_{b,z,Rd}$	1830	1720	1590	1430	1260	1080	910	652	480	366	287	231	190
$f_y W_{el,y}$ = 256	0.744	$M_{b,Rd}$	256	256	243	227	209	193	176	147	124	106	91.7	80.9	72.4
$f_y W_{el,z}$ = 31.6	**0.217**	$M_{b,Rd}$	290	290	271	250	229	209	189	155	129	109	94.4	83.0	74.0
* 406x140x53 +	0.777	$N_{b,y,Rd}$	1870	1870	1870	1870	1860	1850	1830	1800	1770	1730	1690	1640	1580
$N_{pl,Rd}$ = 1870		$N_{b,z,Rd}$	1750	1600	1410	1190	967	781	635	435	314	237	184	148	121
$f_y W_{el,y}$ = 247	0.777	$M_{b,Rd}$	247	240	220	200	181	163	147	120	101	86.5	75.7	67.4	60.7
$f_y W_{el,z}$ = 24.5	**0.241**	$M_{b,Rd}$	284	270	245	221	197	175	156	126	105	89.2	77.8	69.0	61.3
* 406x140x46	0.599	$N_{b,y,Rd}$	1610	1610	1610	1610	1610	1600	1580	1560	1530	1490	1460	1410	1360
$N_{pl,Rd}$ = 1610		$N_{b,z,Rd}$	1500	1370	1210	1010	824	665	539	369	266	200	156	125	102
$f_y W_{el,y}$ = 214	0.599	$M_{b,Rd}$	214	207	189	171	153	137	122	98.2	81.2	68.9	59.8	52.8	46.8
$f_y W_{el,z}$ = 20.9	**0.158**	$M_{b,Rd}$	244	232	210	187	166	146	129	102	83.9	70.8	61.2	53.3	46.8
* 406x140x39	0.534	$N_{b,y,Rd}$	1370	1370	1370	1370	1360	1350	1340	1320	1290	1260	1230	1190	1140
$N_{pl,Rd}$ = 1370		$N_{b,z,Rd}$	1260	1140	988	813	650	519	418	284	204	154	120	95.6	78.2
$f_y W_{el,y}$ = 173	0.534	$M_{b,Rd}$	173	165	150	134	119	105	92.3	72.6	58.9	49.3	42.3	36.4	31.7
$f_y W_{el,z}$ = 16.0	**0.142**	$M_{b,Rd}$	199	186	167	148	129	112	97.4	75.5	60.8	50.5	42.6	36.4	31.7

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

n = N_{Ed} / $N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.

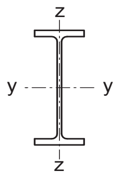
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
356x171x67		$M_{c,y,Rd}$	333	333	333	333	333	333	333	333	333	333	333
$N_{pl,Rd}$ = 2350	n/a	$M_{c,z,Rd}$	66.8	66.8	66.8	66.8	66.8	66.8	66.8	66.8	66.8	66.8	66.8
	1.00	$M_{N,y,Rd}$	333	333	326	285	244	204	163	122	81.4	40.7	0
		$M_{N,z,Rd}$	66.8	66.8	66.8	66.8	66.6	63.8	57.6	48.2	35.4	19.4	0
356x171x57		$M_{c,y,Rd}$	278	278	278	246	246	246	246	246	246	246	246
$N_{pl,Rd}$ = 2000	1.00	$M_{c,z,Rd}$	54.7	54.7	54.7	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5
	0.292	$M_{N,y,Rd}$	278	278	275	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	54.7	54.7	54.7	-	-	-	-	-	-	-	-
356x171x51		$M_{c,y,Rd}$	246	246	246	219	219	219	219	219	219	✖	$
$N_{pl,Rd}$ = 1780	0.883	$M_{c,z,Rd}$	47.9	47.9	47.9	31.1	31.1	31.1	31.1	31.1	31.1	✖	$
	0.247	$M_{N,y,Rd}$	246	246	245	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	47.9	47.9	47.9	-	-	-	-	-	-	-	-
356x171x45		$M_{c,y,Rd}$	213	213	213	189	189	189	189	189	189	✖	$
$N_{pl,Rd}$ = 1580	0.808	$M_{c,z,Rd}$	40.4	40.4	40.4	26.1	26.1	26.1	26.1	26.1	26.1	✖	$
	0.232	$M_{N,y,Rd}$	213	213	213	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	40.4	40.4	40.4	-	-	-	-	-	-	-	-
356x127x39		$M_{c,y,Rd}$	181	181	181	158	158	158	158	158	✖	✖	$
$N_{pl,Rd}$ = 1370	0.734	$M_{c,z,Rd}$	24.5	24.5	24.5	15.7	15.7	15.7	15.7	15.7	✖	✖	$
	0.218	$M_{N,y,Rd}$	181	181	181	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	24.5	24.5	24.5	-	-	-	-	-	-	-	-
356x127x33		$M_{c,y,Rd}$	149	149	130	130	130	130	130	✖	✖	✖	$
$N_{pl,Rd}$ = 1160	0.621	$M_{c,z,Rd}$	19.3	19.3	12.4	12.4	12.4	12.4	12.4	✖	✖	✖	$
	0.179	$M_{N,y,Rd}$	149	149	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	19.3	19.3	-	-	-	-	-	-	-	-	-

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N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

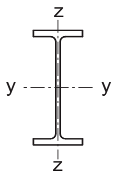
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
356x171x67	1.00	$N_{b,y,Rd}$	2350	2350	2350	2350	2340	2320	2300	2250	2200	2150	2080	2010	1920
$N_{pl,Rd}$ = 2350		$N_{b,z,Rd}$	2280	2150	1990	1810	1610	1390	1180	855	633	483	380	306	251
$f_y W_{el,y}$ = 295	**1.00**	$M_{b,Rd}$	333	333	315	294	273	253	235	202	175	154	137	124	113
$f_y W_{el,z}$ = 43.2															
356x171x57	1.00	$N_{b,y,Rd}$	2000	2000	2000	2000	1980	1970	1950	1910	1870	1820	1760	1700	1620
$N_{pl,Rd}$ = 2000		$N_{b,z,Rd}$	1930	1810	1680	1520	1340	1150	978	703	519	396	311	250	205
$f_y W_{el,y}$ = 246	1.00	$M_{b,Rd}$	246	246	235	220	204	190	175	150	129	113	100	89.8	81.4
$f_y W_{el,z}$ = 35.5	**0.292**	$M_{b,Rd}$	278	278	260	242	223	205	188	159	135	117	103	92.4	83.5
* 356x171x51	0.883	$N_{b,y,Rd}$	1780	1780	1780	1780	1770	1760	1740	1710	1670	1620	1570	1510	1440
$N_{pl,Rd}$ = 1780		$N_{b,z,Rd}$	1720	1620	1500	1350	1190	1020	859	616	454	346	271	218	179
$f_y W_{el,y}$ = 219	0.883	$M_{b,Rd}$	219	219	208	194	180	166	152	129	110	94.9	83.4	74.3	67.0
$f_y W_{el,z}$ = 31.1	**0.247**	$M_{b,Rd}$	246	246	230	213	196	179	163	136	114	98.2	85.9	76.2	68.6
* 356x171x45	0.808	$N_{b,y,Rd}$	1580	1580	1580	1580	1560	1550	1530	1500	1470	1430	1380	1320	1260
$N_{pl,Rd}$ = 1580		$N_{b,z,Rd}$	1520	1420	1310	1170	1020	870	732	521	383	291	228	183	151
$f_y W_{el,y}$ = 189	0.808	$M_{b,Rd}$	189	189	178	165	153	140	128	106	89.3	76.3	66.4	58.7	52.6
$f_y W_{el,z}$ = 26.1	**0.232**	$M_{b,Rd}$	213	213	197	182	166	151	136	112	92.9	78.8	68.2	60.1	53.7
* 356x127x39	0.734	$N_{b,y,Rd}$	1370	1370	1370	1370	1360	1340	1330	1300	1270	1240	1190	1140	1090
$N_{pl,Rd}$ = 1370		$N_{b,z,Rd}$	1250	1110	941	754	592	466	373	252	181	135	105	84.0	68.7
$f_y W_{el,y}$ = 158	0.734	$M_{b,Rd}$	158	148	134	119	105	93.3	82.9	66.8	55.6	47.6	41.6	36.9	32.7
$f_y W_{el,z}$ = 15.7	**0.218**	$M_{b,Rd}$	181	166	148	130	113	99.0	87.1	69.4	57.3	48.8	42.5	36.9	32.7
* 356x127x33	0.621	$N_{b,y,Rd}$	1160	1160	1160	1160	1150	1130	1120	1100	1070	1040	1000	958	906
$N_{pl,Rd}$ = 1160		$N_{b,z,Rd}$	1050	927	771	608	473	371	296	199	142	107	82.7	66.1	54.0
$f_y W_{el,y}$ = 130	0.621	$M_{b,Rd}$	130	120	108	94.8	82.8	72.2	63.2	49.9	40.8	34.5	29.7	25.6	22.6
$f_y W_{el,z}$ = 12.4	**0.179**	$M_{b,Rd}$	149	135	119	103	88.6	76.3	66.3	51.6	41.9	35.3	29.7	25.6	22.6

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

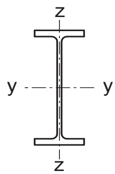
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
305x165x54		$M_{c,y,Rd}$	233	233	233	233	233	233	233	233	233	233	233
$N_{pl,Rd}$ = 1890	n/a	$M_{c,z,Rd}$	53.9	53.9	53.9	53.9	53.9	53.9	53.9	53.9	53.9	53.9	53.9
	1.00	$M_{N,y,Rd}$	233	233	224	196	168	140	112	83.9	55.9	28.0	0
		$M_{N,z,Rd}$	53.9	53.9	53.9	53.9	53.4	50.6	45.4	37.7	27.6	15.0	0
305x165x46		$M_{c,y,Rd}$	198	198	198	178	178	178	178	178	178	178	$
$N_{pl,Rd}$ = 1610	0.971	$M_{c,z,Rd}$	45.7	45.7	45.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	$
	0.240	$M_{N,y,Rd}$	198	198	190	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	45.7	45.7	45.7	-	-	-	-	-	-	-	-
305x165x40		$M_{c,y,Rd}$	171	171	154	154	154	154	154	154	154	✖	$
$N_{pl,Rd}$ = 1410	0.818	$M_{c,z,Rd}$	39.1	39.1	25.6	25.6	25.6	25.6	25.6	25.6	25.6	✖	$
	0.193	$M_{N,y,Rd}$	171	171	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	39.1	39.1	-	-	-	-	-	-	-	-	-
305x127x48		$M_{c,y,Rd}$	196	196	196	196	196	196	196	196	196	196	196
$N_{pl,Rd}$ = 1680	n/a	$M_{c,z,Rd}$	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9
	1.00	$M_{N,y,Rd}$	196	196	196	174	149	124	99.4	74.6	49.7	24.9	0
		$M_{N,z,Rd}$	31.9	31.9	31.9	31.9	31.9	31.4	29.0	24.7	18.4	10.2	0
305x127x42		$M_{c,y,Rd}$	169	169	169	169	169	169	169	169	169	169	169
$N_{pl,Rd}$ = 1470	n/a	$M_{c,z,Rd}$	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
	1.00	$M_{N,y,Rd}$	169	169	169	151	130	108	86.4	64.8	43.2	21.6	0
		$M_{N,z,Rd}$	27.0	27.0	27.0	27.0	27.0	26.6	24.7	21.1	15.7	8.72	0
305x127x37		$M_{c,y,Rd}$	148	148	148	148	130	130	130	130	130	130	130
$N_{pl,Rd}$ = 1300	1.00	$M_{c,z,Rd}$	23.4	23.4	23.4	23.4	14.9	14.9	14.9	14.9	14.9	14.9	14.9
	0.355	$M_{N,y,Rd}$	148	148	148	133	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	23.4	23.4	23.4	23.4	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

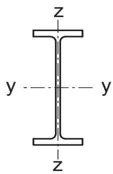
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
305x165x54	1.00	$N_{b,y,Rd}$	1890	1890	1890	1880	1860	1840	1820	1780	1730	1670	1600	1510	1410
$N_{pl,Rd}$ = 1890		$N_{b,z,Rd}$	1830	1720	1600	1450	1280	1100	933	672	496	379	297	239	196
$f_y W_{el,y}$ = 207	**1.00**	$M_{b,Rd}$	233	233	223	212	200	188	176	153	134	118	105	94.1	85.2
$f_y W_{el,z}$ = 34.9															
* 305x165x46	0.971	$N_{b,y,Rd}$	1610	1610	1610	1610	1590	1570	1560	1520	1480	1420	1360	1290	1200
$N_{pl,Rd}$ = 1610		$N_{b,z,Rd}$	1560	1470	1360	1230	1080	929	788	566	418	319	250	201	165
$f_y W_{el,y}$ = 178	0.971	$M_{b,Rd}$	178	178	171	163	154	145	136	118	103	89.7	79.4	71.1	63.9
$f_y W_{el,z}$ = 29.7	**0.240**	$M_{b,Rd}$	198	198	189	179	168	157	146	125	107	92.7	81.6	72.5	63.9
* 305x165x40	0.818	$N_{b,y,Rd}$	1410	1410	1410	1400	1390	1370	1360	1330	1290	1240	1190	1120	1040
$N_{pl,Rd}$ = 1410		$N_{b,z,Rd}$	1360	1280	1180	1070	937	803	679	487	359	273	214	173	142
$f_y W_{el,y}$ = 154	0.818	$M_{b,Rd}$	154	154	148	140	132	124	115	98.2	83.9	72.4	63.4	56.0	49.2
$f_y W_{el,z}$ = 25.6	**0.193**	$M_{b,Rd}$	171	171	163	153	144	133	123	103	87.0	74.5	64.9	56.0	49.2
305x127x48	1.00	$N_{b,y,Rd}$	1680	1680	1680	1670	1650	1640	1620	1580	1530	1470	1400	1310	1210
$N_{pl,Rd}$ = 1680		$N_{b,z,Rd}$	1540	1380	1180	951	751	594	477	322	231	173	135	108	88.0
$f_y W_{el,y}$ = 169	**1.00**	$M_{b,Rd}$	196	182	165	149	134	121	110	92.0	79.0	69.2	61.6	55.5	50.5
$f_y W_{el,z}$ = 20.4															
305x127x42	1.00	$N_{b,y,Rd}$	1470	1470	1470	1460	1440	1430	1410	1370	1330	1280	1210	1140	1050
$N_{pl,Rd}$ = 1470		$N_{b,z,Rd}$	1340	1200	1010	816	641	506	406	274	196	147	114	91.4	74.7
$f_y W_{el,y}$ = 147	**1.00**	$M_{b,Rd}$	169	156	140	125	111	99.5	89.3	73.6	62.4	54.2	47.9	43.0	38.9
$f_y W_{el,z}$ = 17.3															
305x127x37	1.00	$N_{b,y,Rd}$	1300	1300	1300	1290	1270	1260	1250	1210	1170	1130	1070	1000	921
$N_{pl,Rd}$ = 1300		$N_{b,z,Rd}$	1190	1050	889	711	558	439	352	237	170	127	99.0	79.1	64.6
$f_y W_{el,y}$ = 130	1.00	$M_{b,Rd}$	130	121	110	98.6	88.1	78.8	70.8	58.3	49.3	42.7	37.7	33.7	30.6
$f_y W_{el,z}$ = 14.9	**0.355**	$M_{b,Rd}$	148	136	121	108	94.9	84.0	74.7	60.7	51.0	43.9	38.6	34.5	30.6

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
$n = N_{Ed} / N_{pl,Rd}$
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.
For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

S275 / Advance® 275

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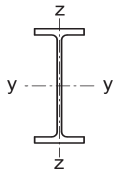
Advance® UKB

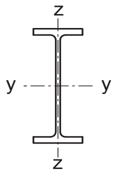


Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
305x102x33		$M_{c,y,Rd}$	132	132	132	132	114	114	114	114	114	✖	$
$N_{pl,Rd}$ = 1150	0.893	$M_{c,z,Rd}$	16.5	16.5	16.5	16.5	10.5	10.5	10.5	10.5	10.5	✖	$
	0.307	$M_{N,y,Rd}$	132	132	132	121	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	16.5	16.5	16.5	16.5	-	-	-	-	-	-	-
305x102x28		$M_{c,y,Rd}$	111	111	111	95.7	95.7	95.7	95.7	95.7	✖	✖	$
$N_{pl,Rd}$ = 987	0.767	$M_{c,z,Rd}$	13.2	13.2	13.2	8.53	8.53	8.53	8.53	8.53	✖	✖	$
	0.260	$M_{N,y,Rd}$	111	111	111	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	13.2	13.2	13.2	-	-	-	-	-	-	-	-
305x102x25		$M_{c,y,Rd}$	94.1	94.1	94.1	80.3	80.3	80.3	80.3	80.3	✖	✖	$
$N_{pl,Rd}$ = 869	0.724	$M_{c,z,Rd}$	10.7	10.7	10.7	6.60	6.60	6.60	6.60	6.60	✖	✖	$
	0.262	$M_{N,y,Rd}$	94.1	94.1	94.1	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	10.7	10.7	10.7	-	-	-	-	-	-	-	-
254x146x43		$M_{c,y,Rd}$	156	156	156	156	156	156	156	156	156	156	156
$N_{pl,Rd}$ = 1510	n/a	$M_{c,z,Rd}$	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8
	1.00	$M_{N,y,Rd}$	156	156	148	129	111	92.5	74.0	55.5	37.0	18.5	0
		$M_{N,z,Rd}$	38.8	38.8	38.8	38.8	38.2	36.0	32.1	26.6	19.4	10.5	0
254x146x37		$M_{c,y,Rd}$	133	133	133	133	133	133	133	133	133	133	133
$N_{pl,Rd}$ = 1300	n/a	$M_{c,z,Rd}$	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7
	1.00	$M_{N,y,Rd}$	133	133	127	111	95.1	79.2	63.4	47.5	31.7	15.8	0
		$M_{N,z,Rd}$	32.7	32.7	32.7	32.7	32.3	30.5	27.3	22.6	16.5	8.96	0
254x146x31		$M_{c,y,Rd}$	108	108	108	108	96.5	96.5	96.5	96.5	96.5	96.5	96.5
$N_{pl,Rd}$ = 1090	1.00	$M_{c,z,Rd}$	25.9	25.9	25.9	25.9	16.8	16.8	16.8	16.8	16.8	16.8	16.8
	0.308	$M_{N,y,Rd}$	108	108	106	92.7	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	25.9	25.9	25.9	25.9	-	-	-	-	-	-	-
254x102x28		$M_{c,y,Rd}$	97.1	97.1	97.1	97.1	84.7	84.7	84.7	84.7	84.7	84.7	84.7
$N_{pl,Rd}$ = 993	1.00	$M_{c,z,Rd}$	15.1	15.1	15.1	15.1	9.63	9.63	9.63	9.63	9.63	9.63	9.63
	0.380	$M_{N,y,Rd}$	97.1	97.1	97.1	86.8	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	15.1	15.1	15.1	15.1	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 305x102x33	0.893	$N_{b,y,Rd}$	1150	1150	1150	1140	1130	1120	1100	1080	1040	1000	954	895	827
$N_{pl,Rd}$ = 1150		$N_{b,z,Rd}$	998	830	635	469	351	270	213	141	100	74.8	57.9	46.2	37.7
$f_y W_{el,y}$ = 114	0.893	$M_{b,Rd}$	113	100	87.8	76.3	66.4	58.2	51.5	41.8	35.1	30.3	26.6	23.4	20.8
$f_y W_{el,z}$ = 10.5	**0.307**	$M_{b,Rd}$	128	112	96.6	82.4	70.7	61.3	53.8	43.2	36.1	31.0	26.6	23.4	20.8
* 305x102x28	0.767	$N_{b,y,Rd}$	987	987	987	979	969	958	946	921	891	854	810	756	695
$N_{pl,Rd}$ = 987		$N_{b,z,Rd}$	849	696	524	383	285	219	172	114	80.9	60.3	46.7	37.2	30.3
$f_y W_{el,y}$ = 95.7	0.767	$M_{b,Rd}$	93.7	82.5	71.3	60.9	52.1	45.0	39.4	31.3	25.9	22.1	18.9	16.5	14.7
$f_y W_{el,z}$ = 8.53	**0.260**	$M_{b,Rd}$	106	92.2	78.2	65.5	55.2	47.2	40.9	32.2	26.6	22.1	18.9	16.5	14.7
* 305x102x25	0.724	$N_{b,y,Rd}$	869	869	869	861	851	841	831	807	780	746	704	654	598
$N_{pl,Rd}$ = 869		$N_{b,z,Rd}$	734	587	430	310	229	175	137	90.7	64.2	47.9	37.0	29.5	24.0
$f_y W_{el,y}$ = 80.3	0.724	$M_{b,Rd}$	78.0	68.0	58.0	48.8	41.1	35.1	30.4	23.8	19.5	16.1	13.7	12.0	10.6
$f_y W_{el,z}$ = 6.60	**0.262**	$M_{b,Rd}$	89.3	76.5	63.7	52.5	43.5	36.7	31.5	24.5	19.6	16.1	13.7	12.0	10.6
254x146x43	1.00	$N_{b,y,Rd}$	1510	1510	1500	1490	1470	1450	1430	1380	1320	1250	1160	1050	943
$N_{pl,Rd}$ = 1510		$N_{b,z,Rd}$	1440	1340	1220	1070	917	766	637	447	326	247	193	155	127
$f_y W_{el,y}$ = 139	**1.00**	$M_{b,Rd}$	156	154	146	138	129	121	113	97.9	85.5	75.5	67.4	60.9	54.8
$f_y W_{el,z}$ = 25.3															
254x146x37	1.00	$N_{b,y,Rd}$	1300	1300	1290	1280	1260	1250	1230	1190	1130	1070	991	900	803
$N_{pl,Rd}$ = 1300		$N_{b,z,Rd}$	1240	1150	1040	918	781	650	539	378	275	208	163	131	107
$f_y W_{el,y}$ = 119	**1.00**	$M_{b,Rd}$	133	131	124	116	108	100	92.6	78.8	67.6	59.0	52.2	46.1	40.9
$f_y W_{el,z}$ = 21.5															
254x146x31	1.00	$N_{b,y,Rd}$	1090	1090	1090	1070	1060	1040	1030	992	946	888	817	736	653
$N_{pl,Rd}$ = 1090		$N_{b,z,Rd}$	1040	958	864	752	632	522	430	299	217	164	128	103	84.3
$f_y W_{el,y}$ = 96.5	1.00	$M_{b,Rd}$	96.5	95.5	90.3	84.7	78.9	72.9	67.0	56.3	47.8	41.2	36.2	31.4	27.7
$f_y W_{el,z}$ = 16.8	**0.308**	$M_{b,Rd}$	108	106	99.5	92.7	85.5	78.2	71.1	58.8	49.4	42.3	36.2	31.4	27.7
254x102x28	1.00	$N_{b,y,Rd}$	993	993	989	976	964	950	935	902	860	808	743	669	594
$N_{pl,Rd}$ = 993		$N_{b,z,Rd}$	869	732	569	425	320	246	195	129	92.0	68.7	53.2	42.4	34.6
$f_y W_{el,y}$ = 84.7	1.00	$M_{b,Rd}$	84.0	75.0	66.4	58.4	51.5	45.6	40.8	33.6	28.5	24.8	21.9	19.7	17.6
$f_y W_{el,z}$ = 9.63	**0.380**	$M_{b,Rd}$	94.7	83.5	72.8	63.1	54.8	48.1	42.7	34.8	29.3	25.4	22.4	19.7	17.6

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n = N_{Ed} / $N_{pl,Rd}$

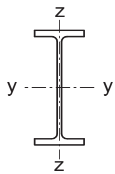
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.

Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
254x102x25		$M_{c,y,Rd}$	84.2	84.2	84.2	84.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2
$N_{pl,Rd}$ = 880	1.00	$M_{c,z,Rd}$	12.7	12.7	12.7	12.7	7.98	7.98	7.98	7.98	7.98	7.98	7.98
	0.372	$M_{N,y,Rd}$	84.2	84.2	84.2	76.8	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-
254x102x22		$M_{c,y,Rd}$	71.2	71.2	71.2	71.2	61.6	61.6	61.6	61.6	61.6	61.6	$
$N_{pl,Rd}$ = 770	0.974	$M_{c,z,Rd}$	10.2	10.2	10.2	10.2	6.33	6.33	6.33	6.33	6.33	6.33	$
	0.365	$M_{N,y,Rd}$	71.2	71.2	71.2	66.5	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	10.2	10.2	10.2	10.2	-	-	-	-	-	-	-
203x133x30		$M_{c,y,Rd}$	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4
$N_{pl,Rd}$ = 1050	n/a	$M_{c,z,Rd}$	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2
	1.00	$M_{N,y,Rd}$	86.4	86.4	82.6	72.3	61.9	51.6	41.3	31.0	20.6	10.3	0
		$M_{N,z,Rd}$	24.2	24.2	24.2	24.2	23.9	22.6	20.2	16.8	12.2	6.66	0
203x133x25		$M_{c,y,Rd}$	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0
$N_{pl,Rd}$ = 880	n/a	$M_{c,z,Rd}$	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
	1.00	$M_{N,y,Rd}$	71.0	71.0	68.8	60.2	51.6	43.0	34.4	25.8	17.2	8.60	0
		$M_{N,z,Rd}$	19.5	19.5	19.5	19.5	19.4	18.5	16.6	13.9	10.2	5.55	0
203x102x23		$M_{c,y,Rd}$	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4
$N_{pl,Rd}$ = 809	n/a	$M_{c,z,Rd}$	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
	1.00	$M_{N,y,Rd}$	64.4	64.4	62.6	54.8	47.0	39.1	31.3	23.5	15.7	7.83	0
		$M_{N,z,Rd}$	13.8	13.8	13.8	13.8	13.7	13.1	11.8	9.83	7.21	3.94	0
178x102x19		$M_{c,y,Rd}$	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0
$N_{pl,Rd}$ = 668	n/a	$M_{c,z,Rd}$	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
	1.00	$M_{N,y,Rd}$	47.0	47.0	45.4	39.7	34.0	28.4	22.7	17.0	11.3	5.67	0
		$M_{N,z,Rd}$	11.6	11.6	11.6	11.6	11.5	10.9	9.77	8.13	5.95	3.24	0
152x89x16		$M_{c,y,Rd}$	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8
$N_{pl,Rd}$ = 558	n/a	$M_{c,z,Rd}$	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53	8.53
	1.00	$M_{N,y,Rd}$	33.8	33.8	32.4	28.3	24.3	20.2	16.2	12.1	8.09	4.04	0
		$M_{N,z,Rd}$	8.53	8.53	8.53	8.53	8.42	7.96	7.12	5.91	4.31	2.35	0
127x76x13		$M_{c,y,Rd}$	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1
$N_{pl,Rd}$ = 454	n/a	$M_{c,z,Rd}$	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33
	1.00	$M_{N,y,Rd}$	23.1	23.1	21.7	19.0	16.3	13.6	10.9	8.15	5.43	2.72	0
		$M_{N,z,Rd}$	6.33	6.33	6.33	6.32	6.20	5.81	5.16	4.26	3.10	1.68	0

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N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

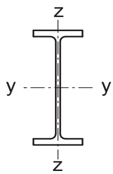
FOR EXPLANATION OF TABLES SEE NOTE 10.

BS EN 1993-1-1:2005
BS 4-1:2005

AXIAL FORCE & BENDING

S275 / Advance® 275

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
254x102x25	1.00	$N_{b,y,Rd}$	880	880	875	864	853	840	827	796	758	709	649	582	513
$N_{pl,Rd}$ = 880		$N_{b,z,Rd}$	764	635	486	359	269	207	163	108	76.8	57.3	44.4	35.4	28.8
$f_y W_{el,y}$ = 73.2	1.00	$M_{b,Rd}$	72.1	63.9	56.0	48.6	42.2	37.0	32.8	26.6	22.3	19.2	16.9	14.8	13.2
$f_y W_{el,z}$ = 7.98	**0.372**	$M_{b,Rd}$	81.5	71.3	61.3	52.3	44.9	38.9	34.2	27.4	22.9	19.7	16.9	14.8	13.2
* 254x102x22	0.974	$N_{b,y,Rd}$	770	770	765	755	745	734	722	694	658	613	559	498	438
$N_{pl,Rd}$ = 770		$N_{b,z,Rd}$	660	539	404	295	219	168	132	87.4	62.0	46.2	35.7	28.5	23.2
$f_y W_{el,y}$ = 61.6	0.974	$M_{b,Rd}$	60.2	53.0	45.8	39.1	33.5	29.0	25.4	20.2	16.8	14.4	12.3	10.8	9.59
$f_y W_{el,z}$ = 6.33	**0.365**	$M_{b,Rd}$	68.3	59.1	50.1	42.1	35.5	30.4	26.4	20.9	17.3	14.4	12.3	10.8	9.59
203x133x30	1.00	$N_{b,y,Rd}$	1050	1050	1040	1020	1000	983	961	909	840	753	657	563	481
$N_{pl,Rd}$ = 1050		$N_{b,z,Rd}$	988	907	807	689	568	463	378	260	188	142	111	88.7	72.6
$f_y W_{el,y}$ = 77.0	**1.00**	$M_{b,Rd}$	86.4	83.9	79.0	73.8	68.7	63.6	58.7	50.2	43.5	38.2	34.0	30.2	26.9
$f_y W_{el,z}$ = 15.7															
203x133x25	1.00	$N_{b,y,Rd}$	880	880	866	853	838	821	803	757	696	621	539	460	392
$N_{pl,Rd}$ = 880		$N_{b,z,Rd}$	825	755	668	565	463	375	306	210	152	114	89.0	71.3	58.3
$f_y W_{el,y}$ = 63.3	**1.00**	$M_{b,Rd}$	71.0	68.5	64.1	59.4	54.6	49.8	45.3	37.8	32.0	27.7	24.0	20.9	18.6
$f_y W_{el,z}$ = 12.7															
203x102x23	1.00	$N_{b,y,Rd}$	809	808	795	783	769	753	736	693	635	564	488	416	353
$N_{pl,Rd}$ = 809		$N_{b,z,Rd}$	719	619	495	378	288	223	177	118	84.1	62.9	48.7	38.9	31.7
$f_y W_{el,y}$ = 56.9	**1.00**	$M_{b,Rd}$	63.7	58.7	53.5	48.3	43.3	38.8	35.0	29.0	24.7	20.9	18.1	16.0	14.3
$f_y W_{el,z}$ = 8.80															
178x102x19	1.00	$N_{b,y,Rd}$	668	664	652	639	625	609	591	543	480	408	341	284	238
$N_{pl,Rd}$ = 668		$N_{b,z,Rd}$	595	513	411	314	239	186	147	98.3	70.1	52.4	40.6	32.4	26.4
$f_y W_{el,y}$ = 42.1	**1.00**	$M_{b,Rd}$	46.6	42.9	39.1	35.2	31.6	28.3	25.5	21.1	17.9	15.2	13.1	11.6	10.3
$f_y W_{el,z}$ = 7.43															
152x89x16	1.00	$N_{b,y,Rd}$	558	550	538	524	509	491	468	410	341	276	223	183	151
$N_{pl,Rd}$ = 558		$N_{b,z,Rd}$	481	396	300	220	164	126	99.0	65.6	46.6	34.7	26.9	21.4	17.5
$f_y W_{el,y}$ = 30.0	**1.00**	$M_{b,Rd}$	32.9	30.1	27.2	24.4	21.9	19.7	17.8	14.9	12.7	10.8	9.39	8.31	7.45
$f_y W_{el,z}$ = 5.50															
127x76x13	1.00	$N_{b,y,Rd}$	452	441	429	414	396	373	344	278	215	168	133	107	88.2
$N_{pl,Rd}$ = 454		$N_{b,z,Rd}$	374	289	204	145	106	80.7	63.2	41.6	29.5	21.9	16.9	13.5	11.0
$f_y W_{el,y}$ = 20.6	**1.00**	$M_{b,Rd}$	22.0	20.0	18.1	16.3	14.7	13.3	12.1	10.2	8.78	7.52	6.55	5.81	5.22
$f_y W_{el,z}$ = 4.13															

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$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

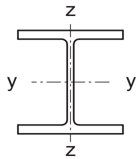
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
356x406x634		$M_{c,y,Rd}$	3490	3490	3490	3490	3490	3490	3490	3490	3490	3490	3490
$N_{pl,Rd}$ = 19800	n/a	$M_{c,z,Rd}$	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740
	1.00	$M_{N,y,Rd}$	3490	3470	3090	2700	2310	1930	1540	1160	772	386	0
		$M_{N,z,Rd}$	1740	1740	1740	1710	1630	1490	1300	1050	755	404	0
356x406x551		$M_{c,y,Rd}$	2960	2960	2960	2960	2960	2960	2960	2960	2960	2960	2960
$N_{pl,Rd}$ = 17200	n/a	$M_{c,z,Rd}$	1480	1480	1480	1480	1480	1480	1480	1480	1480	1480	1480
	1.00	$M_{N,y,Rd}$	2960	2950	2620	2300	1970	1640	1310	984	656	328	0
		$M_{N,z,Rd}$	1480	1480	1480	1460	1390	1270	1110	900	646	346	0
356x406x467		$M_{c,y,Rd}$	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550
$N_{pl,Rd}$ = 15200	n/a	$M_{c,z,Rd}$	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280
	1.00	$M_{N,y,Rd}$	2550	2550	2260	1980	1700	1410	1130	849	566	283	0
		$M_{N,z,Rd}$	1280	1280	1280	1260	1200	1100	960	780	559	300	0
356x406x393		$M_{c,y,Rd}$	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100
$N_{pl,Rd}$ = 12800	n/a	$M_{c,z,Rd}$	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060
	1.00	$M_{N,y,Rd}$	2100	2100	1860	1630	1400	1170	932	699	466	233	0
		$M_{N,z,Rd}$	1060	1060	1060	1040	993	911	795	646	464	248	0
356x406x340		$M_{c,y,Rd}$	1780	1780	1780	1780	1780	1780	1780	1780	1780	1780	1780
$N_{pl,Rd}$ = 11000	n/a	$M_{c,z,Rd}$	904	904	904	904	904	904	904	904	904	904	904
	1.00	$M_{N,y,Rd}$	1780	1780	1590	1390	1190	992	794	595	397	198	0
		$M_{N,z,Rd}$	904	904	904	890	848	777	679	551	396	212	0
356x406x287		$M_{c,y,Rd}$	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540
$N_{pl,Rd}$ = 9700	n/a	$M_{c,z,Rd}$	782	782	782	782	782	782	782	782	782	782	782
	1.00	$M_{N,y,Rd}$	1540	1540	1370	1200	1030	858	686	515	343	172	0
		$M_{N,z,Rd}$	782	782	782	770	734	674	588	478	343	184	0
356x406x235		$M_{c,y,Rd}$	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240
$N_{pl,Rd}$ = 7920	n/a	$M_{c,z,Rd}$	632	632	632	632	632	632	632	632	632	632	632
	1.00	$M_{N,y,Rd}$	1240	1240	1110	967	829	691	553	415	276	138	0
		$M_{N,z,Rd}$	632	632	632	622	593	544	475	386	277	148	0

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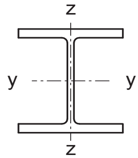
N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL COLUMNS
Advance® UKC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
356x406x634	1.00	$N_{b,y,Rd}$	19800	19800	19500	19100	18700	18200	17700	17200	16700	16100	15400	14700	14000
$N_{pl,Rd}$ = 19800		$N_{b,z,Rd}$	19800	18800	17800	16800	15600	14400	13200	12000	10800	9720	8720	7820	7030
$f_y W_{el,y}$ = 2840	**1.00**	$M_{b,Rd}$	3490	3490	3490	3490	3490	3490	3460	3420	3390	3350	3320	3280	3250
$f_y W_{el,z}$ = 1130															
356x406x551	1.00	$N_{b,y,Rd}$	17200	17200	16900	16600	16200	15800	15300	14900	14400	13800	13200	12600	12000
$N_{pl,Rd}$ = 17200		$N_{b,z,Rd}$	17200	16300	15400	14500	13500	12500	11400	10300	9310	8350	7480	6710	6030
$f_y W_{el,y}$ = 2440	**1.00**	$M_{b,Rd}$	2960	2960	2960	2960	2960	2950	2910	2870	2840	2810	2780	2750	2720
$f_y W_{el,z}$ = 968															
356x406x467	1.00	$N_{b,y,Rd}$	15200	15200	14900	14500	14200	13800	13400	12900	12400	11900	11400	10800	10200
$N_{pl,Rd}$ = 15200		$N_{b,z,Rd}$	15100	14300	13500	12600	11700	10800	9770	8790	7870	7030	6270	5600	5020
$f_y W_{el,y}$ = 2140	**1.00**	$M_{b,Rd}$	2550	2550	2550	2550	2540	2500	2470	2430	2400	2370	2340	2310	2280
$f_y W_{el,z}$ = 839															
356x406x393	1.00	$N_{b,y,Rd}$	12800	12800	12500	12200	11900	11500	11200	10800	10400	9910	9420	8910	8380
$N_{pl,Rd}$ = 12800		$N_{b,z,Rd}$	12700	12000	11300	10600	9770	8940	8100	7270	6490	5780	5140	4590	4110
$f_y W_{el,y}$ = 1780	**1.00**	$M_{b,Rd}$	2100	2100	2100	2100	2070	2030	2000	1970	1940	1910	1880	1850	1820
$f_y W_{el,z}$ = 694															
356x406x340	1.00	$N_{b,y,Rd}$	11000	11000	10800	10500	10200	9940	9620	9270	8900	8490	8050	7590	7130
$N_{pl,Rd}$ = 11000		$N_{b,z,Rd}$	11000	10400	9750	9100	8410	7680	6940	6220	5550	4930	4390	3910	3500
$f_y W_{el,y}$ = 1540	**1.00**	$M_{b,Rd}$	1780	1780	1780	1780	1750	1710	1680	1650	1620	1590	1560	1540	1510
$f_y W_{el,z}$ = 593															
356x406x287	1.00	$N_{b,y,Rd}$	9700	9680	9440	9200	8940	8660	8360	8040	7680	7300	6890	6470	6040
$N_{pl,Rd}$ = 9700		$N_{b,z,Rd}$	9600	9060	8500	7910	7270	6610	5950	5300	4710	4170	3700	3290	2940
$f_y W_{el,y}$ = 1340	**1.00**	$M_{b,Rd}$	1540	1540	1540	1520	1490	1450	1420	1390	1360	1330	1300	1270	1240
$f_y W_{el,z}$ = 514															
356x406x235	1.00	$N_{b,y,Rd}$	7920	7900	7700	7500	7290	7060	6810	6530	6240	5920	5580	5230	4880
$N_{pl,Rd}$ = 7920		$N_{b,z,Rd}$	7840	7390	6930	6430	5910	5370	4820	4290	3800	3360	2980	2650	2360
$f_y W_{el,y}$ = 1100	**1.00**	$M_{b,Rd}$	1240	1240	1240	1220	1180	1150	1120	1090	1060	1030	1010	979	953
$f_y W_{el,z}$ = 416															

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$n = N_{Ed} / N_{pl,Rd}$

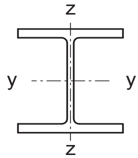
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
356x368x202		$M_{c,y,Rd}$	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
$N_{pl,Rd}$ = 6810	n/a	$M_{c,z,Rd}$	509	509	509	509	509	509	509	509	509	509	509
	1.00	$M_{N,y,Rd}$	1050	1050	942	824	707	589	471	353	236	118	0
		$M_{N,z,Rd}$	509	509	509	502	480	441	386	314	226	121	0
356x368x177		$M_{c,y,Rd}$	916	916	916	916	916	916	916	916	916	916	916
$N_{pl,Rd}$ = 5990	n/a	$M_{c,z,Rd}$	443	443	443	443	443	443	443	443	443	443	443
	1.00	$M_{N,y,Rd}$	916	916	821	718	616	513	410	308	205	103	0
		$M_{N,z,Rd}$	443	443	443	438	418	384	336	274	197	106	0
356x368x153		$M_{c,y,Rd}$	786	786	786	786	786	786	786	786	786	786	786
$N_{pl,Rd}$ = 5170	n/a	$M_{c,z,Rd}$	380	380	380	380	380	380	380	380	380	380	380
	1.00	$M_{N,y,Rd}$	786	786	704	616	528	440	352	264	176	88.0	0
		$M_{N,z,Rd}$	380	380	380	376	359	330	288	235	169	90.5	0
356x368x129		$M_{c,y,Rd}$	657	657	657	657	657	657	657	657	657	657	657
$N_{pl,Rd}$ = 4350	n/a	$M_{c,z,Rd}$	318	318	318	318	318	318	318	318	318	318	318
	1.00	$M_{N,y,Rd}$	657	657	588	515	441	368	294	221	147	73.6	0
		$M_{N,z,Rd}$	318	318	318	314	300	276	241	196	141	75.7	0
305x305x283		$M_{c,y,Rd}$	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
$N_{pl,Rd}$ = 9180	n/a	$M_{c,z,Rd}$	597	597	597	597	597	597	597	597	597	597	597
	1.00	$M_{N,y,Rd}$	1300	1300	1160	1020	873	728	582	437	291	146	0
		$M_{N,z,Rd}$	597	597	597	590	563	517	452	368	264	142	0
305x305x240		$M_{c,y,Rd}$	1130	1130	1130	1130	1130	1130	1130	1130	1130	1130	1130
$N_{pl,Rd}$ = 8110	n/a	$M_{c,z,Rd}$	517	517	517	517	517	517	517	517	517	517	517
	1.00	$M_{N,y,Rd}$	1130	1130	1010	883	757	631	505	378	252	126	0
		$M_{N,z,Rd}$	517	517	517	511	488	449	393	320	230	123	0
305x305x198		$M_{c,y,Rd}$	912	912	912	912	912	912	912	912	912	912	912
$N_{pl,Rd}$ = 6680	n/a	$M_{c,z,Rd}$	419	419	419	419	419	419	419	419	419	419	419
	1.00	$M_{N,y,Rd}$	912	912	818	716	613	511	409	307	204	102	0
		$M_{N,z,Rd}$	419	419	419	414	396	364	318	259	186	100	0

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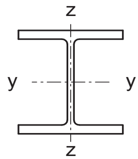
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

BS EN 1993-1-1:2005
BS 4-1:2005

AXIAL FORCE & BENDING

S275 / Advance® 275

UNIVERSAL COLUMNS
Advance® UKC



Member buckling check

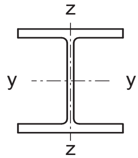
Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
356x368x202	1.00	$N_{b,y,Rd}$	6810	6780	6610	6440	6250	6050	5830	5590	5330	5050	4750	4450	4140
$N_{pl,Rd}$ = 6810		$N_{b,z,Rd}$	6690	6280	5850	5390	4910	4400	3910	3440	3030	2660	2340	2070	1840
$f_y W_{el,y}$ = 937	**1.00**	$M_{b,Rd}$	1050	1050	1050	1020	987	956	927	898	870	842	815	789	764
$f_y W_{el,z}$ = 335															
356x368x177	1.00	$N_{b,y,Rd}$	5990	5960	5810	5650	5480	5300	5100	4890	4660	4400	4140	3860	3590
$N_{pl,Rd}$ = 5990		$N_{b,z,Rd}$	5880	5510	5130	4730	4300	3850	3420	3010	2640	2320	2040	1810	1610
$f_y W_{el,y}$ = 822	**1.00**	$M_{b,Rd}$	916	916	911	881	851	822	793	765	738	711	685	660	635
$f_y W_{el,z}$ = 292															
356x368x153	1.00	$N_{b,y,Rd}$	5170	5140	5010	4870	4720	4570	4400	4210	4000	3780	3550	3320	3080
$N_{pl,Rd}$ = 5170		$N_{b,z,Rd}$	5070	4750	4420	4070	3700	3310	2930	2580	2260	1990	1750	1550	1370
$f_y W_{el,y}$ = 711	**1.00**	$M_{b,Rd}$	786	786	779	751	723	696	668	641	615	589	564	540	518
$f_y W_{el,z}$ = 251															
356x368x129	1.00	$N_{b,y,Rd}$	4350	4320	4210	4090	3960	3830	3680	3520	3340	3160	2960	2750	2550
$N_{pl,Rd}$ = 4350		$N_{b,z,Rd}$	4260	3990	3710	3410	3100	2770	2450	2150	1890	1660	1460	1290	1140
$f_y W_{el,y}$ = 600	**1.00**	$M_{b,Rd}$	657	657	649	624	599	573	547	522	496	472	448	426	405
$f_y W_{el,z}$ = 210															
305x305x283	1.00	$N_{b,y,Rd}$	9180	9100	8850	8590	8320	8020	7690	7320	6930	6510	6070	5630	5200
$N_{pl,Rd}$ = 9180		$N_{b,z,Rd}$	8860	8230	7550	6820	6050	5290	4580	3950	3410	2960	2580	2270	2000
$f_y W_{el,y}$ = 1100	**1.00**	$M_{b,Rd}$	1300	1300	1300	1280	1250	1230	1200	1180	1160	1140	1120	1090	1070
$f_y W_{el,z}$ = 390															
305x305x240	1.00	$N_{b,y,Rd}$	8110	8010	7780	7540	7280	7000	6690	6350	5970	5580	5170	4770	4380
$N_{pl,Rd}$ = 8110		$N_{b,z,Rd}$	7790	7210	6580	5910	5200	4510	3880	3330	2870	2480	2160	1890	1670
$f_y W_{el,y}$ = 965	**1.00**	$M_{b,Rd}$	1130	1130	1120	1090	1060	1040	1010	991	968	946	924	903	882
$f_y W_{el,z}$ = 338															
305x305x198	1.00	$N_{b,y,Rd}$	6680	6590	6390	6190	5970	5730	5460	5170	4850	4520	4180	3840	3510
$N_{pl,Rd}$ = 6680		$N_{b,z,Rd}$	6400	5910	5390	4830	4240	3670	3150	2690	2320	2000	1740	1530	1350
$f_y W_{el,y}$ = 794	**1.00**	$M_{b,Rd}$	912	912	899	872	847	823	800	778	756	735	714	694	674
$f_y W_{el,z}$ = 275															

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
$n = N_{Ed} / N_{pl,Rd}$
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.
For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

S275 / Advance® 275

UNIVERSAL COLUMNS
Advance® UKC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance n = N_{Ed} / $N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
305x305x158		$M_{c,y,Rd}$	710	710	710	710	710	710	710	710	710	710	710
$N_{pl,Rd}$ = 5330	n/a	$M_{c,z,Rd}$	326	326	326	326	326	326	326	326	326	326	326
	1.00	$M_{N,y,Rd}$	710	710	641	561	480	400	320	240	160	80.1	0
		$M_{N,z,Rd}$	326	326	326	323	309	285	250	204	147	78.8	0
305x305x137		$M_{c,y,Rd}$	609	609	609	609	609	609	609	609	609	609	609
$N_{pl,Rd}$ = 4610	n/a	$M_{c,z,Rd}$	279	279	279	279	279	279	279	279	279	279	279
	1.00	$M_{N,y,Rd}$	609	609	550	481	412	344	275	206	137	68.7	0
		$M_{N,z,Rd}$	279	279	279	277	265	244	214	175	126	67.6	0
305x305x118		$M_{c,y,Rd}$	519	519	519	519	519	519	519	519	519	519	519
$N_{pl,Rd}$ = 3980	n/a	$M_{c,z,Rd}$	237	237	237	237	237	237	237	237	237	237	237
	1.00	$M_{N,y,Rd}$	519	519	470	411	352	294	235	176	117	58.7	0
		$M_{N,z,Rd}$	237	237	237	235	226	209	183	149	108	57.9	0
305x305x97		$M_{c,y,Rd}$	438	438	438	438	438	438	438	438	438	438	438
$N_{pl,Rd}$ = 3380	n/a	$M_{c,z,Rd}$	200	200	200	200	200	200	200	200	200	200	200
	1.00	$M_{N,y,Rd}$	438	438	397	347	298	248	199	149	99.3	49.6	0
		$M_{N,z,Rd}$	200	200	200	198	190	176	154	126	90.8	48.8	0
254x254x167		$M_{c,y,Rd}$	642	642	642	642	642	642	642	642	642	642	642
$N_{pl,Rd}$ = 5640	n/a	$M_{c,z,Rd}$	301	301	301	301	301	301	301	301	301	301	301
	1.00	$M_{N,y,Rd}$	642	642	574	503	431	359	287	215	144	71.8	0
		$M_{N,z,Rd}$	301	301	301	297	284	261	228	186	133	71.5	0
254x254x132		$M_{c,y,Rd}$	495	495	495	495	495	495	495	495	495	495	495
$N_{pl,Rd}$ = 4450	n/a	$M_{c,z,Rd}$	233	233	233	233	233	233	233	233	233	233	233
	1.00	$M_{N,y,Rd}$	495	495	444	388	333	277	222	166	111	55.4	0
		$M_{N,z,Rd}$	233	233	233	230	220	202	176	144	103	55.4	0
254x254x107		$M_{c,y,Rd}$	393	393	393	393	393	393	393	393	393	393	393
$N_{pl,Rd}$ = 3600	n/a	$M_{c,z,Rd}$	185	185	185	185	185	185	185	185	185	185	185
	1.00	$M_{N,y,Rd}$	393	393	354	309	265	221	177	133	88.4	44.2	0
		$M_{N,z,Rd}$	185	185	185	183	175	161	141	115	82.6	44.3	0

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N_{Ed} = Design value of the axial force.

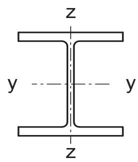
n = N_{Ed} / $N_{pl,Rd}$

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
305x305x158	1.00	$N_{b,y,Rd}$	5330	5330	5330	5320	5240	5160	5090	4920	4740	4540	4320	4080	3810
$N_{pl,Rd}$ = 5330		$N_{b,z,Rd}$	5330	5290	5090	4900	4700	4490	4270	3810	3330	2870	2450	2100	1800
$f_y W_{el,y}$ = 628	**1.00**	$M_{b,Rd}$	710	710	710	710	710	706	693	668	645	622	601	580	559
$f_y W_{el,z}$ = 214															
305x305x137	1.00	$N_{b,y,Rd}$	4610	4610	4610	4600	4530	4460	4390	4250	4090	3910	3710	3500	3270
$N_{pl,Rd}$ = 4610		$N_{b,z,Rd}$	4610	4570	4400	4230	4060	3870	3680	3280	2860	2460	2100	1790	1540
$f_y W_{el,y}$ = 543	**1.00**	$M_{b,Rd}$	609	609	609	609	609	602	590	567	544	523	502	481	461
$f_y W_{el,z}$ = 183															
305x305x118	1.00	$N_{b,y,Rd}$	3980	3980	3980	3960	3910	3850	3780	3660	3520	3360	3190	3000	2800
$N_{pl,Rd}$ = 3980		$N_{b,z,Rd}$	3980	3940	3790	3640	3490	3330	3160	2810	2450	2100	1790	1530	1310
$f_y W_{el,y}$ = 466	**1.00**	$M_{b,Rd}$	519	519	519	519	519	511	500	478	457	436	416	396	377
$f_y W_{el,z}$ = 156															
305x305x97	1.00	$N_{b,y,Rd}$	3380	3380	3380	3360	3310	3260	3210	3090	2970	2830	2670	2500	2320
$N_{pl,Rd}$ = 3380		$N_{b,z,Rd}$	3380	3340	3210	3080	2950	2810	2660	2350	2030	1730	1470	1250	1070
$f_y W_{el,y}$ = 397	**1.00**	$M_{b,Rd}$	438	438	438	438	437	427	417	396	375	354	333	313	294
$f_y W_{el,z}$ = 132															
254x254x167	1.00	$N_{b,y,Rd}$	5640	5640	5640	5570	5470	5370	5270	5050	4810	4530	4230	3890	3550
$N_{pl,Rd}$ = 5640		$N_{b,z,Rd}$	5640	5500	5260	5020	4760	4500	4210	3630	3060	2550	2130	1790	1510
$f_y W_{el,y}$ = 550	**1.00**	$M_{b,Rd}$	642	642	642	642	642	637	627	609	592	576	561	546	531
$f_y W_{el,z}$ = 197															
254x254x132	1.00	$N_{b,y,Rd}$	4450	4450	4450	4380	4300	4220	4140	3960	3760	3530	3280	3010	2730
$N_{pl,Rd}$ = 4450		$N_{b,z,Rd}$	4450	4330	4140	3940	3740	3520	3290	2820	2370	1970	1640	1370	1160
$f_y W_{el,y}$ = 432	**1.00**	$M_{b,Rd}$	495	495	495	495	495	485	476	460	444	429	415	401	387
$f_y W_{el,z}$ = 153															
254x254x107	1.00	$N_{b,y,Rd}$	3600	3600	3600	3540	3470	3410	3340	3190	3020	2820	2610	2380	2150
$N_{pl,Rd}$ = 3600		$N_{b,z,Rd}$	3600	3500	3340	3180	3010	2830	2640	2260	1880	1560	1300	1080	915
$f_y W_{el,y}$ = 348	**1.00**	$M_{b,Rd}$	393	393	393	393	389	381	373	357	342	328	314	301	288
$f_y W_{el,z}$ = 121															

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$n = N_{Ed} / N_{pl,Rd}$

Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

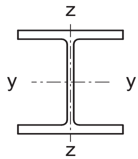
For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

S275 / Advance® 275

UNIVERSAL COLUMNS
Advance® UKC



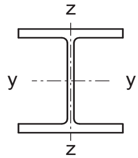
Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
254x254x89		$M_{c,y,Rd}$	324	324	324	324	324	324	324	324	324	324	324
$N_{pl,Rd}$ = 2990	n/a	$M_{c,z,Rd}$	152	152	152	152	152	152	152	152	152	152	152
	1.00	$M_{N,y,Rd}$	324	324	291	254	218	182	145	109	72.7	36.3	0
		$M_{N,z,Rd}$	152	152	152	151	144	132	116	94.3	67.8	36.4	0
254x254x73		$M_{c,y,Rd}$	273	273	273	273	273	273	273	273	273	273	273
$N_{pl,Rd}$ = 2560	n/a	$M_{c,z,Rd}$	128	128	128	128	128	128	128	128	128	128	128
	1.00	$M_{N,y,Rd}$	273	273	246	215	184	154	123	92.1	61.4	30.7	0
		$M_{N,z,Rd}$	128	128	128	127	121	112	97.9	79.8	57.4	30.8	0
203x203x127 +		$M_{c,y,Rd}$	402	402	402	402	402	402	402	402	402	402	402
$N_{pl,Rd}$ = 4290	n/a	$M_{c,z,Rd}$	187	187	187	187	187	187	187	187	187	187	187
	1.00	$M_{N,y,Rd}$	402	402	358	314	269	224	179	134	89.6	44.8	0
		$M_{N,z,Rd}$	187	187	187	184	175	161	141	114	82.1	44.0	0
203x203x113 +		$M_{c,y,Rd}$	352	352	352	352	352	352	352	352	352	352	352
$N_{pl,Rd}$ = 3840	n/a	$M_{c,z,Rd}$	164	164	164	164	164	164	164	164	164	164	164
	1.00	$M_{N,y,Rd}$	352	352	315	276	237	197	158	118	78.8	39.4	0
		$M_{N,z,Rd}$	164	164	164	162	155	142	124	101	72.7	39.0	0
203x203x100 +		$M_{c,y,Rd}$	304	304	304	304	304	304	304	304	304	304	304
$N_{pl,Rd}$ = 3370	n/a	$M_{c,z,Rd}$	142	142	142	142	142	142	142	142	142	142	142
	1.00	$M_{N,y,Rd}$	304	304	273	239	205	170	136	102	68.2	34.1	0
		$M_{N,z,Rd}$	142	142	142	140	134	123	107	87.5	62.9	33.8	0
203x203x86		$M_{c,y,Rd}$	259	259	259	259	259	259	259	259	259	259	259
$N_{pl,Rd}$ = 2920	n/a	$M_{c,z,Rd}$	121	121	121	121	121	121	121	121	121	121	121
	1.00	$M_{N,y,Rd}$	259	259	233	204	175	146	116	87.3	58.2	29.1	0
		$M_{N,z,Rd}$	121	121	121	120	114	105	92.2	75.1	54.1	29.0	0
203x203x71		$M_{c,y,Rd}$	212	212	212	212	212	212	212	212	212	212	212
$N_{pl,Rd}$ = 2400	n/a	$M_{c,z,Rd}$	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
	1.00	$M_{N,y,Rd}$	212	212	189	166	142	118	94.6	71.0	47.3	23.7	0
		$M_{N,z,Rd}$	99.0	99.0	99.0	97.7	93.3	85.7	74.9	60.9	43.8	23.5	0

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



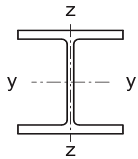
Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
254x254x89	1.00	$N_{b,y,Rd}$	2990	2990	2990	2940	2880	2830	2770	2640	2500	2340	2150	1960	1770
$N_{pl,Rd}$ = 2990		$N_{b,z,Rd}$	2990	2900	2770	2640	2490	2340	2190	1860	1560	1290	1070	891	752
$f_y W_{el,y}$ = 291	**1.00**	$M_{b,Rd}$	324	324	324	324	319	311	304	289	275	261	248	235	223
$f_y W_{el,z}$ = 100															
254x254x73	1.00	$N_{b,y,Rd}$	2560	2560	2550	2510	2460	2410	2360	2240	2110	1970	1810	1640	1470
$N_{pl,Rd}$ = 2560		$N_{b,z,Rd}$	2560	2470	2360	2240	2110	1980	1840	1550	1290	1060	873	728	613
$f_y W_{el,y}$ = 247	**1.00**	$M_{b,Rd}$	273	273	273	273	266	258	251	237	222	208	195	182	171
$f_y W_{el,z}$ = 84.4															
203x203x127 +	1.00	$N_{b,y,Rd}$	4290	4290	4240	4150	4060	3970	3860	3640	3370	3080	2760	2440	2150
$N_{pl,Rd}$ = 4290		$N_{b,z,Rd}$	4280	4060	3830	3590	3330	3060	2780	2250	1790	1440	1170	961	803
$f_y W_{el,y}$ = 339	**1.00**	$M_{b,Rd}$	402	402	402	402	399	393	387	375	364	354	344	334	325
$f_y W_{el,z}$ = 122															
203x203x113 +	1.00	$N_{b,y,Rd}$	3840	3840	3790	3710	3630	3540	3440	3240	2990	2720	2430	2150	1880
$N_{pl,Rd}$ = 3840		$N_{b,z,Rd}$	3830	3630	3420	3200	2970	2720	2470	1990	1590	1270	1030	847	707
$f_y W_{el,y}$ = 300	**1.00**	$M_{b,Rd}$	352	352	352	352	347	341	335	324	314	304	295	285	276
$f_y W_{el,z}$ = 107															
203x203x100 +	1.00	$N_{b,y,Rd}$	3370	3370	3320	3250	3170	3090	3010	2820	2600	2360	2100	1850	1610
$N_{pl,Rd}$ = 3370		$N_{b,z,Rd}$	3350	3170	2980	2790	2580	2370	2150	1720	1370	1090	886	728	608
$f_y W_{el,y}$ = 262	**1.00**	$M_{b,Rd}$	304	304	304	304	298	292	286	276	266	256	247	238	230
$f_y W_{el,z}$ = 92.8															
203x203x86	1.00	$N_{b,y,Rd}$	2920	2920	2870	2810	2740	2670	2590	2430	2230	2010	1790	1570	1360
$N_{pl,Rd}$ = 2920		$N_{b,z,Rd}$	2900	2740	2580	2410	2230	2040	1840	1480	1170	934	755	621	518
$f_y W_{el,y}$ = 225	**1.00**	$M_{b,Rd}$	259	259	259	257	251	246	240	230	221	212	203	194	186
$f_y W_{el,z}$ = 79.2															
203x203x71	1.00	$N_{b,y,Rd}$	2400	2400	2360	2300	2250	2190	2130	1990	1820	1640	1450	1270	1100
$N_{pl,Rd}$ = 2400		$N_{b,z,Rd}$	2380	2250	2120	1970	1820	1670	1510	1200	952	758	613	504	420
$f_y W_{el,y}$ = 187	**1.00**	$M_{b,Rd}$	212	212	212	209	203	198	193	183	174	165	157	149	142
$f_y W_{el,z}$ = 65.2															

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
n = N_{Ed} / $N_{pl,Rd}$
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.
For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
203x203x60		$M_{c,y,Rd}$	180	180	180	180	180	180	180	180	180	180	180
$N_{pl,Rd}$ = 2100	n/a	$M_{c,z,Rd}$	84.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0
	1.00	$M_{N,y,Rd}$	180	180	164	143	123	102	81.8	61.3	40.9	20.4	0
		$M_{N,z,Rd}$	84.0	84.0	84.0	83.3	80.0	73.9	64.8	52.9	38.2	20.5	0
203x203x52		$M_{c,y,Rd}$	156	156	156	156	156	156	156	156	156	156	156
$N_{pl,Rd}$ = 1820	n/a	$M_{c,z,Rd}$	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7
	1.00	$M_{N,y,Rd}$	156	156	141	123	106	88.1	70.5	52.9	35.3	17.6	0
		$M_{N,z,Rd}$	72.7	72.7	72.7	72.0	69.1	63.7	55.9	45.6	32.8	17.6	0
203x203x46		$M_{c,y,Rd}$	137	137	137	137	137	137	137	137	137	137	137
$N_{pl,Rd}$ = 1610	n/a	$M_{c,z,Rd}$	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5
	1.00	$M_{N,y,Rd}$	137	137	124	109	93.1	77.6	62.1	46.6	31.0	15.5	0
		$M_{N,z,Rd}$	63.5	63.5	63.5	63.0	60.6	55.9	49.1	40.1	28.9	15.5	0
152x152x51 +		$M_{c,y,Rd}$	120	120	120	120	120	120	120	120	120	120	120
$N_{pl,Rd}$ = 1790	n/a	$M_{c,z,Rd}$	54.7	54.7	54.7	54.7	54.7	54.7	54.7	54.7	54.7	54.7	54.7
	1.00	$M_{N,y,Rd}$	120	120	110	95.9	82.2	68.5	54.8	41.1	27.4	13.7	0
		$M_{N,z,Rd}$	54.7	54.7	54.7	54.4	52.3	48.4	42.5	34.7	25.1	13.5	0
152x152x44 +		$M_{c,y,Rd}$	102	102	102	102	102	102	102	102	102	102	102
$N_{pl,Rd}$ = 1540	n/a	$M_{c,z,Rd}$	46.5	46.5	46.5	46.5	46.5	46.5	46.5	46.5	46.5	46.5	46.5
	1.00	$M_{N,y,Rd}$	102	102	93.2	81.6	69.9	58.3	46.6	35.0	23.3	11.7	0
		$M_{N,z,Rd}$	46.5	46.5	46.5	46.2	44.5	41.1	36.2	29.6	21.3	11.5	0
152x152x37		$M_{c,y,Rd}$	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9
$N_{pl,Rd}$ = 1300	n/a	$M_{c,z,Rd}$	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
	1.00	$M_{N,y,Rd}$	84.9	84.9	77.5	67.8	58.1	48.4	38.7	29.0	19.4	9.68	0
		$M_{N,z,Rd}$	38.4	38.4	38.4	38.2	36.8	34.0	29.9	24.5	17.7	9.51	0
152x152x30		$M_{c,y,Rd}$	68.1	68.1	68.1	68.1	68.1	68.1	68.1	68.1	68.1	68.1	68.1
$N_{pl,Rd}$ = 1050	n/a	$M_{c,z,Rd}$	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7
	1.00	$M_{N,y,Rd}$	68.1	68.1	62.3	54.5	46.7	38.9	31.1	23.3	15.6	7.78	0
		$M_{N,z,Rd}$	30.7	30.7	30.7	30.5	29.4	27.3	24.0	19.6	14.2	7.63	0
152x152x23		$M_{c,y,Rd}$	45.1	45.1	45.1	45.1	45.1	45.1	45.1	45.1	45.1	45.1	45.1
$N_{pl,Rd}$ = 803	1.00	$M_{c,z,Rd}$	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5
	0.00	$M_{N,y,Rd}$	-	-	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	-	-	-	-	-	-	-	-	-	-	-

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+ These sections are in addition to the range of BS 4 sections

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

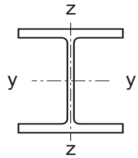
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
203x203x60	1.00	$N_{b,y,Rd}$	2100	2100	2060	2010	1960	1900	1840	1710	1560	1390	1220	1050	911
$N_{pl,Rd}$ = 2100		$N_{b,z,Rd}$	2080	1960	1840	1710	1570	1420	1280	1010	791	627	506	414	345
$f_y W_{el,y}$ = 161	**1.00**	$M_{b,Rd}$	180	180	180	176	171	165	160	150	141	132	124	116	109
$f_y W_{el,z}$ = 55.2															
203x203x52	1.00	$N_{b,y,Rd}$	1820	1820	1790	1740	1700	1650	1600	1480	1350	1200	1050	908	785
$N_{pl,Rd}$ = 1820		$N_{b,z,Rd}$	1800	1700	1590	1480	1360	1230	1110	871	683	541	436	357	297
$f_y W_{el,y}$ = 140	**1.00**	$M_{b,Rd}$	156	156	156	151	146	142	137	127	118	109	102	94.4	88.0
$f_y W_{el,z}$ = 47.9															
203x203x46	1.00	$N_{b,y,Rd}$	1610	1610	1580	1540	1500	1460	1410	1310	1190	1050	918	794	684
$N_{pl,Rd}$ = 1610		$N_{b,z,Rd}$	1590	1500	1410	1300	1200	1080	970	762	596	472	380	311	259
$f_y W_{el,y}$ = 124	**1.00**	$M_{b,Rd}$	137	137	137	132	127	123	118	109	100	92.0	84.5	78.0	72.2
$f_y W_{el,z}$ = 41.8															
152x152x51 +	1.00	$N_{b,y,Rd}$	1790	1760	1710	1650	1590	1520	1450	1280	1090	912	758	632	532
$N_{pl,Rd}$ = 1790		$N_{b,z,Rd}$	1710	1570	1430	1270	1110	949	809	591	442	341	270	219	180
$f_y W_{el,y}$ = 104	**1.00**	$M_{b,Rd}$	120	120	118	115	111	108	105	99.2	93.6	88.3	83.2	78.5	74.1
$f_y W_{el,z}$ = 35.8															
152x152x44 +	1.00	$N_{b,y,Rd}$	1540	1520	1470	1420	1370	1310	1240	1090	925	770	638	531	447
$N_{pl,Rd}$ = 1540		$N_{b,z,Rd}$	1470	1350	1220	1080	943	808	687	501	374	288	228	185	152
$f_y W_{el,y}$ = 89.7	**1.00**	$M_{b,Rd}$	102	102	99.8	96.4	93.2	90.1	87.1	81.4	76.0	71.0	66.3	62.1	58.2
$f_y W_{el,z}$ = 30.3															
152x152x37	1.00	$N_{b,y,Rd}$	1300	1270	1230	1190	1140	1090	1030	905	766	635	525	437	367
$N_{pl,Rd}$ = 1300		$N_{b,z,Rd}$	1230	1130	1020	903	782	668	568	412	308	237	187	151	125
$f_y W_{el,y}$ = 75.1	**1.00**	$M_{b,Rd}$	84.9	84.9	82.1	78.9	75.9	72.9	70.0	64.6	59.5	54.8	50.6	46.9	43.7
$f_y W_{el,z}$ = 25.2															
152x152x30	1.00	$N_{b,y,Rd}$	1050	1030	999	964	926	883	836	729	614	508	419	348	292
$N_{pl,Rd}$ = 1050		$N_{b,z,Rd}$	999	916	826	729	630	537	455	330	246	189	149	121	99.7
$f_y W_{el,y}$ = 61.0	**1.00**	$M_{b,Rd}$	68.1	68.1	65.2	62.3	59.5	56.6	53.9	48.7	44.0	39.9	36.3	33.3	30.7
$f_y W_{el,z}$ = 20.2															
152x152x23	1.00	$N_{b,y,Rd}$	803	785	759	731	700	665	627	541	451	370	303	251	210
$N_{pl,Rd}$ = 803		$N_{b,z,Rd}$	758	692	620	543	465	393	331	238	177	136	107	86.5	71.3
$f_y W_{el,y}$ = 45.1	1.00	$M_{b,Rd}$	45.1	45.1	43.2	41.1	39.0	36.8	34.8	30.8	27.3	24.4	21.9	19.9	18.2
$f_y W_{el,z}$ = 14.5															

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

\+ These sections are in addition to the range of BS 4 sections

n = N_{Ed} / $N_{pl,Rd}$

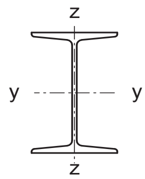
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

JOISTS



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
254x203x82		$M_{c,y,Rd}$	285	285	285	285	285	285	285	285	285	285	285
$N_{pl,Rd}$ = 2780	n/a	$M_{c,z,Rd}$	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3
	1.00	$M_{N,y,Rd}$	285	285	258	226	193	161	129	96.7	64.5	32.2	0
		$M_{N,z,Rd}$	98.3	98.3	98.3	97.5	93.5	86.2	75.6	61.7	44.4	23.9	0
254x114x37		$M_{c,y,Rd}$	126	126	126	126	126	126	126	126	126	126	126
$N_{pl,Rd}$ = 1300	n/a	$M_{c,z,Rd}$	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8
	1.00	$M_{N,y,Rd}$	126	126	125	109	93.6	78.0	62.4	46.8	31.2	15.6	0
		$M_{N,z,Rd}$	21.8	21.8	21.8	21.8	21.7	21.0	19.0	16.0	11.8	6.46	0
203x152x52		$M_{c,y,Rd}$	143	143	143	143	143	143	143	143	143	143	143
$N_{pl,Rd}$ = 1760	n/a	$M_{c,z,Rd}$	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6
	1.00	$M_{N,y,Rd}$	143	143	131	114	98.0	81.7	65.3	49.0	32.7	16.3	0
		$M_{N,z,Rd}$	46.6	46.6	46.6	46.4	44.7	41.3	36.3	29.7	21.4	11.5	0
152x127x37		$M_{c,y,Rd}$	76.7	76.7	76.7	76.7	76.7	76.7	76.7	76.7	76.7	76.7	76.7
$N_{pl,Rd}$ = 1310	n/a	$M_{c,z,Rd}$	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
	1.00	$M_{N,y,Rd}$	76.7	76.7	72.0	63.0	54.0	45.0	36.0	27.0	18.0	9.00	0
		$M_{N,z,Rd}$	27.4	27.4	27.4	27.4	26.8	25.1	22.3	18.4	13.3	7.23	0
127x114x29		$M_{c,y,Rd}$	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8
$N_{pl,Rd}$ = 1030	n/a	$M_{c,z,Rd}$	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
	1.00	$M_{N,y,Rd}$	49.8	49.8	46.8	40.9	35.1	29.2	23.4	17.5	11.7	5.85	0
		$M_{N,z,Rd}$	19.5	19.5	19.5	19.5	19.1	17.8	15.9	13.1	9.50	5.15	0
127x114x27		$M_{c,y,Rd}$	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3
$N_{pl,Rd}$ = 941	n/a	$M_{c,z,Rd}$	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.8
	1.00	$M_{N,y,Rd}$	47.3	47.3	43.0	37.6	32.2	26.8	21.5	16.1	10.7	5.37	0
		$M_{N,z,Rd}$	18.8	18.8	18.8	18.6	17.9	16.5	14.5	11.9	8.55	4.60	0
127x76x16		$M_{c,y,Rd}$	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6
$N_{pl,Rd}$ = 580	n/a	$M_{c,z,Rd}$	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26
	1.00	$M_{N,y,Rd}$	28.6	28.6	27.0	23.6	20.3	16.9	13.5	10.1	6.76	3.38	0
		$M_{N,z,Rd}$	7.26	7.26	7.26	7.26	7.13	6.70	5.96	4.92	3.58	1.94	0

N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

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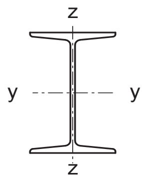

Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
254x203x82	1.00	$N_{b,y,Rd}$	2780	2780	2780	2740	2710	2670	2630	2550	2440	2300	2140	1950	1740
$N_{pl,Rd}$ = 2780		$N_{b,z,Rd}$	2740	2620	2480	2320	2140	1930	1720	1310	1000	777	617	500	412
$f_y W_{el,y}$ = 251	**1.00**	$M_{b,Rd}$	285	285	285	278	270	263	256	243	231	219	208	197	187
$f_y W_{el,z}$ = 59.4															
254x114x37	1.00	$N_{b,y,Rd}$	1300	1300	1290	1280	1260	1240	1220	1180	1120	1050	966	869	768
$N_{pl,Rd}$ = 1300		$N_{b,z,Rd}$	1160	1000	806	618	472	366	291	194	139	104	80.3	64.1	52.3
$f_y W_{el,y}$ = 110	**1.00**	$M_{b,Rd}$	126	113	102	92.0	83.2	75.6	69.1	58.8	51.1	45.1	40.4	36.6	33.5
$f_y W_{el,z}$ = 13.0															
203x152x52	1.00	$N_{b,y,Rd}$	1760	1760	1740	1710	1680	1650	1610	1520	1410	1260	1090	937	799
$N_{pl,Rd}$ = 1760		$N_{b,z,Rd}$	1690	1570	1440	1270	1090	912	760	535	391	296	232	186	153
$f_y W_{el,y}$ = 125	**1.00**	$M_{b,Rd}$	143	143	139	134	129	125	121	113	106	98.7	92.2	86.3	80.9
$f_y W_{el,z}$ = 28.4															
152x127x37	1.00	$N_{b,y,Rd}$	1310	1270	1220	1170	1120	1060	990	838	686	556	452	372	311
$N_{pl,Rd}$ = 1310		$N_{b,z,Rd}$	1170	1020	851	689	551	442	359	247	179	136	106	85.1	69.9
$f_y W_{el,y}$ = 65.7	**1.00**	$M_{b,Rd}$	76.7	75.5	72.6	69.9	67.5	65.1	62.8	58.4	54.3	50.4	46.9	43.7	40.9
$f_y W_{el,z}$ = 16.4															
127x114x29	1.00	$N_{b,y,Rd}$	1020	977	932	880	820	753	680	535	415	325	259	211	174
$N_{pl,Rd}$ = 1030		$N_{b,z,Rd}$	893	758	612	480	375	296	238	162	117	88.1	68.7	55.1	45.1
$f_y W_{el,y}$ = 42.4	**1.00**	$M_{b,Rd}$	49.8	48.5	46.7	44.9	43.3	41.8	40.2	37.3	34.6	32.1	29.8	27.7	25.9
$f_y W_{el,z}$ = 11.6															
127x114x27	1.00	$N_{b,y,Rd}$	934	897	857	811	759	701	636	506	395	311	248	202	167
$N_{pl,Rd}$ = 941		$N_{b,z,Rd}$	825	706	578	458	360	286	231	158	114	85.9	67.1	53.8	44.1
$f_y W_{el,y}$ = 41.0	**1.00**	$M_{b,Rd}$	47.3	46.0	44.1	42.3	40.7	39.1	37.6	34.7	32.0	29.5	27.3	25.3	23.6
$f_y W_{el,z}$ = 11.4															
127x76x16	1.00	$N_{b,y,Rd}$	578	563	546	526	502	470	432	344	264	205	162	131	107
$N_{pl,Rd}$ = 580		$N_{b,z,Rd}$	462	340	233	162	118	89.3	69.8	45.8	32.4	24.1	18.6	14.8	12.0
$f_y W_{el,y}$ = 24.8	**1.00**	$M_{b,Rd}$	27.4	25.3	23.5	21.7	20.1	18.6	17.2	14.9	13.1	11.6	10.4	9.23	8.30
$f_y W_{el,z}$ = 4.40															

n = N_{Ed} / $N_{pl,Rd}$

Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

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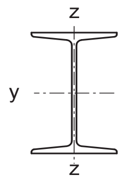

Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
114x114x27		$M_{c,y,Rd}$	41.5	41.5	41.5	41.5	41.5	41.5	41.5	41.5	41.5	41.5	41.5
$N_{pl,Rd}$ = 949	n/a	$M_{c,z,Rd}$	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1
	1.00	$M_{N,y,Rd}$	41.5	41.5	38.9	34.0	29.2	24.3	19.4	14.6	9.72	4.86	0
		$M_{N,z,Rd}$	18.1	18.1	18.1	18.1	17.7	16.5	14.7	12.1	8.77	4.74	0
102x102x23		$M_{c,y,Rd}$	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1
$N_{pl,Rd}$ = 806	n/a	$M_{c,z,Rd}$	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9
	1.00	$M_{N,y,Rd}$	31.1	31.1	29.0	25.4	21.8	18.1	14.5	10.9	7.25	3.63	0
		$M_{N,z,Rd}$	13.9	13.9	13.9	13.9	13.6	12.7	11.2	9.23	6.70	3.62	0
102x44x7		$M_{c,y,Rd}$	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74
$N_{pl,Rd}$ = 261	n/a	$M_{c,z,Rd}$	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66
	1.00	$M_{N,y,Rd}$	9.74	9.74	9.74	8.67	7.43	6.19	4.96	3.72	2.48	1.24	0
		$M_{N,z,Rd}$	1.66	1.66	1.66	1.66	1.66	1.63	1.51	1.28	0.958	0.530	0
89x89x19		$M_{c,y,Rd}$	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7
$N_{pl,Rd}$ = 685	n/a	$M_{c,z,Rd}$	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
	1.00	$M_{N,y,Rd}$	22.7	22.7	21.3	18.7	16.0	13.3	10.7	7.99	5.33	2.66	0
		$M_{N,z,Rd}$	10.5	10.5	10.5	10.4	10.2	9.55	8.48	6.99	5.08	2.75	0
76x76x15		$M_{c,y,Rd}$	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
$N_{pl,Rd}$ = 525	n/a	$M_{c,z,Rd}$	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10
	1.00	$M_{N,y,Rd}$	14.9	14.9	14.0	12.2	10.5	8.75	7.00	5.25	3.50	1.75	0
		$M_{N,z,Rd}$	7.10	7.10	7.10	7.09	6.94	6.50	5.77	4.76	3.46	1.87	0
76x76x13		$M_{c,y,Rd}$	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
$N_{pl,Rd}$ = 446	n/a	$M_{c,z,Rd}$	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16
	1.00	$M_{N,y,Rd}$	13.4	13.4	12.0	10.5	8.98	7.48	5.98	4.49	2.99	1.50	0
		$M_{N,z,Rd}$	6.16	6.16	6.16	6.08	5.80	5.33	4.66	3.79	2.72	1.46	0

N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

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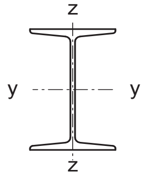


Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
114x114x27	1.00	$N_{b,y,Rd}$	932	888	839	783	717	644	568	430	326	252	200	162	133
$N_{pl,Rd}$ = 949		$N_{b,z,Rd}$	825	701	567	445	347	275	221	151	109	81.9	63.9	51.2	41.9
$f_y W_{el,y}$ = 35.5	**1.00**	$M_{b,Rd}$	41.5	40.7	39.3	38.0	36.7	35.5	34.4	32.1	30.0	28.0	26.2	24.5	23.0
$f_y W_{el,z}$ = 10.8															
102x102x23	1.00	$N_{b,y,Rd}$	782	738	688	628	559	486	416	302	224	172	135	109	89.3
$N_{pl,Rd}$ = 806		$N_{b,z,Rd}$	678	556	432	328	251	196	156	106	75.8	56.9	44.3	35.5	29.0
$f_y W_{el,y}$ = 26.3	**1.00**	$M_{b,Rd}$	31.1	30.3	29.2	28.2	27.2	26.3	25.4	23.7	22.1	20.5	19.1	17.9	16.7
$f_y W_{el,z}$ = 8.33															
102x44x7	1.00	$N_{b,y,Rd}$	256	247	235	219	198	173	147	105	76.3	57.6	44.9	36.0	29.4
$N_{pl,Rd}$ = 261		$N_{b,z,Rd}$	115	59.6	35.4	23.3	16.5	12.3	9.49	6.15	4.31	3.18	2.45	1.94	1.58
$f_y W_{el,y}$ = 8.28	**1.00**	$M_{b,Rd}$	7.39	6.05	5.07	4.35	3.80	3.38	3.03	2.53	2.14	1.83	1.60	1.42	1.28
$f_y W_{el,z}$ = 0.965															
89x89x19	1.00	$N_{b,y,Rd}$	653	608	553	487	416	347	288	202	147	112	87.3	70.1	57.5
$N_{pl,Rd}$ = 685		$N_{b,z,Rd}$	550	430	317	233	175	135	107	71.5	51.0	38.2	29.7	23.7	19.4
$f_y W_{el,y}$ = 19.0	**1.00**	$M_{b,Rd}$	22.7	22.1	21.3	20.5	19.9	19.2	18.5	17.3	16.1	15.0	14.0	13.0	12.2
$f_y W_{el,z}$ = 6.27															
76x76x15	1.00	$N_{b,y,Rd}$	490	446	391	327	265	213	173	118	85.2	64.1	49.9	40.0	32.7
$N_{pl,Rd}$ = 525		$N_{b,z,Rd}$	398	293	205	147	108	82.9	65.3	43.4	30.9	23.1	17.9	14.3	11.7
$f_y W_{el,y}$ = 12.4	**1.00**	$M_{b,Rd}$	14.9	14.3	13.7	13.2	12.8	12.3	11.8	10.9	10.1	9.37	8.68	8.07	7.53
$f_y W_{el,z}$ = 4.18															
76x76x13	1.00	$N_{b,y,Rd}$	418	383	339	288	236	192	156	107	77.6	58.5	45.6	36.5	29.9
$N_{pl,Rd}$ = 446		$N_{b,z,Rd}$	338	250	176	125	92.8	71.0	56.0	37.2	26.5	19.8	15.4	12.2	10.0
$f_y W_{el,y}$ = 11.4	**1.00**	$M_{b,Rd}$	13.2	12.6	12.0	11.5	11.0	10.5	10.0	9.15	8.34	7.63	7.00	6.46	5.98
$f_y W_{el,z}$ = 3.74															

$n = N_{Ed} / N_{pl,Rd}$

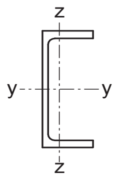
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

PARALLEL FLANGE CHANNEL
Advance® UKPFC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
	Class 2	n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
430x100x64	n/a	$M_{c,y,Rd}$	324	324	324	324	324	324	324	324	324	324	324
$N_{pl,Rd}$ = 2180	**1.00**	$M_{c,z,Rd}$	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
380x100x54	n/a	$M_{c,y,Rd}$	247	247	247	247	247	247	247	247	247	247	247
$N_{pl,Rd}$ = 1820	**1.00**	$M_{c,z,Rd}$	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
300x100x46	n/a	$M_{c,y,Rd}$	170	170	170	170	170	170	170	170	170	170	170
$N_{pl,Rd}$ = 1540	**1.00**	$M_{c,z,Rd}$	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
300x90x41	n/a	$M_{c,y,Rd}$	156	156	156	156	156	156	156	156	156	156	156
$N_{pl,Rd}$ = 1450	**1.00**	$M_{c,z,Rd}$	31.4	31.4	31.4	31.4	31.4	31.4	31.4	31.4	31.4	31.4	31.4
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
260x90x35	n/a	$M_{c,y,Rd}$	117	117	117	117	117	117	117	117	117	117	117
$N_{pl,Rd}$ = 1220	**1.00**	$M_{c,z,Rd}$	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
260x75x28	n/a	$M_{c,y,Rd}$	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2
$N_{pl,Rd}$ = 965	**1.00**	$M_{c,z,Rd}$	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
230x90x32	n/a	$M_{c,y,Rd}$	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6
$N_{pl,Rd}$ = 1130	**1.00**	$M_{c,z,Rd}$	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
230x75x26	n/a	$M_{c,y,Rd}$	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5
$N_{pl,Rd}$ = 899	**1.00**	$M_{c,z,Rd}$	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											

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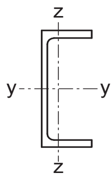
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
Reduced moment resistance $M_{N,y,Rd}$ and $M_{N,z,Rd}$ are not calculated for channels.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

PARALLEL FLANGE CHANNEL
Advance® UKPFC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
430x100x64	1.00	$N_{b,y,Rd}$	2180	2170	2090	2010	1930	1850	1770	1680	1590	1490	1400	1300	1210
$N_{pl,Rd}$ = 2180		$N_{b,z,Rd}$	1490	1010	668	464	338	257	201	162	133	111	94.1	80.8	70.1
$f_y W_{el,y}$ = 270	**1.00**	$M_{b,Rd}$	260	204	165	138	119	105	94.0	85.2	78.0	71.9	66.8	62.4	58.5
$f_y W_{el,z}$ = 25.9															
380x100x54	1.00	$N_{b,y,Rd}$	1820	1790	1720	1650	1580	1500	1420	1330	1250	1160	1070	990	911
$N_{pl,Rd}$ = 1820		$N_{b,z,Rd}$	1270	873	586	409	298	227	178	143	118	98.3	83.3	71.6	62.1
$f_y W_{el,y}$ = 210	**1.00**	$M_{b,Rd}$	200	158	129	109	94.0	83.0	74.4	67.5	61.8	57.1	53.1	49.6	46.6
$f_y W_{el,z}$ = 23.6															
300x100x46	1.00	$N_{b,y,Rd}$	1540	1470	1400	1320	1230	1150	1060	964	875	790	712	641	578
$N_{pl,Rd}$ = 1540		$N_{b,z,Rd}$	1090	758	512	358	262	199	156	126	104	86.6	73.4	63.1	54.8
$f_y W_{el,y}$ = 145	**1.00**	$M_{b,Rd}$	141	114	95.8	82.4	72.4	64.6	58.4	53.4	49.2	45.6	42.5	39.9	37.5
$f_y W_{el,z}$ = 21.7															
300x90x41	1.00	$N_{b,y,Rd}$	1450	1380	1310	1230	1150	1060	971	882	795	715	642	576	518
$N_{pl,Rd}$ = 1450		$N_{b,z,Rd}$	931	597	387	266	193	146	114	91.4	74.9	62.5	53.0	45.5	39.5
$f_y W_{el,y}$ = 132	**1.00**	$M_{b,Rd}$	121	95.0	78.1	66.3	57.7	51.2	46.1	41.9	38.5	35.6	33.1	31.0	29.1
$f_y W_{el,z}$ = 17.4															
260x90x35	1.00	$N_{b,y,Rd}$	1210	1140	1060	988	907	822	736	655	579	512	454	403	359
$N_{pl,Rd}$ = 1220		$N_{b,z,Rd}$	795	515	336	231	168	127	99.1	79.6	65.3	54.5	46.2	39.7	34.4
$f_y W_{el,y}$ = 100	**1.00**	$M_{b,Rd}$	91.1	72.4	59.9	51.1	44.7	39.7	35.8	32.6	30.0	27.8	25.9	24.2	22.8
$f_y W_{el,z}$ = 15.5															
260x75x28	1.00	$N_{b,y,Rd}$	951	895	837	775	709	640	572	506	447	394	348	309	275
$N_{pl,Rd}$ = 965		$N_{b,z,Rd}$	520	303	189	127	91.5	68.8	53.5	42.8	35.1	29.2	24.7	21.2	18.4
$f_y W_{el,y}$ = 76.5	**1.00**	$M_{b,Rd}$	61.6	46.6	37.3	31.2	26.9	23.7	21.2	19.2	17.6	16.2	15.0	14.0	13.2
$f_y W_{el,z}$ = 9.46															
230x90x32	1.00	$N_{b,y,Rd}$	1100	1030	952	871	785	697	613	535	467	408	358	316	280
$N_{pl,Rd}$ = 1130		$N_{b,z,Rd}$	743	485	317	219	159	120	94.0	75.5	61.9	51.7	43.8	37.6	32.6
$f_y W_{el,y}$ = 84.2	**1.00**	$M_{b,Rd}$	77.5	62.8	52.7	45.5	40.1	35.8	32.4	29.7	27.3	25.4	23.7	22.2	20.9
$f_y W_{el,z}$ = 15.1															
230x75x26	1.00	$N_{b,y,Rd}$	876	818	757	691	622	551	483	421	367	320	281	247	219
$N_{pl,Rd}$ = 899		$N_{b,z,Rd}$	496	292	182	123	88.7	66.7	51.9	41.6	34.0	28.4	24.0	20.6	17.8
$f_y W_{el,y}$ = 65.7	**1.00**	$M_{b,Rd}$	54.0	42.0	34.3	29.1	25.3	22.5	20.2	18.4	16.8	15.6	14.5	13.6	12.7
$f_y W_{el,z}$ = 9.57															

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$n = N_{Ed} / N_{pl,Rd}$

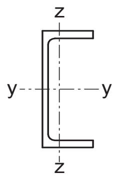
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

PARALLEL FLANGE CHANNEL
Advance® UKPFC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
200x90x30	n/a	$M_{c,y,Rd}$	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
$N_{pl,Rd}$ = 1040	**1.00**	$M_{c,z,Rd}$	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
200x75x23	n/a	$M_{c,y,Rd}$	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
$N_{pl,Rd}$ = 822	**1.00**	$M_{c,z,Rd}$	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
180x90x26	n/a	$M_{c,y,Rd}$	63.8	63.8	63.8	63.8	63.8	63.8	63.8	63.8	63.8	63.8	63.8
$N_{pl,Rd}$ = 913	**1.00**	$M_{c,z,Rd}$	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
180x75x20	n/a	$M_{c,y,Rd}$	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4
$N_{pl,Rd}$ = 712	**1.00**	$M_{c,z,Rd}$	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
150x90x24	n/a	$M_{c,y,Rd}$	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2
$N_{pl,Rd}$ = 836	**1.00**	$M_{c,z,Rd}$	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
150x75x18	n/a	$M_{c,y,Rd}$	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
$N_{pl,Rd}$ = 627	**1.00**	$M_{c,z,Rd}$	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
125x65x15	n/a	$M_{c,y,Rd}$	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
$N_{pl,Rd}$ = 517	**1.00**	$M_{c,z,Rd}$	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
100x50x10	n/a	$M_{c,y,Rd}$	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
$N_{pl,Rd}$ = 358	**1.00**	$M_{c,z,Rd}$	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											

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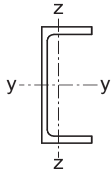
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
Reduced moment resistance $M_{N,y,Rd}$ and $M_{N,z,Rd}$ are not calculated for channels.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

PARALLEL FLANGE CHANNEL
Advance® UKPFC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
200x90x30	1.00	$N_{b,y,Rd}$	1040	1040	999	961	922	882	840	751	659	570	489	418	359
$N_{pl,Rd}$ = 1040		$N_{b,z,Rd}$	935	819	690	563	452	364	296	204	149	112	88.0	70.7	58.0
$f_y W_{el,y}$ = 69.3	**1.00**	$M_{b,Rd}$	80.0	72.7	65.0	58.9	53.8	49.5	45.9	40.1	35.6	32.1	29.2	26.8	24.8
$f_y W_{el,z}$ = 14.7															
200x75x23	1.00	$N_{b,y,Rd}$	822	817	787	757	726	694	661	591	518	447	383	327	281
$N_{pl,Rd}$ = 822		$N_{b,z,Rd}$	701	584	461	355	274	215	172	116	83.6	62.9	49.0	39.2	32.1
$f_y W_{el,y}$ = 53.9	**1.00**	$M_{b,Rd}$	60.6	52.0	45.5	40.3	36.2	32.9	30.1	25.8	22.7	20.2	18.2	16.6	15.3
$f_y W_{el,z}$ = 9.30															
180x90x26	1.00	$N_{b,y,Rd}$	913	897	861	824	786	746	705	617	529	447	377	318	271
$N_{pl,Rd}$ = 913		$N_{b,z,Rd}$	820	718	606	495	398	320	261	180	131	99.1	77.6	62.3	51.1
$f_y W_{el,y}$ = 55.6	**1.00**	$M_{b,Rd}$	63.8	58.0	51.9	47.0	42.9	39.5	36.7	32.0	28.5	25.7	23.4	21.4	19.8
$f_y W_{el,z}$ = 13.0															
180x75x20	1.00	$N_{b,y,Rd}$	712	699	670	641	610	578	545	475	405	341	287	242	206
$N_{pl,Rd}$ = 712		$N_{b,z,Rd}$	607	505	398	306	235	185	148	100.0	71.9	54.1	42.1	33.7	27.6
$f_y W_{el,y}$ = 41.8	**1.00**	$M_{b,Rd}$	46.9	40.2	35.0	31.0	27.8	25.2	23.0	19.7	17.3	15.4	13.9	12.6	11.6
$f_y W_{el,z}$ = 7.92															
150x90x24	1.00	$N_{b,y,Rd}$	836	802	762	720	677	630	582	485	397	323	265	220	185
$N_{pl,Rd}$ = 836		$N_{b,z,Rd}$	751	658	555	453	364	293	239	165	120	90.8	71.0	57.1	46.8
$f_y W_{el,y}$ = 42.6	**1.00**	$M_{b,Rd}$	49.2	45.4	41.1	37.6	34.8	32.3	30.2	26.7	24.0	21.7	19.9	18.4	17.0
$f_y W_{el,z}$ = 12.2															
150x75x18	1.00	$N_{b,y,Rd}$	627	601	571	540	506	471	435	362	296	241	198	164	138
$N_{pl,Rd}$ = 627		$N_{b,z,Rd}$	536	447	353	272	210	165	132	89.3	64.3	48.3	37.7	30.2	24.7
$f_y W_{el,y}$ = 31.6	**1.00**	$M_{b,Rd}$	35.5	30.7	27.1	24.3	22.0	20.1	18.5	16.0	14.2	12.7	11.5	10.5	9.69
$f_y W_{el,z}$ = 7.32															
125x65x15	1.00	$N_{b,y,Rd}$	510	480	449	416	381	344	307	241	188	148	119	97.6	81.2
$N_{pl,Rd}$ = 517		$N_{b,z,Rd}$	418	330	245	181	136	105	83.5	55.9	40.0	30.0	23.3	18.6	15.2
$f_y W_{el,y}$ = 21.3	**1.00**	$M_{b,Rd}$	23.3	20.3	18.0	16.2	14.7	13.5	12.5	10.9	9.62	8.64	7.84	7.18	6.63
$f_y W_{el,z}$ = 5.17															
100x50x10	1.00	$N_{b,y,Rd}$	342	315	286	255	222	191	163	120	89.7	69.2	54.8	44.4	36.6
$N_{pl,Rd}$ = 358		$N_{b,z,Rd}$	253	174	117	82.1	60.0	45.6	35.8	23.7	16.8	12.5	9.70	7.73	6.30
$f_y W_{el,y}$ = 11.4	**1.00**	$M_{b,Rd}$	11.8	10.2	8.99	8.05	7.29	6.67	6.14	5.31	4.68	4.18	3.79	3.46	3.19
$f_y W_{el,z}$ = 2.72															

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n = N_{Ed} / $N_{pl,Rd}$

Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

BS EN 1993-1-8:2005
BS EN ISO 4016
BS EN ISO 4018

BOLT RESISTANCES

S275

Non Preloaded bolts

Property Class 4.6 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	24.3	16.2	32.4	2.1
16	157	45.2	30.1	60.3	3.1
20	245	70.6	47.0	94.1	3.9
24	353	102	67.8	136	4.7
30	561	162	108	215	5.8

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	26.4	31.7	*37*	*42.2*	*47.5*	*52.8*	*63.4*	*79.2*	*106*	*132*	*158*
16	25	35	50	50	37.2	44.7	52.1	59.6	*67*	*74.5*	*89.3*	*112*	*149*	*186*	*223*
20	30	40	60	60	**42.1**	50.5	58.9	67.4	75.8	84.2	*101*	*126*	*168*	*211*	*253*
24	35	50	70	70	**52.2**	**62.6**	73.1	83.5	94	104	125	*157*	*209*	*261*	*313*
30	45	60	85	90	**63.2**	**75.8**	**88.4**	**101**	114	126	152	189	*253*	*316*	*379*

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d\, t/\gamma_{M2}$
FOR EXPLANATION OF TABLES SEE NOTE 11.

BS EN 1993-1-8:2005
BS EN ISO 4014
BS EN ISO 4017

BOLT RESISTANCES

S275

Non Preloaded bolts

Property Class 8.8 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	48.6	27.5	55.0	4.2
16	157	90.4	60.3	121	6.3
20	245	141	94.1	188	7.8
24	353	203	136	271	9.4
30	561	323	215	431	11.6

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	**26.4**	31.7	37	42.2	47.5	52.8	*63.4*	*79.2*	*106*	*132*	*158*
16	25	35	50	50	**37.2**	**44.7**	**52.1**	**59.6**	67	74.5	89.3	112	*149*	*186*	*223*
20	30	40	60	60	**42.1**	**50.5**	**58.9**	**67.4**	**75.8**	**84.2**	101	126	168	*211*	*253*
24	35	50	70	70	**52.2**	**62.6**	**73.1**	**83.5**	**94**	**104**	**125**	157	209	261	*313*
30	45	60	85	90	**63.2**	**75.8**	**88.4**	**101**	**114**	**126**	**152**	**189**	253	316	379

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	25	40	50	45	46.3	*55.5*	*64.8*	*74*	*83.3*	*92.5*	*111*	*139*	*185*	*231*	*278*
16	30	50	65	55	60.7	72.9	85	97.2	109	121	*146*	*182*	*243*	*304*	*364*
20	35	60	80	70	**74.5**	**89.5**	104	119	134	149	179	*224*	*298*	*373*	*447*
24	40	75	95	80	**94.6**	**114**	**132**	151	170	189	227	*284*	*378*	*473*	*568*
30	50	90	115	100	**112**	**134**	**157**	**179**	**201**	224	268	335	*447*	*559*	*671*

For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d\, t/\gamma_{M2}$
FOR EXPLANATION OF TABLES SEE NOTE 11.

BOLT RESISTANCES

Non Preloaded bolts

Property Class 10.9 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	60.7	28.7	57.3	5.3
16	157	113	62.8	126	7.9
20	245	176	98.0	196	9.8
24	353	254	141	282	11.7
30	561	404	224	449	14.5

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	**26.4**	31.7	37	42.2	47.5	52.8	*63.4*	*79.2*	*106*	*132*	*158*
16	25	35	50	50	**37.2**	**44.7**	**52.1**	**59.6**	67	74.5	89.3	112	*149*	*186*	*223*
20	30	40	60	60	**42.1**	**50.5**	**58.9**	**67.4**	**75.8**	**84.2**	101	126	168	*211*	*253*
24	35	50	70	70	**52.2**	**62.6**	**73.1**	**83.5**	**94**	**104**	**125**	157	209	261	*313*
30	45	60	85	90	**63.2**	**75.8**	**88.4**	**101**	**114**	**126**	**152**	**189**	253	316	379

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	25	40	50	45	46.3	55.5	*64.8*	*74*	*83.3*	*92.5*	*111*	*139*	*185*	*231*	*278*
16	30	50	65	55	**60.7**	72.9	85	97.2	109	121	*146*	*182*	*243*	*304*	*364*
20	35	60	80	70	**74.5**	**89.5**	104	119	134	149	179	*224*	*298*	*373*	*447*
24	40	75	95	80	**94.6**	**114**	**132**	151	170	189	227	*284*	*378*	*473*	*568*
30	50	90	115	100	**112**	**134**	**157**	**179**	**201**	224	268	335	447	*559*	*671*

For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d t/\gamma_{M2}$
FOR EXPLANATION OF TABLES SEE NOTE 11.

BOLT RESISTANCES

Non Preloaded bolts

Property Class 4.6 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	17.0	16.2	32.4	1.5
16	157	31.7	30.1	60.3	2.2
20	245	49.4	47.0	94.1	2.7
24	353	71.2	67.8	136	3.3
30	561	113	108	215	4.1

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge											
d	e_2	e_1	p_1	p_2	Thickness in mm of ply, t.										
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	**10.6**	**15.8**	21.1	26.4	*31.7*	*37.0*	*47.5*	*63.4*	*89.8*	*116*	*143*
16	25	35	50	50	**7.4**	**14.9**	**22.3**	**29.8**	37.2	44.7	59.6	*81.9*	*119*	*156*	*194*
20	30	40	60	60	**0**	**8.4**	**16.8**	**25.3**	**33.7**	**42.1**	58.9	84.2	*126*	*168*	*211*
24	35	50	70	70	**0**	**0**	**10.4**	**20.9**	**31.3**	**41.8**	**62.6**	94.0	*146*	*198*	*251*
30	45	60	85	90	**0**	**0**	**0**	**6.3**	**18.9**	**31.6**	**56.8**	**94.7**	158	*221*	*284*

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d\, t / \gamma_{M2}$

FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Non Preloaded bolts

Property Class 8.8 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	34.0	27.5	55.0	3.0
16	157	63.3	60.3	121	4.4
20	245	98.8	94.1	188	5.5
24	353	142	136	271	6.6
30	561	226	215	431	8.1

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	**10.6**	**15.8**	**21.1**	**26.4**	31.7	37.0	47.5	*63.4*	*89.8*	*116*	*143*
16	25	35	50	50	**7.4**	**14.9**	**22.3**	**29.8**	**37.2**	**44.7**	**59.6**	81.9	119	*156*	*194*
20	30	40	60	60	**0**	**8.4**	**16.8**	**25.3**	**33.7**	**42.1**	**58.9**	**84.2**	126	168	*211*
24	35	50	70	70	**0**	**0**	**10.4**	**20.9**	**31.3**	**41.8**	**62.6**	**94.0**	146	198	251
30	45	60	85	90	**0**	**0**	**0**	**6.3**	**18.9**	**31.6**	**56.8**	**94.7**	**158**	221	284

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	25	40	50	45	**18.5**	27.8	37.0	46.3	*55.5*	*64.8*	*83.3*	*111*	*157*	*204*	*250*
16	30	50	65	55	**12.1**	**24.3**	**36.4**	**48.6**	60.7	72.9	97	*134*	*194*	*255*	*316*
20	35	60	80	70	**0**	**14.9**	**29.8**	**44.7**	**59.6**	**74.5**	104	149	*224*	*298*	*373*
24	40	75	95	80	**0**	**0**	**18.9**	**37.8**	**56.8**	**75.7**	**114**	170	265	*360*	*454*
30	50	90	115	100	**0**	**0**	**0**	**11.2**	**33.5**	**55.9**	**101**	**168**	280	391	*503*

For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d t/\gamma_{M2}$
FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Non Preloaded bolts

Property Class 10.9 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	42.5	28.7	57.3	3.7
16	157	79.1	62.8	126	5.5
20	245	123	98.0	196	6.8
24	353	178	141	282	8.2
30	561	283	224	449	10.1

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	**10.6**	**15.8**	**21.1**	**26.4**	31.7	37.0	47.5	*63.4*	*89.8*	*116*	*143*
16	25	35	50	50	**7.4**	**14.9**	**22.3**	**29.8**	**37.2**	**44.7**	**59.6**	81.9	119	*156*	*194*
20	30	40	60	60	**0**	**8.4**	**16.8**	**25.3**	**33.7**	**42.1**	**58.9**	**84.2**	126	168	*211*
24	35	50	70	70	**0**	**0**	**10.4**	**20.9**	**31.3**	**41.8**	**62.6**	**94.0**	146	198	251
30	45	60	85	90	**0**	**0**	**0**	**6.3**	**18.9**	**31.6**	**56.8**	**94.7**	**158**	**221**	284

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	25	40	50	45	**18.5**	**27.8**	37.0	46.3	55.5	*64.8*	*83.3*	*111*	*157*	*204*	*250*
16	30	50	65	55	**12.1**	**24.3**	**36.4**	**48.6**	**60.7**	72.9	97	*134*	*194*	*255*	*316*
20	35	60	80	70	**0**	**14.9**	**29.8**	**44.7**	**59.6**	**74.5**	104	149	*224*	*298*	*373*
24	40	75	95	80	**0**	**0**	**18.9**	**37.8**	**56.8**	**75.7**	**114**	170	265	*360*	*454*
30	50	90	115	100	**0**	**0**	**0**	**11.2**	**33.5**	**55.9**	**101**	**168**	280	391	*503*

For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.

Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.

Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.

Bearing values assume standard clearance holes.

If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.

If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.

In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u\, d\, t/\gamma_{M2}$

FOR EXPLANATION OF TABLES SEE NOTE 11

Preloaded bolts at serviceability limit state (Category B)

Property Class 8.8 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Shear Resistance		Slip resistance, $F_{s,Rd,ser}$							
		Single Shear	Double Shear	μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
				Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
d	A_s	$F_{v,Rd}$	2 x $F_{v,Rd}$								
mm	mm^2	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
12	84.3	27.5	55.0	8.6	17.2	12.9	25.7	17.2	34.3	21.5	42.9
16	157	60.3	121	16.0	32.0	24.0	48.0	32.0	63.9	40.0	79.9
20	245	94.1	188	24.9	49.9	37.4	74.8	49.9	100	62.4	125
24	353	136	271	35.9	71.9	53.9	108	71.9	144	89.9	180
30	561	215	431	57.1	114	85.7	171	114	228	143	286

Bearing resistances may be taken from the tables for non-preloaded bolts
For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
The shear resistances are ULS values
The slip resistances are SLS values
Values have been calculated assuming k_s=1. See BS EN 1993-1-8, section 3.9 for other values of k_s.

Preloaded bolts in tension (Category E)

Property Class 8.8 hexagon head bolts

Diameter of bolt	Tensile Stress Area	Tension Resistance	Min. thickness for punching shear
d	A_s	$F_{t,Rd}$	t_{min}
mm	mm^2	kN	mm
12	84.3	48.6	3.7
16	157	90.4	5.4
20	245	141	7.1
24	353	203	8
30	561	323	10.5

The minimum thickness is such that the design punching shear resistance $B_{p,Rd}$ is equal to the design tension resistance $F_{t,Rd}$.
FOR EXPLANATION OF TABLES SEE NOTE 11

Preloaded bolts at serviceability limit state (Category B)

Property Class 10.9 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Shear Resistance		Slip resistance, $F_{s,Rd,ser}$							
		Single Shear	Double Shear	μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
				Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
d	A_s	$F_{v,Rd}$	2 x $F_{v,Rd}$								
mm	mm^2	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
16	157	62.8	126	20.0	40.0	30.0	59.9	40.0	79.9	50.0	99.9
20	245	98.0	196	31.2	62.4	46.8	93.5	62.4	125	78.0	156
24	353	141	282	44.9	89.9	67.4	135	89.9	180	112	225
30	561	224	449	71.4	143	107	214	143	286	179	357

Bearing resistances may be taken from the tables for non-preloaded bolts
For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
The shear resistances are ULS values
The slip resistances are SLS values
Values have been calculated assuming k_s=1. See BS EN 1993-1-8, section 3.9 for other values of k_s.

Preloaded bolts in tension (Category E)

Property Class 10.9 hexagon head bolts

Diameter of bolt	Tensile Stress Area	Tension Resistance	Min. thickness for punching shear
d	A_s	$F_{t,Rd}$	t_{min}
mm	mm^2	kN	mm
16	157	113	6.8
20	245	176	8.9
24	353	254	10.0
30	561	404	13.1

The minimum thickness is such that the design punching shear resistance $B_{p,Rd}$ is equal to the design tension resistance $F_{t,Rd}$.
FOR EXPLANATION OF TABLES SEE NOTE 11

Preloaded bolts at ultimate limit state (Category C)

Property Class 8.8 hexagon head bolts

Diameter of Bolt d mm	Tensile Stress Area A_s mm^2	Slip Resistance							
		μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
		Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN
12	84.3	7.55	15.1	11.3	22.7	15.1	30.2	18.9	37.8
16	157	14.1	28.1	21.1	42.2	28.1	56.3	35.2	70.3
20	245	22.0	43.9	32.9	65.9	43.9	87.8	54.9	110
24	353	31.6	63.3	47.4	94.9	63.3	127	79.1	158
30	561	50.3	101	75.4	151	101	201	126	251

Bearing resistances may be taken from the tables for non-preloaded bolts
Shear resistances may be taken from the tables for Category B joints
FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Preloaded bolts at ultimate limit state (Category C)

Property Class 10.9 hexagon head bolts

Diameter of Bolt d mm	Tensile Stress Area A_s mm^2	Slip Resistance							
		$\mu = 0.2$		$\mu = 0.3$		$\mu = 0.4$		$\mu = 0.5$	
		Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN
16	157	17.6	35.2	26.4	52.8	35.2	70.3	44.0	87.9
20	245	27.4	54.9	41.2	82.3	54.9	110	68.6	137
24	353	39.5	79.1	59.3	119	79.1	158	98.8	198
30	561	62.8	126	94.2	188	126	251	157	314

Bearing resistances may be taken from the tables for non-preloaded bolts
Shear resistances may be taken from the tables for Category B joints
FOR EXPLANATION OF TABLES SEE NOTE 11

Preloaded bolts at serviceability limit state (Category B)

Property Class 8.8 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Shear Resistance		Slip resistance, $F_{s,Rd,ser}$							
		Single Shear	Double Shear	μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
				Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
d	A_s	$F_{v,Rd}$	2 x $F_{v,Rd}$								
mm	mm²	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
12	84.3	27.5	55.0	8.6	17.2	12.9	25.7	17.2	34.3	21.5	42.9
16	157	60.3	121	16.0	32.0	24.0	48.0	32.0	63.9	40.0	79.9
20	245	94.1	188	24.9	49.9	37.4	74.8	49.9	100	62.4	125
24	353	136	271	35.9	71.9	53.9	108	71.9	144	89.9	180
30	561	215	431	57.1	114	85.7	171	114	228	143	286

Bearing resistances may be taken from the tables for non-preloaded countersunk bolts
For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
The shear resistances are ULS values
The slip resistances are SLS values
Values have been calculated assuming k_s=1. See BS EN 1993-1-8, section 3.9 for other values of k_s.

Preloaded bolts in tension (Category E)

Property Class 8.8 countersunk bolts

Diameter of bolt	Tensile Stress Area	Tension Resistance	Min. thickness for punching shear
d	A_s	$F_{t,Rd}$	t_{min}
mm	mm²	kN	mm
12	84.3	34.0	2.6
16	157	63.3	3.8
20	245	98.8	5
24	353	142	5.6
30	561	226	7.3

The minimum thickness is such that the design punching shear resistance $B_{p,Rd}$ is equal to the design tension resistance $F_{t,Rd}$.
FOR EXPLANATION OF TABLES SEE NOTE 11

Preloaded bolts at serviceability limit state (Category B)

Property Class 10.9 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Shear Resistance		Slip resistance, $F_{s,Rd,ser}$							
		Single Shear	Double Shear	$\mu = 0.2$		$\mu = 0.3$		$\mu = 0.4$		$\mu = 0.5$	
				Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
d	A_s	$F_{v,Rd}$	$2 \times F_{v,Rd}$								
mm	mm^2	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
16	157	62.8	126	20.0	40.0	30.0	59.9	40.0	79.9	50.0	99.9
20	245	98.0	196	31.2	62.4	46.8	93.5	62.4	125	78.0	156
24	353	141	282	44.9	89.9	67.4	135	89.9	180	112	225
30	561	224	449	71.4	143	107	214	143	286	179	357

Bearing resistances may be taken from the tables for non-preloaded countersunk bolts
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
The shear resistances are ULS values
The slip resistances are SLS values
Values have been calculated assuming k_s=1. See BS EN 1993-1-8, section 3.9 for other values of k_s.

Preloaded bolts in tension (Category E)

Property Class 10.9 countersunk bolts

Diameter of bolt	Tensile Stress Area	Tension Resistance	Min. thickness for punching shear
d	A_s	$F_{t,Rd}$	t_{min}
mm	mm^2	kN	mm
16	157	79.1	4.7
20	245	124	6.2
24	353	178	7.0
30	561	283	9.1

The minimum thickness is such that the design punching shear resistance $B_{p,Rd}$ is equal to the design tension resistance $F_{t,Rd}$.
FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Preloaded bolts at ultimate limit state (Category C)

Property Class 8.8 countersunk bolts

Diameter of Bolt d mm	Tensile Stress Area A_s mm^2	Slip Resistance							
		μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
		Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN
12	84.3	7.55	15.1	11.3	22.7	15.1	30.2	18.9	37.8
16	157	14.1	28.1	21.1	42.2	28.1	56.3	35.2	70.3
20	245	22.0	43.9	32.9	65.9	43.9	87.8	54.9	110
24	353	31.6	63.3	47.4	94.9	63.3	127	79.1	158
30	561	50.3	101	75.4	151	101	201	126	251

Bearing resistances may be taken from the tables for non-preloaded countersunk bolts
Shear resistances may be taken from the tables for Category B joints
FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Preloaded bolts at ultimate limit state (Category C)

Property Class 10.9 countersunk bolts

Diameter of Bolt d mm	Tensile Stress Area A_s mm^2	Slip Resistance							
		μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
		Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN
16	157	17.6	35.2	26.4	52.8	35.2	70.3	44.0	87.9
20	245	27.4	54.9	41.2	82.3	54.9	110	68.6	137
24	353	39.5	79.1	59.3	119	79.1	158	98.8	198
30	561	62.8	126	94.2	188	126	251	157	314

Bearing resistances may be taken from the tables for non-preloaded countersunk bolts
Shear resistances may be taken from the tables for Category B joints
FOR EXPLANATION OF TABLES SEE NOTE 11

Design weld resistances

Leg Length s mm	Throat Thickness a mm	Longitudinal resistance $F_{w,L,Rd}$ kN/mm	Transverse resistance $F_{w,T,Rd}$ kN/mm
3.0	2.1	0.47	0.57
4.0	2.8	0.62	0.76
5.0	3.5	0.78	0.96
6.0	4.2	0.94	1.15
8.0	5.6	1.25	1.53
10.0	7.0	1.56	1.91
12.0	8.4	1.87	2.29
15.0	10.5	2.34	2.87
18.0	12.6	2.81	3.44
20.0	14.0	3.12	3.82
22.0	15.4	3.43	4.20
25.0	17.5	3.90	4.78

FOR EXPLANATION OF TABLES SEE NOTE 11.2

MEMBERSHIP CAPACITIES

S355

BENDING

UNIVERSAL BEAMS
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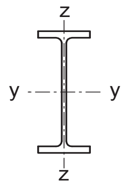

RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S355

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
1016x305x487 +	1	6480	7770	**13000**	**13000**	12200	10900	9670	8620	7700	6900	6220	5650	5180	4780	4440
1016x305x437 +	1	5810	6960	**11600**	**11600**	10900	9720	8660	7710	6890	6180	5570	5060	4640	4280	3980
1016x305x393 +	1	5240	6210	**10500**	**10500**	9780	8710	7750	6900	6160	5520	4970	4520	4140	3820	3550
1016x305x349 +	1	4700	5720	**9400**	**9400**	8920	7950	7090	6330	5660	5080	4580	4160	3820	3520	3270
1016x305x314 +	1	4240	5120	**8490**	**8490**	8010	7140	6360	5670	5070	4550	4100	3730	3420	3150	2930
1016x305x272 +	1	3680	4430	**7360**	**7360**	6930	6180	5500	4900	4380	3930	3540	3220	2950	2720	2530
1016x305x249 +	1	3600	3920	**7210**	7190	6380	5640	4980	4410	3910	3480	3130	2850	2610	2410	2240
1016x305x222 +	1	3430	3380	**6870**	6500	5720	5010	4390	3850	3380	3010	2710	2460	2260	2080	1930
914x419x388	1	4220	6090	**8430**	**8430**	**8430**	8020	7230	6510	5890	5330	4850	4430	4060	3750	3480
914x419x343	1	3800	5340	**7600**	**7600**	**7600**	7100	6380	5740	5180	4690	4260	3880	3560	3290	3050
914x305x289	1	3780	4340	**7550**	**7550**	6930	6150	5450	4840	4310	3850	3470	3150	2890	2670	2480
914x305x253	1	3350	3770	**6690**	**6690**	6070	5380	4770	4230	3760	3360	3020	2750	2520	2320	2160
914x305x224	1	3060	3290	**6120**	6090	5390	4760	4200	3710	3280	2920	2630	2390	2190	2020	1880
914x305x201	1	2870	2880	**5750**	5510	4850	4250	3730	3270	2880	2560	2310	2100	1920	1770	1650
838x292x226	1	2900	3160	**5790**	**5790**	5200	4580	4030	3560	3150	2810	2530	2300	2110	1940	1800
838x292x194	1	2610	2640	**5220**	5090	4460	3900	3410	2990	2640	2340	2110	1920	1760	1620	1510
838x292x176	1	2460	2350	**4930**	4650	4060	3530	3070	2680	2350	2090	1880	1710	1570	1450	1340
762x267x197	1	2530	2470	**5070**	4930	4280	3710	3230	2820	2470	2200	1980	1800	1650	1520	*1410*
762x267x173	1	2290	2140	**4580**	4340	3760	3240	2810	2440	2140	1900	1710	1560	1430	1320	*1220*
762x267x147	1	2040	1780	**4070**	3710	3190	2740	2350	2030	1780	1580	1420	1290	1190	1090	*1020*
762x267x134	1	1970	1650	**3940**	3500	3000	2560	2190	1880	1650	1470	1320	1200	1100	*1010*	*942*
686x254x170	1	2120	1940	**4240**	4040	3470	2970	2560	2220	1940	1730	1550	1410	1300	*1200*	*1110*
686x254x152	1	1920	1730	**3830**	3610	3090	2650	2280	1970	1730	1530	1380	1250	1150	*1060*	*986*
686x254x140	1	1790	1570	**3570**	3320	2840	2430	2080	1800	1570	1400	1260	1140	1050	*968*	*899*
686x254x125	1	1670	1380	**3340**	2980	2530	2150	1830	1570	1380	1220	1100	1000	*919*	*848*	*787*

+ These sections are in addition to the range of BS 4 sections

Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

BENDING

UNIVERSAL BEAMS
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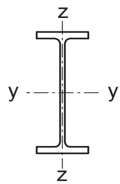

RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S355

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
610x305x238	1	2460	2580	**4920**	**4920**	4470	3860	3350	2930	2580	2300	2070	1880	*1720*	*1590*	*1480*
610x305x179	1	1880	1910	**3750**	**3750**	3340	2880	2490	2180	1910	1700	1530	1390	*1280*	*1180*	*1090*
610x305x149	1	1570	1580	**3140**	**3140**	2770	2390	2070	1800	1580	1410	1270	1150	*1060*	*975*	*906*
610x229x140	1	1690	1430	**3380**	3110	2630	2230	1900	1630	1430	1270	1140	*1040*	*953*	*879*	*817*
610x229x125	1	1520	1270	**3050**	2780	2340	1980	1690	1450	1270	1130	1010	*922*	*845*	*780*	*725*
610x229x113	1	1420	1130	**2840**	2520	2110	1780	1510	1290	1130	1010	906	*823*	*755*	*697*	*647*
610x229x101	1	1370	1020	**2740**	2330	1940	1620	1360	1170	1020	909	818	*744*	*682*	*629*	*584*
610x178x100 +	1	1450	961	2770	2280	1870	1540	1280	1100	961	854	769	*699*	*641*	*591*	*549*
610x178x92 +	1	1410	891	2620	2150	1750	1430	1190	1020	891	792	713	*648*	*594*	*549*	*509*
610x178x82 +	1	1290	779	2340	1900	1540	1250	1040	890	779	692	623	*566*	*519*	*479*	*445*
533x312x272 +	1	2480	2710	**4970**	**4970**	4700	4050	3510	3070	2710	2410	2170	*1970*	*1810*	*1670*	*1550*
533x312x219 +	1	2120	2110	**4240**	**4240**	3750	3210	2760	2400	2110	1880	1690	*1530*	*1410*	*1300*	*1210*
533x312x182 +	1	1740	1740	**3480**	**3480**	3080	2640	2280	1980	1740	1540	*1390*	*1260*	*1160*	*1070*	*993*
533x312x150 +	1	1460	1430	**2910**	**2910**	2550	2180	1880	1630	1430	1270	*1140*	*1040*	*954*	*880*	*817*
533x210x138 +	1	1680	1250	**3370**	2890	2380	1980	1660	1420	1250	1110	*997*	*907*	*831*	*767*	*712*
533x210x122	1	1450	1100	**2900**	2530	2100	1750	1470	1260	1100	980	*882*	*802*	*735*	*679*	*630*
533x210x109	1	1330	976	**2660**	2270	1870	1550	1300	1120	976	868	*781*	*710*	*651*	*601*	*558*
533x210x101	1	1240	901	**2480**	2100	1730	1430	1200	1030	901	801	*721*	*655*	*601*	*555*	*515*
533x210x92	1	1170	838	**2350**	1960	1610	1330	1120	957	838	745	*670*	*609*	*559*	*516*	*479*
533x210x82	1	1120	731	2170	1760	1430	1170	975	835	731	650	*585*	*532*	*487*	*450*	*418*
533x165x85 +	1	1170	726	2210	1780	1430	1160	968	830	726	645	*581*	*528*	*484*	*447*	*415*
533x165x74 +	1	1120	642	2020	1610	1280	1030	856	734	642	*571*	*513*	*467*	*428*	*395*	*367*
533x165x66 +	1	1020	554	1780	1400	1110	887	739	633	554	*493*	*443*	*403*	*369*	*341*	*317*
457x191x161 +	1	1810	1300	**3610**	3090	2520	2080	1740	1490	1300	*1160*	*1040*	*948*	*869*	*802*	*745*
457x191x133 +	1	1510	1060	**3020**	2530	2060	1690	1410	1210	1060	*941*	*847*	*770*	*706*	*652*	*605*
457x191x106 +	1	1230	824	**2460**	1990	1610	1320	1100	942	824	*733*	*659*	*599*	*549*	*507*	*471*
457x191x98	1	1110	770	**2220**	1840	1500	1230	1030	880	770	*684*	*616*	*560*	*513*	*474*	*440*
457x191x89	1	1030	695	**2050**	1680	1360	1110	926	794	695	*618*	*556*	*505*	*463*	*428*	*397*
457x191x82	1	976	650	**1950**	1570	1270	1040	867	743	*650*	*578*	*520*	*473*	*433*	*400*	*371*
457x191x74	1	895	587	1780	1430	1150	938	782	671	*587*	*522*	*469*	*427*	*391*	*361*	*335*
457x191x67	1	839	522	1620	1290	1030	836	696	597	*522*	*464*	*418*	*380*	*348*	*321*	*298*
457x152x82	1	1040	625	1970	1560	1240	1000	834	714	625	*556*	*500*	*455*	*417*	*385*	*357*
457x152x74	1	938	561	1770	1400	1110	898	748	642	561	*499*	*449*	*408*	*374*	*345*	*321*
457x152x67	1	899	516	1650	1300	1030	825	688	590	*516*	*459*	*413*	*375*	*344*	*317*	*295*
457x152x60	1	806	457	1470	1150	909	731	609	522	*457*	*406*	*366*	*332*	*305*	*281*	*261*
457x152x52	1	747	389	1290	1000	778	623	519	445	*389*	*346*	*311*	*283*	*259*	*239*	*222*

+ These sections are in addition to the range of BS 4 sections

Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

BENDING

UNIVERSAL BEAMS
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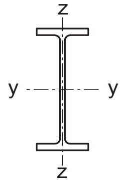


RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S355

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
406x178x85 +	1	966	598	**1930**	**1930**	1890	1680	1490	1320	1180	1060	957	870	797	736	683
406x178x74	1	858	533	**1720**	**1720**	1680	1490	1320	1180	1050	945	853	775	710	656	609
406x178x67	1	790	478	**1580**	**1580**	1520	1350	1190	1060	947	848	765	695	637	588	546
406x178x60	1	709	426	**1420**	**1420**	1360	1200	1070	947	845	757	682	620	568	524	487
406x178x54	1	683	375	**1370**	**1370**	1240	1090	956	844	747	666	599	545	499	461	*428*
406x140x53 +	1	709	366	**1420**	1410	1240	1080	946	830	732	651	586	532	488	450	*418*
406x140x46	1	611	315	**1220**	1220	1070	931	815	715	630	560	504	459	420	388	*360*
406x140x39	1	566	257	**1130**	1050	908	784	677	587	514	457	411	374	343	316	*294*
356x171x67	1	733	430	**1470**	**1470**	1410	1240	1090	963	855	764	688	625	573	*529*	*491*
356x171x57	1	646	359	**1290**	**1290**	1200	1050	919	808	715	637	574	522	478	*441*	*410*
356x171x51	1	587	318	**1170**	**1170**	1070	936	818	719	635	565	509	463	424	*391*	*364*
356x171x45	2	549	275	**1100**	**1100**	952	825	717	626	550	489	440	400	367	*339*	*314*
356x127x39	1	527	234	**1050**	986	843	721	619	535	468	416	374	340	312	*288*	*267*
356x127x33	1	472	193	**944**	839	711	602	513	441	386	343	308	280	*257*	*237*	*220*
305x165x54	1	545	300	**1090**	**1090**	1030	889	774	679	600	534	481	*437*	*400*	*370*	*343*
305x165x46	1	461	256	**922**	**922**	871	756	658	577	510	454	409	*372*	*341*	*315*	*292*
305x165x40	1	411	221	**823**	**823**	761	658	572	501	442	393	354	*322*	*295*	*272*	*253*
305x127x48	1	612	252	**1220**	1120	937	790	671	577	505	449	404	*367*	*337*	*311*	*288*
305x127x42	1	542	218	**1080**	972	814	685	580	498	436	388	349	*317*	*291*	*268*	*249*
305x127x37	1	481	191	**962**	856	717	602	510	437	383	340	306	*278*	*255*	*236*	*219*
305x102x33	1	452	171	**903**	775	646	540	455	390	342	304	273	*248*	*228*	*210*	*195*
305x102x28	1	407	143	803	666	550	456	382	327	286	254	229	*208*	*191*	*176*	*164*
305x102x25	1	386	121	716	586	476	389	324	278	243	216	194	*177*	*162*	*149*	*139*
254x146x43	1	415	201	**829**	**829**	725	616	529	458	402	357	*321*	*292*	*268*	*247*	*230*
254x146x37	1	361	171	**723**	**723**	622	528	452	391	343	305	*274*	*249*	*229*	*211*	*196*
254x146x31	1	336	140	**672**	627	522	438	371	319	279	*248*	*223*	*203*	*186*	*172*	*159*
254x102x28	1	365	125	**730**	598	487	400	334	286	251	*223*	*201*	*182*	*167*	*154*	*143*
254x102x25	1	341	109	658	530	427	348	290	248	217	*193*	*174*	*158*	*145*	*134*	*124*
254x102x22	1	320	91.9	580	460	365	294	245	210	184	*163*	*147*	*134*	*123*	*113*	*105*
203x133x30	1	299	111	**597**	530	430	354	297	255	*223*	*198*	*178*	*162*	*149*	*137*	*127*
203x133x25	1	263	91.6	**527**	444	357	292	244	209	*183*	*163*	*147*	*133*	*122*	*113*	*105*
203x102x23	1	254	83.1	**508**	410	327	266	222	190	*166*	*148*	*133*	*121*	*111*	*102*	*94.9*
178x102x19	1	203	60.7	400	308	241	194	162	*139*	*121*	*108*	*97.1*	*88.3*	*80.9*	*74.7*	*69.4*
152x89x16	1	167	43.7	307	228	175	140	*116*	*99.8*	*87.3*	*77.6*	*69.9*	*63.5*	*58.2*	*53.7*	*49.9*
127x76x13	1	131	29.8	222	158	119	*95.4*	*79.5*	*68.2*	*59.6*	*53.0*	*47.7*	*43.4*	*39.8*	*36.7*	*34.1*

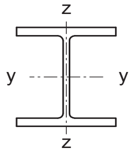
+ These sections are in addition to the range of BS 4 sections

Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

UNIVERSAL COLUMNS
Advance® UKC



RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S355

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
356x406x634	1	4040	4630	**8070**	**8070**	**8070**	7050	6040	5250	4620	*4110*	*3700*	*3360*	*3080*	*2850*	*2640*
356x406x551	1	3490	3920	**6980**	**6980**	**6980**	5990	5130	4450	3920	*3490*	*3140*	*2850*	*2620*	*2420*	*2240*
356x406x467	1	3000	3350	**6010**	**6010**	**6010**	5120	4380	3800	*3350*	*2980*	*2680*	*2440*	*2230*	*2060*	*1910*
356x406x393	1	2520	2750	**5050**	**5050**	5000	4220	3610	3130	*2750*	*2450*	*2200*	*2000*	*1840*	*1700*	*1570*
356x406x340	1	2160	2340	**4320**	**4320**	4260	3590	3070	2670	*2340*	*2080*	*1880*	*1710*	*1560*	*1440*	*1340*
356x406x287	1	1870	2010	**3750**	**3750**	3650	3080	2630	2280	*2000*	*1780*	*1600*	*1460*	*1340*	*1230*	*1150*
356x406x235	1	1500	1620	**3000**	**3000**	2930	2480	2120	*1840*	*1620*	*1440*	*1290*	*1180*	*1080*	*995*	*924*
356x368x202	1	1340	1370	**2680**	**2680**	2520	2110	1800	*1560*	*1370*	*1220*	*1100*	*997*	*914*	*843*	*783*
356x368x177	1	1180	1190	**2360**	**2360**	2200	1840	1570	*1360*	*1190*	*1060*	*954*	*867*	*795*	*734*	*681*
356x368x153	2	1000	1020	**2010**	**2010**	1880	1580	1350	*1170*	*1020*	*909*	*818*	*744*	*682*	*629*	*585*
356x368x129	3	839	781	1450	1340	1230	1110	1000	889	*781*	*694*	*625*	*568*	*521*	*481*	*446*
305x305x283	1	1950	1710	**3910**	**3910**	3270	2700	2270	*1950*	*1710*	*1520*	*1370*	*1240*	*1140*	*1050*	*977*
305x305x240	1	1710	1470	**3430**	**3430**	2810	2310	1950	*1670*	*1470*	*1300*	*1170*	*1070*	*977*	*902*	*837*
305x305x198	1	1400	1190	**2790**	**2790**	2270	1870	1580	*1360*	*1190*	*1050*	*949*	*863*	*791*	*730*	*678*
305x305x158	1	1130	925	**2270**	2210	1780	1470	*1230*	*1060*	*925*	*822*	*740*	*673*	*617*	*569*	*528*
305x305x137	1	984	792	**1970**	1900	1530	1260	*1060*	*906*	*792*	*704*	*634*	*576*	*528*	*488*	*453*
305x305x118	1	856	675	**1710**	1630	1310	1070	*900*	*772*	*675*	*600*	*540*	*491*	*450*	*416*	*386*
305x305x97	3	721	513	1190	1060	935	809	684	*586*	*513*	*456*	*410*	*373*	*342*	*316*	*293*
254x254x167	1	1180	836	**2350**	2090	1650	1340	*1110*	*956*	*836*	*743*	*669*	*608*	*557*	*515*	*478*
254x254x132	1	918	645	**1840**	1620	1270	*1030*	*860*	*737*	*645*	*573*	*516*	*469*	*430*	*397*	*369*
254x254x107	1	751	512	**1500**	1290	1010	*819*	*683*	*585*	*512*	*455*	*410*	*372*	*341*	*315*	*293*
254x254x89	1	607	422	**1210**	1060	832	*675*	*563*	*483*	*422*	*375*	*338*	*307*	*282*	*260*	*241*
254x254x73	2	525	352	**1050**	889	696	*563*	*470*	*403*	*352*	*313*	*282*	*256*	*235*	*217*	*201*
203x203x127 +	1	893	523	**1790**	1360	1040	*837*	*698*	*598*	*523*	*465*	*419*	*381*	*349*	*322*	*299*
203x203x113 +	1	812	459	**1620**	1200	916	*734*	*611*	*524*	*459*	*408*	*367*	*333*	*306*	*282*	*262*
203x203x100 +	1	709	396	**1420**	1030	*791*	*634*	*528*	*453*	*396*	*352*	*317*	*288*	*264*	*244*	*226*
203x203x86	1	619	337	1210	882	*674*	*539*	*449*	*385*	*337*	*300*	*270*	*245*	*225*	*207*	*193*
203x203x71	1	483	276	**966**	717	*550*	*441*	*367*	*315*	*276*	*245*	*220*	*200*	*184*	*170*	*157*
203x203x60	1	455	233	849	612	*466*	*373*	*311*	*266*	*233*	*207*	*186*	*169*	*155*	*143*	*133*
203x203x52	1	385	201	731	529	*403*	*322*	*269*	*230*	*201*	*179*	*161*	*147*	*134*	*124*	*115*
203x203x46	2	347	177	645	465	*353*	*283*	*235*	*202*	*177*	*157*	*141*	*128*	*118*	*109*	*101*
152x152x51 +	1	408	155	604	*415*	*311*	*249*	*207*	*178*	*155*	*138*	*124*	*113*	*104*	*95.7*	*88.9*
152x152x44 +	1	350	132	514	*352*	*264*	*211*	*176*	*151*	*132*	*117*	*106*	*96.0*	*88.0*	*81.3*	*75.5*
152x152x37	1	292	110	427	*292*	*219*	*175*	*146*	*125*	*110*	*97.4*	*87.7*	*79.7*	*73.1*	*67.5*	*62.6*
152x152x30	1	238	87.9	343	*234*	*176*	*141*	*117*	*100*	*87.9*	*78.2*	*70.3*	*63.9*	*58.6*	*54.1*	*50.2*
152x152x23	3	204	58.2	229	155	*116*	*93.2*	*77.6*	*66.5*	*58.2*	*51.8*	*46.6*	*42.3*	*38.8*	*35.8*	*33.3*

+ These sections are in addition to the range of BS 4 sections

Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

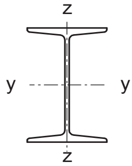
The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

BS EN 1993-1-1:2005
BS 4-1: 2005

BENDING

S355

JOISTS



RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S355

Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
254x203x82	1	676	372	**1350**	**1350**	1330	1130	970	844	742	661	*595*	*540*	*495*	*457*	*425*
254x114x37	1	455	163	**909**	776	631	519	435	372	326	*290*	*261*	*237*	*217*	*201*	*186*
203x152x52	1	456	187	**912**	889	717	591	497	427	*373*	*332*	*299*	*271*	*249*	*230*	*213*
152x127x37	1	388	99.0	711	519	396	317	*264*	*226*	*198*	*176*	*158*	*144*	*132*	*122*	*113*
127x114x29	1	298	64.3	484	342	257	*206*	*171*	*147*	*129*	*114*	*103*	*93.5*	*85.7*	*79.1*	*73.4*
127x114x27	1	230	61.1	441	320	244	*195*	*163*	*140*	*122*	*109*	*97.7*	*88.8*	*81.4*	*75.2*	*69.8*
127x76x16	1	181	36.9	281	197	148	*118*	*98.5*	*84.4*	*73.8*	*65.6*	*59.1*	*53.7*	*49.2*	*45.4*	*42.2*
114x114x27	1	289	53.6	417	286	*214*	*172*	*143*	*123*	*107*	*95.3*	*85.8*	*78.0*	*71.5*	*66.0*	*61.3*
102x102x23	1	238	40.1	316	214	*160*	*128*	*107*	*91.7*	*80.2*	*71.3*	*64.2*	*58.3*	*53.5*	*49.4*	*45.8*
102x44x7	1	106	12.6	101	67.0	*50.3*	*40.2*	*33.5*	*28.7*	*25.1*	*22.3*	*20.1*	*18.3*	*16.8*	*15.5*	*14.4*
89x89x19	1	214	29.4	235	*157*	*117*	*93.9*	*78.3*	*67.1*	*58.7*	*52.2*	*47.0*	*42.7*	*39.1*	*36.1*	*33.6*
76x76x15	1	164	19.2	154	*103*	*77.0*	*61.6*	*51.3*	*44.0*	*38.5*	*34.2*	*30.8*	*28.0*	*25.7*	*23.7*	*22.0*
76x76x13	1	111	17.3	138	*92.2*	*69.2*	*55.3*	*46.1*	*39.5*	*34.6*	*30.7*	*27.7*	*25.1*	*23.1*	*21.3*	*19.8*

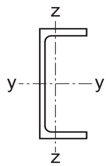
Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

BENDING

PARALLEL FLANGE CHANNELS
Advance® UKPFC



RESTRAINED BEAM RESISTANCES AND ULTIMATE LOADS FOR S355

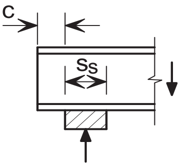
Section Designation	Section Class	Shear Resistance $V_{pl,Rd}$ kN	Moment Resistance $M_{c,y,Rd}$ kNm	Ultimate U.D.L. (kN) for Restrained Beams for Lengths, L (m)												
				1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
430x100x64	1	1030	422	**2070**	1810	1540	1310	1120	964	843	749	675	613	562	519	482
380x100x54	1	809	322	**1620**	1420	1200	1010	857	736	644	572	515	468	429	396	*368*
300x100x46	1	626	221	**1250**	1050	855	705	590	505	442	393	354	*322*	*295*	*272*	*253*
300x90x41	1	613	202	1200	971	788	645	538	461	403	358	323	*293*	*269*	*248*	*230*
260x90x35	1	485	151	939	746	596	483	402	345	302	*268*	*241*	*219*	*201*	*186*	*172*
260x75x28	1	427	116	761	593	465	373	311	266	233	*207*	*186*	*169*	*155*	*143*	*133*
230x90x32	1	414	126	810	632	499	403	336	288	*252*	*224*	*202*	*183*	*168*	*155*	*144*
230x75x26	1	364	98.7	661	507	394	316	263	226	*197*	*175*	*158*	*144*	*132*	*121*	*113*
200x90x30	1	349	103	688	526	411	331	275	*236*	*207*	*184*	*165*	*150*	*138*	*127*	*118*
200x75x23	1	305	80.6	556	418	322	258	215	*184*	*161*	*143*	*129*	*117*	*107*	*99.2*	*92.1*
180x90x26	1	297	82.4	567	426	329	264	220	*188*	*165*	*146*	*132*	*120*	*110*	*101*	*94.1*
180x75x20	1	273	62.5	453	330	250	200	167	*143*	*125*	*111*	*100.0*	*90.9*	*83.3*	*76.9*	*71.4*
150x90x24	1	255	63.5	461	334	254	203	*169*	*145*	*127*	*113*	*102*	*92.4*	*84.7*	*78.2*	*72.6*
150x75x18	1	220	46.9	351	249	187	150	*125*	*107*	*93.7*	*83.3*	*75.0*	*68.2*	*62.5*	*57.7*	*53.6*
125x65x15	1	190	31.9	251	170	128	*102*	*85.1*	*72.9*	*63.8*	*56.7*	*51.1*	*46.4*	*42.6*	*39.3*	*36.5*
100x50x10	1	132	17.4	139	92.6	*69.4*	*55.6*	*46.3*	*39.7*	*34.7*	*30.9*	*27.8*	*25.3*	*23.1*	*21.4*	*19.8*

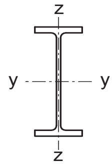
Section classification given applies to members subject to bending about the y-y axis only.

Loads given are the total ultimate uniformaly distributed load supported over a beam span L assuming full lateral restraint to the compression flange. Self weight of the section has not been allowed for.
UDL values in **bold type** are governed by the shear resistance

The unfactored variable action is assumed to be 40% of the ultimate load given.
UDL values in *italic type* (to the right of the zigzag line) may be susceptible to serviceability deflections > L/360
(This deflection limit is for beams which carry a brittle finish.)
Shaded UDL values may be susceptible to serviceability deflections > L/200
(This deflection limit is for beams which do not carry a brittle finish.)
FOR EXPLANATION OF TABLES SEE NOTE 5

UNIVERSAL BEAMS
Advance® UKB





Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
1016x305x487 +	6480	F_{Rd} (c = 0)	1230	1340	1450	1570	1700	1830	2200	2600	3250	3750	4260	4760	5260
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	290
		F_{Rd} (c ≥ c_{lim})	4570	4680	4780	4880	4980	5080	5330	5580	6080	6580	7090	8330	8390
1016x305x437 +	5810	F_{Rd} (c = 0)	1050	1150	1250	1360	1470	1600	1930	2670	3090	3480	3860	4240	4620
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	310
		F_{Rd} (c ≥ c_{lim})	3860	3950	4040	4130	4220	4310	4540	4760	5990	6210	6420	6630	6830
1016x305x393 +	5240	F_{Rd} (c = 0)	894	980	1070	1640	1720	1790	1980	2180	2520	2830	3150	3460	3780
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	300
		F_{Rd} (c ≥ c_{lim})	3250	3330	3410	3490	3570	4440	4540	4640	4830	5020	5190	5370	5530
1016x305x349 +	4700	F_{Rd} (c = 0)	1090	1140	1190	1240	1300	1350	1500	1650	1900	2140	2380	2620	2860
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	290
		F_{Rd} (c ≥ c_{lim})	3170	3200	3230	3270	3300	3330	3410	3480	3630	3770	3910	4040	4170
1016x305x314 +	4240	F_{Rd} (c = 0)	879	921	964	1010	1050	1100	1220	1350	1540	1740	1940	2130	2330
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	270
		F_{Rd} (c ≥ c_{lim})	2540	2570	2590	2620	2650	2670	2740	2800	2920	3040	3150	3260	3370
1016x305x272 +	3680	F_{Rd} (c = 0)	648	679	711	744	778	813	904	993	1140	1290	1430	1580	1730
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	270
		F_{Rd} (c ≥ c_{lim})	1840	1860	1880	1910	1930	1950	2000	2040	2140	2230	2310	2380	2380
1016x305x249 +	3600	F_{Rd} (c = 0)	631	662	695	728	763	799	891	968	1120	1260	1410	1560	1700
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	270
		F_{Rd} (c ≥ c_{lim})	1760	1780	1800	1820	1850	1870	1920	1970	2060	2160	2250	2330	2350
1016x305x222 +	3440	F_{Rd} (c = 0)	580	610	641	673	706	740	820	890	1030	1170	1310	1440	1580
		c_{lim} (mm)	620	610	600	590	580	570	550	520	470	420	370	320	270
		F_{Rd} (c ≥ c_{lim})	1580	1600	1620	1650	1670	1690	1740	1790	1880	1970	2060	2140	2140
914x419x388	4220	F_{Rd} (c = 0)	1160	1210	1270	1330	1390	1460	1620	1790	2080	2350	2620	2890	3160
		c_{lim} (mm)	570	560	550	540	530	520	500	470	420	370	320	280	280
		F_{Rd} (c ≥ c_{lim})	3400	3430	3470	3500	3540	3570	3650	3740	3890	4050	4190	4340	4470
914x419x343	3800	F_{Rd} (c = 0)	932	978	1030	1080	1130	1180	1320	1460	1690	1910	2130	2350	2570
		c_{lim} (mm)	570	560	550	540	530	520	500	470	420	370	320	270	260
		F_{Rd} (c ≥ c_{lim})	2700	2730	2760	2790	2820	2850	2920	2990	3120	3250	3370	3490	3610

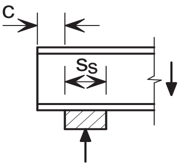
Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

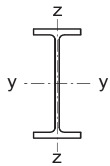
If c < c_{lim}, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
914x305x289	3780	F_{Rd} (c = 0)	910	957	1010	1060	1110	1160	1300	1430	1650	1870	2090	2310	2530
		c_{lim} (mm)	580	570	560	550	540	530	510	480	430	380	330	280	250
		F_{Rd} (c ≥ c_{lim})	2610	2640	2680	2710	2740	2770	2840	2910	3050	3180	3310	3430	3550
914x305x253	3350	F_{Rd} (c = 0)	707	744	782	822	862	904	1010	1110	1280	1460	1630	1800	1970
		c_{lim} (mm)	580	570	560	550	540	530	510	480	430	380	330	280	230
		F_{Rd} (c ≥ c_{lim})	2000	2030	2050	2080	2100	2120	2180	2240	2350	2460	2560	2660	2750
914x305x224	3060	F_{Rd} (c = 0)	587	618	651	685	720	755	847	921	1070	1220	1360	1510	1650
		c_{lim} (mm)	580	570	560	550	540	530	510	480	430	380	330	280	230
		F_{Rd} (c ≥ c_{lim})	1640	1660	1680	1700	1720	1740	1790	1840	1940	2030	2120	2200	2250
914x305x201	2870	F_{Rd} (c = 0)	520	549	578	609	641	673	750	817	950	1080	1220	1350	1480
		c_{lim} (mm)	580	570	560	550	540	530	510	480	430	380	330	280	230
		F_{Rd} (c ≥ c_{lim})	1420	1450	1470	1490	1510	1520	1570	1620	1710	1790	1870	1930	1930
838x292x226	2900	F_{Rd} (c = 0)	618	652	688	725	764	803	906	993	1160	1320	1480	1640	1800
		c_{lim} (mm)	540	530	520	510	500	490	460	440	390	340	290	240	220
		F_{Rd} (c ≥ c_{lim})	1760	1780	1800	1830	1850	1870	1930	1980	2080	2180	2270	2360	2440
838x292x194	2610	F_{Rd} (c = 0)	502	531	561	593	625	658	740	808	944	1080	1220	1350	1490
		c_{lim} (mm)	540	530	520	510	500	490	460	440	390	340	290	240	200
		F_{Rd} (c ≥ c_{lim})	1400	1420	1440	1460	1480	1500	1540	1590	1680	1760	1840	1920	1920
838x292x176	2460	F_{Rd} (c = 0)	448	475	503	531	561	592	661	723	847	970	1090	1220	1330
		c_{lim} (mm)	540	530	520	510	500	490	460	440	390	340	290	240	190
		F_{Rd} (c ≥ c_{lim})	1230	1250	1270	1290	1300	1320	1370	1410	1490	1570	1640	1670	1670
762x267x197	2530	F_{Rd} (c = 0)	582	618	655	694	735	776	883	968	1140	1310	1480	1640	1810
		c_{lim} (mm)	480	470	460	450	440	430	410	380	330	280	230	200	200
		F_{Rd} (c ≥ c_{lim})	1660	1690	1710	1740	1760	1780	1840	1890	1990	2090	2190	2280	2360
762x267x173	2290	F_{Rd} (c = 0)	479	510	542	575	609	644	728	800	942	1080	1230	1370	1510
		c_{lim} (mm)	480	470	460	450	440	430	410	380	330	280	230	190	190
		F_{Rd} (c ≥ c_{lim})	1350	1370	1390	1410	1430	1450	1500	1540	1630	1720	1800	1880	1930
762x267x147	2040	F_{Rd} (c = 0)	376	401	427	453	481	510	571	629	743	857	971	1090	1190
		c_{lim} (mm)	480	470	460	450	440	430	410	380	330	280	230	180	170
		F_{Rd} (c ≥ c_{lim})	1040	1050	1070	1090	1100	1120	1160	1200	1270	1340	1410	1410	1410
762x267x134	1970	F_{Rd} (c = 0)	332	354	377	401	426	452	504	555	658	760	852	924	996
		c_{lim} (mm)	480	470	460	450	440	430	410	380	330	280	230	180	160
		F_{Rd} (c ≥ c_{lim})	903	919	935	950	965	980	1020	1050	1120	1180	1180	1180	1180

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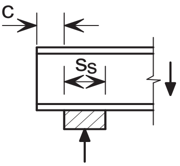
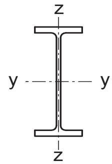
If c < c_{lim}, then use F_{Rd} value for c = 0.
FOR EXPLANATION OF TABLES SEE NOTE 6.



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
686x254x170	2120	F_{Rd} (c = 0)	507	542	578	616	655	695	795	877	1040	1200	1360	1530	1690
		c_{lim} (mm)	440	430	420	410	400	390	360	340	290	240	190	190	190
		F_{Rd} (c ≥ c_{lim})	1460	1480	1500	1530	1550	1570	1620	1670	1770	1860	1950	2030	2120
686x254x152	1920	F_{Rd} (c = 0)	415	444	474	505	538	571	651	718	853	988	1120	1260	1390
		c_{lim} (mm)	440	430	420	410	400	390	360	340	290	240	190	180	180
		F_{Rd} (c ≥ c_{lim})	1180	1200	1220	1240	1250	1270	1320	1360	1440	1520	1590	1660	1690
686x254x140	1790	F_{Rd} (c = 0)	362	387	414	442	471	501	568	628	747	866	984	1100	1220
		c_{lim} (mm)	440	430	420	410	400	390	360	340	290	240	190	170	170
		F_{Rd} (c ≥ c_{lim})	1020	1040	1050	1070	1090	1100	1140	1180	1250	1320	1390	1420	1420
686x254x125	1670	F_{Rd} (c = 0)	316	339	363	388	414	441	497	550	657	762	868	974	1070
		c_{lim} (mm)	440	430	420	410	400	390	360	340	290	240	190	160	160
		F_{Rd} (c ≥ c_{lim})	874	890	906	922	937	952	988	1020	1090	1150	1200	1200	1200
610x305x238	2460	F_{Rd} (c = 0)	580	647	721	801	887	978	1230	1580	1880	2170	2460	2750	3050
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	220	220	220	220
		F_{Rd} (c ≥ c_{lim})	2040	2100	2170	2230	2290	2360	2520	2670	3180	3330	3480	3620	3750
610x305x179	1880	F_{Rd} (c = 0)	503	539	577	617	658	701	811	901	1070	1250	1420	1590	1760
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	190	190	190
		F_{Rd} (c ≥ c_{lim})	1470	1490	1520	1540	1560	1580	1630	1690	1780	1870	1960	2050	2130
610x305x149	1570	F_{Rd} (c = 0)	345	370	397	425	454	485	560	620	741	862	982	1100	1220
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	170	170	170
		F_{Rd} (c ≥ c_{lim})	991	1010	1020	1040	1060	1070	1110	1150	1220	1280	1350	1380	1380
610x229x140	1690	F_{Rd} (c = 0)	418	450	483	518	554	592	680	755	904	1050	1200	1350	1500
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	170	170	170
		F_{Rd} (c ≥ c_{lim})	1210	1230	1250	1270	1290	1310	1360	1400	1490	1570	1650	1720	1790
610x229x125	1530	F_{Rd} (c = 0)	340	366	394	423	453	484	554	616	739	862	985	1110	1230
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	160	160	160
		F_{Rd} (c ≥ c_{lim})	971	989	1010	1020	1040	1060	1100	1130	1210	1280	1340	1400	1400
610x229x113	1420	F_{Rd} (c = 0)	291	314	339	364	391	418	475	529	637	744	851	957	1060
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	150	150	150
		F_{Rd} (c ≥ c_{lim})	821	837	852	867	882	896	932	966	1030	1090	1140	1140	1140
610x229x101	1370	F_{Rd} (c = 0)	259	281	303	326	350	375	424	473	571	668	765	854	930
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	140	140	140
		F_{Rd} (c ≥ c_{lim})	719	734	748	763	776	790	823	855	915	972	978	978	978

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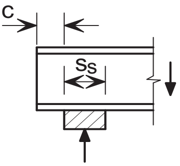
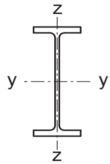
If c < c_{lim}, then use F_{Rd} value for c = 0.
FOR EXPLANATION OF TABLES SEE NOTE 6.



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
610x178x100 +	1450	F_{Rd} (c = 0)	296	320	346	372	400	427	484	540	651	762	873	984	1100
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	150	150	150
		F_{Rd} (c ≥ c_{lim})	828	845	861	877	893	909	946	982	1050	1120	1180	1200	1200
610x178x92 +	1410	F_{Rd} (c = 0)	275	298	322	348	374	397	450	503	609	714	819	923	1030
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	140	140	140
		F_{Rd} (c ≥ c_{lim})	759	775	791	807	822	837	873	908	974	1040	1080	1080	1080
610x178x82 +	1290	F_{Rd} (c = 0)	229	248	269	290	312	330	375	420	508	597	674	739	804
		c_{lim} (mm)	390	380	370	360	350	340	310	290	240	190	140	130	130
		F_{Rd} (c ≥ c_{lim})	622	636	650	663	676	689	720	750	807	846	846	846	846
533x312x272 +	2480	F_{Rd} (c = 0)	754	830	913	1000	1100	1200	1480	1780	2160	2520	2890	3250	3610
		c_{lim} (mm)	340	330	320	310	300	290	260	240	230	230	230	230	230
		F_{Rd} (c ≥ c_{lim})	2680	2750	2830	2900	2970	3040	3230	3410	3770	4140	4500	4860	5320
533x312x219 +	2120	F_{Rd} (c = 0)	543	610	684	764	851	944	1190	1400	1720	2030	2350	2660	2980
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	190	190	190	190
		F_{Rd} (c ≥ c_{lim})	1900	1970	2030	2090	2160	2220	2380	2540	2850	3170	3530	3680	3830
533x312x182 +	1740	F_{Rd} (c = 0)	412	467	530	598	672	867	1010	1130	1360	1590	1820	2040	2240
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	190	190	190	190
		F_{Rd} (c ≥ c_{lim})	1420	1470	1530	1580	1630	1680	2010	2070	2190	2310	2420	2520	2620
533x312x150 +	1460	F_{Rd} (c = 0)	412	446	481	518	557	596	696	776	935	1090	1250	1410	1550
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	170	170	170	170
		F_{Rd} (c ≥ c_{lim})	1210	1230	1250	1270	1290	1310	1350	1400	1490	1570	1650	1720	1800
533x210x138 +	1680	F_{Rd} (c = 0)	323	378	440	509	584	788	913	1020	1230	1450	1660	1870	2060
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	170	170	170	170
		F_{Rd} (c ≥ c_{lim})	1150	1200	1250	1310	1360	1410	1530	1850	1970	2080	2190	2290	2390
533x210x122	1450	F_{Rd} (c = 0)	398	433	469	506	545	586	677	757	917	1080	1240	1400	1530
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	160	160	160	160
		F_{Rd} (c ≥ c_{lim})	1160	1190	1210	1230	1250	1270	1320	1360	1450	1540	1620	1700	1770
533x210x109	1330	F_{Rd} (c = 0)	327	355	386	417	450	485	557	624	757	890	1020	1160	1270
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	150	150	150	150
		F_{Rd} (c ≥ c_{lim})	942	961	979	997	1020	1030	1070	1110	1190	1260	1330	1400	1450
533x210x101	1240	F_{Rd} (c = 0)	281	306	332	360	389	418	479	537	653	769	884	999	1100
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	140	140	140
		F_{Rd} (c ≥ c_{lim})	804	820	836	852	867	883	919	955	1020	1090	1140	1180	1180
533x210x92	1170	F_{Rd} (c = 0)	246	268	292	316	342	368	420	472	575	677	780	882	969
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	140	140	140
		F_{Rd} (c ≥ c_{lim})	696	711	725	739	753	767	800	832	893	949	981	981	981
533x210x82	1120	F_{Rd} (c = 0)	217	238	259	282	305	326	373	419	513	605	698	790	846
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	130	130	130
		F_{Rd} (c ≥ c_{lim})	604	618	632	645	658	671	702	732	788	840	846	846	846

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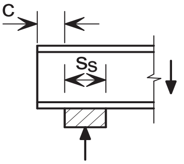
+ These sections are in addition to the range of BS 4 sections

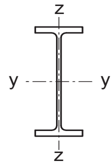
If c < c_{lim}, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm) 0	10	20	30	40	50	75	100	150	200	250	300	350
533x165x85 +	1170	F_{Rd} (c = 0)	249	272	297	322	349	374	427	480	586	691	796	901	991
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	706	722	737	752	766	780	815	848	910	969	1020	1030	1030
533x165x74 +	1120	F_{Rd} (c = 0)	219	240	262	285	309	329	377	424	520	614	709	803	867
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	608	623	637	650	664	677	709	740	798	851	867	867	867
533x165x66 +	1020	F_{Rd} (c = 0)	182	200	218	238	256	272	313	353	433	513	578	637	679
		c_{lim} (mm)	340	330	320	310	300	290	260	240	190	140	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	496	508	521	533	544	556	583	610	659	679	679	679	679
457x191x161 +	1810	F_{Rd} (c = 0)	468	534	608	690	778	872	1130	1280	1590	1900	2210	2520	2840
		c_{lim} (mm)	290	280	270	260	250	240	220	190	180	180	180	180	180
		F_{Rd} ($c \geq c_{lim}$)	1720	1780	1840	1910	1970	2030	2190	2340	2650	2960	3270	3580	3930
457x191x133 +	1510	F_{Rd} (c = 0)	352	409	473	544	622	704	894	1030	1290	1550	1820	2080	2410
		c_{lim} (mm)	290	280	270	260	250	240	220	190	150	150	150	150	170
		F_{Rd} ($c \geq c_{lim}$)	1270	1330	1380	1430	1480	1540	1670	1800	2070	2400	2530	2650	2800
457x191x106 +	1230	F_{Rd} (c = 0)	248	296	350	411	570	618	718	810	994	1180	1360	1520	1610
		c_{lim} (mm)	290	280	270	260	250	240	220	190	150	150	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	882	925	969	1010	1060	1100	1350	1410	1510	1600	1690	1770	1850
457x191x98	1110	F_{Rd} (c = 0)	224	359	393	429	467	505	587	663	814	964	1120	1240	1320
		c_{lim} (mm)	290	280	270	260	250	240	220	190	150	150	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	788	984	1000	1020	1040	1060	1100	1150	1230	1300	1380	1450	1510
457x191x89	1030	F_{Rd} (c = 0)	273	301	330	361	393	426	493	557	685	813	940	1050	1110
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	140	140	140	140
		F_{Rd} ($c \geq c_{lim}$)	798	815	832	849	865	881	919	956	1030	1090	1150	1210	1260
457x191x82	976	F_{Rd} (c = 0)	243	268	294	322	351	381	439	497	612	728	843	942	1000
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	130	130	130	130
		F_{Rd} ($c \geq c_{lim}$)	701	717	733	748	763	777	813	847	911	971	1030	1060	1060
457x191x74	895	F_{Rd} (c = 0)	199	219	241	264	289	312	360	408	503	599	694	776	811
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	568	581	595	607	620	632	662	691	744	794	811	811	811
457x191x67	839	F_{Rd} (c = 0)	174	192	212	233	255	273	316	359	444	529	614	687	687
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	490	503	515	527	538	549	577	603	652	687	687	687	687

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

If $c < c_{lim}$, then use F_{Rd} value for c = 0.

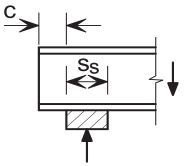
FOR EXPLANATION OF TABLES SEE NOTE 6.

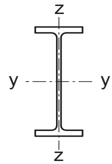
BS EN 1993-1-5: 2007
BS 4-1: 2005

WEB BEARING AND BUCKLING

S355 / Advance® 355

UNIVERSAL BEAMS
Advance® UKB





Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
457x152x82	1040	F_{Rd} (c = 0)	271	299	328	359	391	424	489	554	682	809	937	1050	1110
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	140	140	140	140
		F_{Rd} ($c \ge c_{lim}$)	794	811	828	845	861	877	916	953	1020	1090	1150	1210	1250
457x152x74	938	F_{Rd} (c = 0)	224	247	271	297	324	351	405	459	566	673	779	871	925
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	130	130	130	130
		F_{Rd} ($c \ge c_{lim}$)	648	663	677	691	705	719	752	784	843	899	951	970	970
457x152x67	899	F_{Rd} (c = 0)	196	217	239	262	287	308	356	404	500	595	690	772	807
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	120	120	120	120
		F_{Rd} ($c \ge c_{lim}$)	560	574	587	600	613	625	655	684	738	789	807	807	807
457x152x60	806	F_{Rd} (c = 0)	157	174	192	211	231	247	286	325	402	479	556	600	600
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	120	120	120	120
		F_{Rd} ($c \ge c_{lim}$)	443	454	465	476	487	497	522	545	590	600	600	600	600
457x152x52	747	F_{Rd} (c = 0)	135	150	166	183	199	212	247	281	350	411	463	499	499
		c_{lim} (mm)	290	280	270	260	250	240	220	190	140	100	100	100	100
		F_{Rd} ($c \ge c_{lim}$)	373	383	393	403	413	422	445	466	499	499	499	499	499
406x178x85 +	966	F_{Rd} (c = 0)	198	239	287	407	446	486	566	644	798	953	1110	1190	1270
		c_{lim} (mm)	260	250	240	230	220	210	180	160	130	130	130	130	130
		F_{Rd} ($c \ge c_{lim}$)	696	734	771	809	971	989	1030	1080	1160	1230	1310	1370	1440
406x178x74	858	F_{Rd} (c = 0)	229	254	282	311	341	371	431	491	610	730	849	914	971
		c_{lim} (mm)	260	250	240	230	220	210	180	160	120	120	120	120	120
		F_{Rd} ($c \ge c_{lim}$)	669	685	700	716	731	745	780	814	878	937	993	1050	1050
406x178x67	790	F_{Rd} (c = 0)	193	215	239	264	290	314	366	417	519	622	724	780	829
		c_{lim} (mm)	260	250	240	230	220	210	180	160	120	120	120	120	120
		F_{Rd} ($c \ge c_{lim}$)	558	572	586	599	612	625	656	686	741	793	840	840	840
406x178x60	709	F_{Rd} (c = 0)	154	172	191	211	232	250	292	333	416	499	581	619	619
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	110	110	110	110
		F_{Rd} ($c \ge c_{lim}$)	440	451	463	474	484	495	520	544	590	619	619	619	619
406x178x54	683	F_{Rd} (c = 0)	142	159	178	198	217	232	272	311	390	468	547	571	571
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	100	100	100	100
		F_{Rd} ($c \ge c_{lim}$)	400	411	422	433	444	454	479	503	547	571	571	571	571

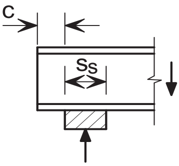
Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

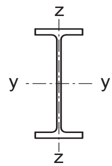
If $c < c_{lim}$, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
406x140x53 +	709	F_{Rd} (c = 0)	151	169	188	209	230	246	288	329	412	495	577	615	615
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	110	110	110	110
		F_{Rd} (c ≥ c_{lim})	430	442	453	465	476	486	512	537	583	615	615	615	615
406x140x46	611	F_{Rd} (c = 0)	111	124	138	154	168	181	212	242	304	355	401	405	405
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	100	100	100	100
		F_{Rd} (c ≥ c_{lim})	311	320	329	337	345	353	373	391	405	405	405	405	405
406x140x39	566	F_{Rd} (c = 0)	94.9	107	120	133	144	156	183	210	258	297	335	338	338
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	90	90	90	90
		F_{Rd} (c ≥ c_{lim})	260	268	276	284	292	299	317	334	338	338	338	338	338
356x171x67	733	F_{Rd} (c = 0)	216	243	272	302	334	366	429	491	617	742	832	892	949
		c_{lim} (mm)	230	220	210	200	190	180	150	130	120	120	120	120	120
		F_{Rd} (c ≥ c_{lim})	544	657	672	688	703	717	753	786	850	909	964	1020	1050
356x171x57	646	F_{Rd} (c = 0)	166	187	211	235	261	282	332	382	481	581	652	701	746
		c_{lim} (mm)	230	220	210	200	190	180	150	130	110	110	110	110	110
		F_{Rd} (c ≥ c_{lim})	482	496	509	521	534	546	575	603	655	703	746	746	746
356x171x51	587	F_{Rd} (c = 0)	136	154	174	194	216	232	274	316	399	482	542	576	576
		c_{lim} (mm)	230	220	210	200	190	180	150	130	100	100	100	100	100
		F_{Rd} (c ≥ c_{lim})	391	402	414	424	435	445	470	494	538	576	576	576	576
356x171x45	549	F_{Rd} (c = 0)	119	135	153	171	188	203	241	278	352	427	480	489	489
		c_{lim} (mm)	230	220	210	200	190	180	150	130	90	90	90	90	90
		F_{Rd} (c ≥ c_{lim})	334	345	355	366	375	385	408	430	470	489	489	489	489
356x127x39	527	F_{Rd} (c = 0)	105	119	135	152	167	180	213	246	313	379	415	415	415
		c_{lim} (mm)	230	220	210	200	190	180	150	130	90	90	90	90	90
		F_{Rd} (c ≥ c_{lim})	298	307	316	325	334	342	363	382	415	415	415	415	415
356x127x33	472	F_{Rd} (c = 0)	84.4	96.6	110	123	134	145	173	200	255	298	316	316	316
		c_{lim} (mm)	230	220	210	200	190	180	150	130	80	80	80	80	80
		F_{Rd} (c ≥ c_{lim})	234	242	250	258	265	272	290	306	316	316	316	316	316
305x165x54	545	F_{Rd} (c = 0)	166	190	216	243	271	297	352	408	518	617	671	720	767
		c_{lim} (mm)	190	180	170	160	150	140	120	110	110	110	110	110	110
		F_{Rd} (c ≥ c_{lim})	495	508	522	535	548	560	590	619	673	722	769	803	803
305x165x46	461	F_{Rd} (c = 0)	117	135	153	173	194	210	250	290	370	441	480	503	503
		c_{lim} (mm)	190	180	170	160	150	140	120	100	100	100	100	100	100
		F_{Rd} (c ≥ c_{lim})	345	355	365	374	384	393	415	436	476	503	503	503	503
305x165x40	411	F_{Rd} (c = 0)	92.0	106	121	137	153	166	198	230	294	351	367	367	367
		c_{lim} (mm)	190	180	170	160	150	140	120	90	90	90	90	90	90
		F_{Rd} (c ≥ c_{lim})	266	275	283	291	299	307	325	342	367	367	367	367	367

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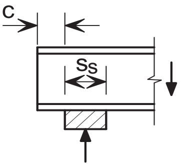
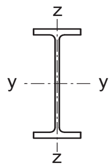
+ These sections are in addition to the range of BS 4 sections

If c < c_{lim}, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
305x127x48	612	F_{Rd} (c = 0)	118	154	198	248	295	327	443	515	659	788	858	924	985
		c_{lim} (mm)	190	180	170	160	150	140	120	100	100	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	423	455	487	519	551	583	740	778	850	916	978	1040	1090
305x127x42	542	F_{Rd} (c = 0)	95.8	128	212	240	266	289	346	403	517	618	674	726	775
		c_{lim} (mm)	190	180	170	160	150	140	120	90	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	340	368	396	425	524	538	571	602	660	713	762	808	822
305x127x37	481	F_{Rd} (c = 0)	124	144	165	188	207	225	270	315	405	485	529	570	583
		c_{lim} (mm)	190	180	170	160	150	140	120	90	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	279	370	382	393	405	416	442	467	513	555	583	583	583
305x102x33	452	F_{Rd} (c = 0)	106	122	140	160	175	190	228	266	341	412	450	462	462
		c_{lim} (mm)	200	190	180	170	160	150	120	100	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	303	314	324	334	344	353	376	397	436	462	462	462	462
305x102x28	407	F_{Rd} (c = 0)	85.1	99.0	114	129	141	154	185	217	279	338	351	351	351
		c_{lim} (mm)	200	190	180	170	160	150	120	100	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	239	248	257	265	274	282	301	319	351	351	351	351	351
305x102x25	386	F_{Rd} (c = 0)	77.5	90.7	105	117	129	141	170	200	258	313	316	316	316
		c_{lim} (mm)	200	190	180	170	160	150	120	100	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	212	221	230	238	246	254	273	290	316	316	316	316	316
254x146x43	415	F_{Rd} (c = 0)	104	132	192	219	248	271	327	382	493	555	604	650	693
		c_{lim} (mm)	160	150	140	130	120	110	100	100	100	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	359	384	453	466	478	490	519	546	596	643	686	727	728
254x146x37	361	F_{Rd} (c = 0)	106	124	144	166	187	204	246	289	374	421	460	495	496
		c_{lim} (mm)	160	150	140	130	120	110	90	90	90	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	314	325	335	345	355	364	387	408	448	484	496	496	496
254x146x31	336	F_{Rd} (c = 0)	91.1	108	127	147	162	178	217	255	332	376	411	427	427
		c_{lim} (mm)	160	150	140	130	120	110	90	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	264	274	284	294	303	312	334	354	391	425	427	427	427

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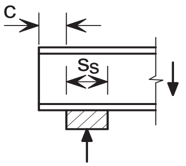
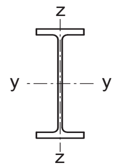
If $c < c_{lim}$, then use F_{Rd} value for c = 0.
FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



UNIVERSAL BEAMS
Advance® UKB



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
254x102x28	365	F_{Rd} (c = 0)	98.7	117	137	158	175	191	233	275	358	408	447	477	477
		c_{lim} (mm)	170	160	150	140	130	120	90	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	225	299	310	320	330	340	364	386	426	463	477	477	477
254x102x25	341	F_{Rd} (c = 0)	87.0	104	123	140	155	170	208	246	321	367	402	413	413
		c_{lim} (mm)	170	160	150	140	130	120	90	70	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	183	259	269	279	289	298	320	341	378	413	413	413	413
254x102x22	320	F_{Rd} (c = 0)	76.4	91.8	109	123	137	150	185	219	287	329	354	354	354
		c_{lim} (mm)	170	160	150	140	130	120	90	70	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	144	223	233	242	251	260	280	299	334	354	354	354	354
203x133x30	299	F_{Rd} (c = 0)	70.5	96.8	129	166	191	213	270	343	426	476	521	562	601
		c_{lim} (mm)	130	120	110	100	90	80	70	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	243	266	289	311	334	357	413	447	495	538	578	616	628
203x133x25	263	F_{Rd} (c = 0)	54.0	77.9	125	146	163	181	224	268	333	373	409	443	447
		c_{lim} (mm)	130	120	110	100	90	80	70	70	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	184	204	225	245	289	299	322	343	382	418	447	447	447
203x102x23	254	F_{Rd} (c = 0)	54.7	94.7	114	134	150	166	205	245	303	339	372	390	390
		c_{lim} (mm)	130	120	110	100	90	80	70	70	70	70	70	70	70
		F_{Rd} ($c \geq c_{lim}$)	190	210	250	259	268	276	297	316	350	382	390	390	390
178x102x19	203	F_{Rd} (c = 0)	43.7	77.3	94.9	112	126	140	176	212	252	283	311	312	312
		c_{lim} (mm)	110	100	90	80	70	60	60	60	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	151	168	200	208	216	224	241	258	288	312	312	312	312
152x89x16	167	F_{Rd} (c = 0)	38.6	57.8	90.6	107	122	137	174	205	239	268	295	301	301
		c_{lim} (mm)	100	90	80	70	60	60	60	60	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	134	150	166	193	201	208	226	242	271	298	301	301	301
127x76x13	131	F_{Rd} (c = 0)	33.3	50.4	72.1	89.6	104	118	154	177	207	234	257	259	259
		c_{lim} (mm)	80	70	60	50	50	50	50	60	60	60	60	60	60
		F_{Rd} ($c \geq c_{lim}$)	116	130	144	163	170	176	192	208	234	258	259	259	259

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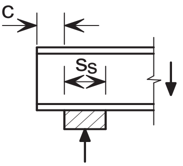
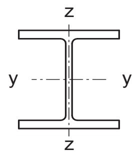
If $c < c_{lim}$, then use F_{Rd} value for c = 0.
FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING

UNIVERSAL COLUMNS
Advance® UKC





Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
356x406x634	4040	F_{Rd} (c = 0)	2510	2670	2840	3020	3210	3400	3930	4500	5740	6650	7420	8200	8970
		c_{lim} (mm)	390	390	390	390	390	390	390	390	390	390	390	390	390
		F_{Rd} ($c \geq c_{lim}$)	9490	9650	9800	9960	10100	10300	10700	11000	11800	12600	13400	14100	14900
356x406x551	3490	F_{Rd} (c = 0)	2060	2200	2350	2510	2680	2850	3330	3840	4960	5650	6330	7020	7700
		c_{lim} (mm)	350	350	350	350	350	350	350	350	350	350	350	350	350
		F_{Rd} ($c \geq c_{lim}$)	7670	7810	7950	8080	8220	8360	8700	9040	9720	10400	11100	11800	12500
356x406x467	3000	F_{Rd} (c = 0)	1670	1790	1930	2070	2220	2370	2800	3250	4160	4760	5360	5960	6560
		c_{lim} (mm)	320	320	320	320	320	320	320	320	320	320	320	320	320
		F_{Rd} ($c \geq c_{lim}$)	6110	6230	6350	6470	6590	6710	7010	7310	7910	8510	9110	9710	10300
356x406x393	2520	F_{Rd} (c = 0)	1300	1410	1520	1640	1770	1910	2280	2680	3380	3890	4400	4920	5430
		c_{lim} (mm)	280	280	280	280	280	280	280	280	280	280	280	280	280
		F_{Rd} ($c \geq c_{lim}$)	4690	4790	4890	5000	5100	5200	5460	5710	6230	6740	7250	7760	8280
356x406x340	2160	F_{Rd} (c = 0)	1050	1150	1250	1350	1470	1590	1920	2270	2830	3270	3720	4160	4610
		c_{lim} (mm)	260	260	260	260	260	260	260	260	260	260	260	260	260
		F_{Rd} ($c \geq c_{lim}$)	3740	3830	3920	4010	4100	4190	4410	4630	5080	5520	5970	6410	6860
356x406x287	1870	F_{Rd} (c = 0)	846	927	1020	1110	1210	1320	1610	1930	2370	2760	3150	3540	3930
		c_{lim} (mm)	230	230	230	230	230	230	230	230	230	230	230	230	230
		F_{Rd} ($c \geq c_{lim}$)	2960	3040	3120	3200	3270	3350	3550	3740	4130	4520	4910	5300	5690
356x406x235	1500	F_{Rd} (c = 0)	628	695	768	847	931	1020	1260	1520	1840	2160	2480	2790	3110
		c_{lim} (mm)	220	210	210	210	210	210	210	210	210	210	210	210	210
		F_{Rd} ($c \geq c_{lim}$)	2160	2220	2290	2350	2410	2480	2640	2790	3110	3430	3750	4060	4380
356x368x202	1340	F_{Rd} (c = 0)	518	578	644	716	793	876	1100	1300	1590	1870	2160	2440	2730
		c_{lim} (mm)	220	210	200	190	190	190	190	190	190	190	190	190	190
		F_{Rd} ($c \geq c_{lim}$)	1770	1830	1890	1940	2000	2060	2200	2340	2630	2910	3200	3480	3770
356x368x177	1180	F_{Rd} (c = 0)	425	478	536	600	668	741	938	1100	1350	1600	1840	2090	2340
		c_{lim} (mm)	220	210	200	190	180	170	170	170	170	170	170	170	170
		F_{Rd} ($c \geq c_{lim}$)	1440	1490	1540	1590	1640	1690	1810	1940	2190	2430	2680	2800	2920
356x368x153	1010	F_{Rd} (c = 0)	341	386	436	491	551	614	785	906	1120	1330	1540	1720	1820
		c_{lim} (mm)	220	210	200	190	180	170	160	160	160	160	160	170	170
		F_{Rd} ($c \geq c_{lim}$)	1140	1180	1230	1270	1310	1350	1460	1560	1730	1830	1920	2020	2110
356x368x129	839	F_{Rd} (c = 0)	264	303	346	430	470	512	618	701	868	1040	1140	1220	1290
		c_{lim} (mm)	220	210	200	190	180	170	150	150	150	150	150	150	150
		F_{Rd} ($c \geq c_{lim}$)	873	909	1000	1020	1040	1060	1100	1140	1210	1280	1350	1420	1480

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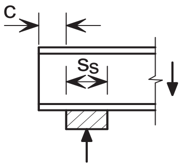
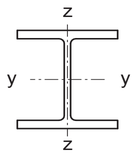
If $c < c_{lim}$, then use F_{Rd} value for c = 0.
FOR EXPLANATION OF TABLES SEE NOTE 6.



UNIVERSAL COLUMNS
Advance® UKC



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
305x305x283	1950	F_{Rd} (c = 0)	971	1070	1170	1280	1390	1520	1860	2220	2720	3170	3620	4070	4520
		c_{lim} (mm)	250	250	250	250	250	250	250	250	250	250	250	250	250
		F_{Rd} (c ≥ c_{lim})	3540	3630	3720	3810	3900	3990	4210	4440	4880	5330	5780	6230	6680
305x305x240	1710	F_{Rd} (c = 0)	787	870	962	1060	1170	1280	1580	1910	2300	2700	3100	3490	3890
		c_{lim} (mm)	220	220	220	220	220	220	220	220	220	220	220	220	220
		F_{Rd} (c ≥ c_{lim})	2820	2900	2980	3060	3140	3220	3420	3620	4020	4410	4810	5210	5600
305x305x198	1400	F_{Rd} (c = 0)	594	663	740	823	913	1010	1270	1500	1830	2160	2490	2820	3150
		c_{lim} (mm)	200	200	200	200	200	200	200	200	200	200	200	200	200
		F_{Rd} (c ≥ c_{lim})	2090	2160	2230	2290	2360	2420	2590	2750	3080	3410	3740	4070	4400
305x305x158	1130	F_{Rd} (c = 0)	428	486	550	621	698	780	1000	1150	1420	1700	1970	2240	2510
		c_{lim} (mm)	190	180	170	170	170	170	170	170	170	170	170	170	170
		F_{Rd} (c ≥ c_{lim})	1480	1540	1590	1650	1700	1760	1890	2030	2300	2570	2850	3120	3390
305x305x137	984	F_{Rd} (c = 0)	346	397	454	517	585	658	846	965	1200	1440	1680	1920	2160
		c_{lim} (mm)	190	180	170	160	150	150	150	150	150	150	150	150	150
		F_{Rd} (c ≥ c_{lim})	1190	1230	1280	1330	1380	1420	1540	1660	1900	2140	2380	2610	2790
305x305x118	856	F_{Rd} (c = 0)	277	322	372	428	488	553	702	806	1010	1220	1430	1630	1820
		c_{lim} (mm)	190	180	170	160	150	140	140	140	140	140	140	140	140
		F_{Rd} (c ≥ c_{lim})	939	980	1020	1060	1100	1150	1250	1350	1560	1780	1880	1980	2080
305x305x97	721	F_{Rd} (c = 0)	213	251	294	343	395	451	564	652	828	1010	1100	1170	1250
		c_{lim} (mm)	190	180	170	160	150	140	120	120	120	130	130	130	130
		F_{Rd} (c ≥ c_{lim})	709	745	780	815	850	885	998	1040	1120	1210	1280	1350	1410
254x254x167	1180	F_{Rd} (c = 0)	552	622	700	785	877	975	1240	1440	1770	2110	2440	2770	3100
		c_{lim} (mm)	190	190	190	190	190	190	190	190	190	190	190	190	190
		F_{Rd} (c ≥ c_{lim})	1980	2050	2110	2180	2250	2310	2480	2640	2970	3310	3640	3970	4300
254x254x132	918	F_{Rd} (c = 0)	390	447	510	580	655	735	948	1080	1340	1610	1870	2140	2400
		c_{lim} (mm)	160	160	160	160	160	160	160	160	160	160	160	160	160
		F_{Rd} (c ≥ c_{lim})	1370	1420	1480	1530	1580	1640	1770	1900	2160	2430	2690	2950	3220
254x254x107	751	F_{Rd} (c = 0)	288	335	389	449	514	584	738	849	1070	1290	1510	1730	1950
		c_{lim} (mm)	160	150	140	140	140	140	140	140	140	140	140	140	140
		F_{Rd} (c ≥ c_{lim})	995	1040	1080	1130	1170	1220	1330	1440	1660	1880	2100	2320	2540
254x254x89	607	F_{Rd} (c = 0)	217	255	299	348	401	458	573	662	840	1020	1200	1380	1470
		c_{lim} (mm)	160	150	140	130	130	130	130	130	130	130	130	130	130
		F_{Rd} (c ≥ c_{lim})	736	772	807	843	878	914	1000	1090	1270	1420	1500	1590	1670
254x254x73	525	F_{Rd} (c = 0)	167	200	239	282	329	379	465	541	694	832	902	967	1030
		c_{lim} (mm)	160	150	140	130	120	110	110	110	110	120	120	120	120
		F_{Rd} (c ≥ c_{lim})	558	589	620	650	681	711	803	840	910	982	1040	1100	1150

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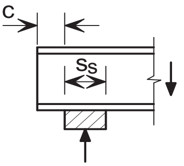
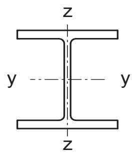
If c < c_{lim}, then use F_{Rd} value for c = 0.
FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



UNIVERSAL COLUMNS
Advance® UKC



Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
203x203x127 +	893	F_{Rd} (c = 0)	457	524	599	681	770	866	1110	1270	1580	1900	2210	2520	2830
		c_{lim} (mm)	170	170	170	170	170	170	170	170	170	170	170	170	170
		F_{Rd} (c ≥ c_{lim})	1670	1730	1790	1860	1920	1980	2140	2290	2610	2920	3230	3540	3850
203x203x113 +	812	F_{Rd} (c = 0)	386	446	514	590	672	759	967	1110	1390	1670	1950	2230	2510
		c_{lim} (mm)	160	160	160	160	160	160	160	160	160	160	160	160	160
		F_{Rd} (c ≥ c_{lim})	1390	1450	1510	1560	1620	1680	1820	1960	2240	2520	2800	3080	3360
203x203x100 +	709	F_{Rd} (c = 0)	319	373	435	503	577	656	827	952	1200	1450	1700	1950	2200
		c_{lim} (mm)	140	140	140	140	140	140	140	140	140	140	140	140	140
		F_{Rd} (c ≥ c_{lim})	1140	1190	1240	1290	1340	1390	1520	1640	1890	2140	2390	2640	2890
203x203x86	619	F_{Rd} (c = 0)	258	305	360	421	487	557	693	803	1020	1240	1460	1680	1900
		c_{lim} (mm)	130	130	130	130	130	130	130	130	130	130	130	130	130
		F_{Rd} (c ≥ c_{lim})	909	952	996	1040	1080	1130	1240	1350	1570	1790	2000	2220	2440
203x203x71	483	F_{Rd} (c = 0)	192	229	273	321	374	430	530	616	789	961	1130	1310	1480
		c_{lim} (mm)	130	120	120	120	120	120	120	120	120	120	120	120	120
		F_{Rd} (c ≥ c_{lim})	662	696	731	765	800	834	920	1010	1180	1350	1520	1640	1720
203x203x60	455	F_{Rd} (c = 0)	157	194	237	286	339	389	472	555	722	889	1060	1220	1350
		c_{lim} (mm)	130	120	110	100	100	100	100	100	100	100	100	100	100
		F_{Rd} (c ≥ c_{lim})	538	572	605	638	672	705	788	872	1040	1210	1340	1420	1500
203x203x52	385	F_{Rd} (c = 0)	126	157	194	236	281	318	389	459	599	739	830	893	952
		c_{lim} (mm)	130	120	110	100	90	90	90	90	90	90	100	100	100
		F_{Rd} (c ≥ c_{lim})	427	455	483	511	539	567	637	707	815	879	944	1000	1050
203x203x46	347	F_{Rd} (c = 0)	106	134	169	207	249	277	341	405	533	628	684	737	786
		c_{lim} (mm)	130	120	110	100	90	90	90	90	90	90	90	90	90
		F_{Rd} (c ≥ c_{lim})	355	381	406	432	457	483	547	604	663	723	772	819	864
152x152x51 +	408	F_{Rd} (c = 0)	164	208	260	319	383	427	525	622	818	1010	1210	1400	1600
		c_{lim} (mm)	100	100	100	100	100	100	100	100	100	100	100	100	100
		F_{Rd} (c ≥ c_{lim})	586	625	665	704	743	782	879	977	1170	1370	1560	1760	1950
152x152x44 +	350	F_{Rd} (c = 0)	131	169	215	267	321	354	439	523	692	860	1030	1200	1370
		c_{lim} (mm)	100	90	90	90	90	90	90	90	90	90	90	90	90
		F_{Rd} (c ≥ c_{lim})	463	497	531	565	598	632	716	801	969	1140	1310	1480	1640
152x152x37	292	F_{Rd} (c = 0)	101	134	173	218	257	285	356	427	569	711	853	995	1100
		c_{lim} (mm)	100	90	80	80	80	80	80	80	80	80	80	80	80
		F_{Rd} (c ≥ c_{lim})	352	381	409	437	466	494	565	636	778	920	1060	1130	1200
152x152x30	238	F_{Rd} (c = 0)	74.4	101	134	171	198	221	278	336	451	568	623	673	719
		c_{lim} (mm)	100	90	80	70	70	70	70	70	70	70	70	70	70
		F_{Rd} (c ≥ c_{lim})	254	277	300	323	346	369	427	485	585	642	690	736	778
152x152x23	204	F_{Rd} (c = 0)	50.7	75.3	107	133	154	175	226	278	381	444	488	528	566
		c_{lim} (mm)	100	90	80	70	60	50	50	50	50	60	60	60	60
		F_{Rd} (c ≥ c_{lim})	171	192	213	233	254	274	326	377	442	491	531	568	603

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

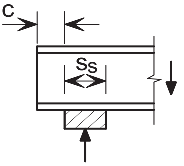
+ These sections are in addition to the range of BS 4 sections

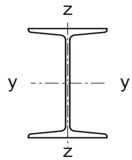
If c < c_{lim}, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING

JOISTS



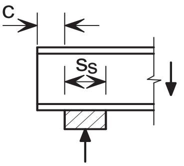


Unstiffened webs

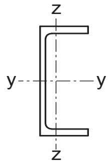
Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm)												
			Stiff bearing length, s_s (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
254x203x82	676	F_{Rd} (c = 0)	221	259	302	351	403	458	576	664	840	1020	1190	1370	1480
		c_{lim} (mm)	150	140	130	130	130	130	130	130	130	130	130	130	140
		F_{Rd} (c ≥ c_{lim})	765	800	836	871	906	941	1030	1120	1290	1450	1530	1610	1690
254x114x37	455	F_{Rd} (c = 0)	94.7	125	163	206	242	269	361	425	552	617	674	727	776
		c_{lim} (mm)	160	150	140	130	120	110	90	90	90	90	90	90	90
		F_{Rd} (c ≥ c_{lim})	337	364	391	418	445	472	567	599	657	711	761	808	852
203x152x52	456	F_{Rd} (c = 0)	148	182	222	267	315	363	440	517	670	824	977	1130	1230
		c_{lim} (mm)	120	110	110	110	110	110	110	110	110	110	110	110	110
		F_{Rd} (c ≥ c_{lim})	521	551	582	613	643	674	751	828	981	1140	1240	1310	1380
152x127x37	388	F_{Rd} (c = 0)	120	163	215	274	318	355	447	540	724	909	1090	1280	1460
		c_{lim} (mm)	90	80	80	80	80	80	80	80	80	80	80	80	80
		F_{Rd} (c ≥ c_{lim})	438	475	512	549	586	623	715	807	992	1180	1360	1550	1730
127x114x29	298	F_{Rd} (c = 0)	98.6	141	195	248	284	320	411	501	683	864	1050	1230	1410
		c_{lim} (mm)	70	70	70	70	70	70	70	70	70	70	70	70	70
		F_{Rd} (c ≥ c_{lim})	362	398	434	471	507	543	634	724	905	1090	1270	1450	1630
127x114x27	230	F_{Rd} (c = 0)	83.2	114	151	193	223	249	315	380	512	643	774	906	1040
		c_{lim} (mm)	70	70	70	70	70	70	70	70	70	70	70	70	70
		F_{Rd} (c ≥ c_{lim})	295	322	348	374	400	427	492	558	689	821	952	1080	1160
127x76x16	181	F_{Rd} (c = 0)	49.8	73.5	103	130	150	170	219	269	369	468	515	558	597
		c_{lim} (mm)	80	70	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} (c ≥ c_{lim})	179	199	219	239	258	278	328	378	473	522	564	603	640
114x114x27	289	F_{Rd} (c = 0)	88.5	128	179	226	260	294	378	462	631	800	968	1140	1310
		c_{lim} (mm)	70	60	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} (c ≥ c_{lim})	323	356	390	424	457	491	575	660	828	997	1170	1330	1500
102x102x23	238	F_{Rd} (c = 0)	80.3	121	172	215	248	282	367	451	619	788	957	1130	1290
		c_{lim} (mm)	60	60	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} (c ≥ c_{lim})	297	330	364	398	432	465	550	634	803	971	1140	1310	1480
102x44x7	106	F_{Rd} (c = 0)	21.2	41.4	60.5	75.8	91.0	106	144	183	258	293	324	353	379
		c_{lim} (mm)	60	50	40	40	40	40	40	40	40	40	40	40	40
		F_{Rd} (c ≥ c_{lim})	78.5	93.8	109	124	140	155	193	231	284	316	345	372	388
89x89x19	214	F_{Rd} (c = 0)	72.2	113	166	203	237	271	355	439	608	777	945	1110	1280
		c_{lim} (mm)	60	60	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} (c ≥ c_{lim})	271	305	338	372	406	440	524	608	777	946	1110	1280	1450
76x76x15	164	F_{Rd} (c = 0)	56.3	96.1	143	174	206	238	317	396	553	711	869	1030	1190
		c_{lim} (mm)	50	50	50	50	50	50	50	50	50	50	50	50	50
		F_{Rd} (c ≥ c_{lim})	212	244	275	307	339	370	449	528	686	844	1000	1160	1320
76x76x13	111	F_{Rd} (c = 0)	41.6	63.4	91.3	113	131	149	195	240	330	421	511	602	663
		c_{lim} (mm)	50	50	50	50	50	50	50	50	50	50	50	50	60
		F_{Rd} (c ≥ c_{lim})	148	166	184	202	220	239	284	329	420	510	601	662	705

If c < c_{lim}, then use F_{Rd} value for c = 0.

FOR EXPLANATION OF TABLES SEE NOTE 6.



PARALLEL FLANGE CHANNELS
Advance® UKPFC

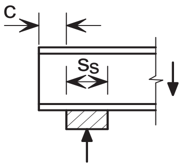


Unstiffened webs

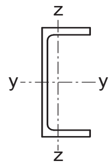
Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm)												
			0	10	20	30	40	50	75	100	150	200	250	300	350
430x100x64	977	F_{Rd} (c = 0)	154	196	247	396	436	467	545	622	775	928	1080	1180	1250
		c_{lim} (mm)	270	260	250	240	230	220	190	170	120	120	120	120	120
		F_{Rd} ($c \geq c_{lim}$)	579	617	655	693	731	769	998	1040	1130	1210	1280	1350	1410
380x100x54	757	F_{Rd} (c = 0)	132	168	279	311	345	371	437	502	632	761	866	930	990
		c_{lim} (mm)	230	220	210	200	190	180	160	130	110	110	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	487	520	552	585	720	736	774	811	879	943	1000	1060	1110
300x100x46	577	F_{Rd} (c = 0)	121	156	198	246	295	326	404	481	637	801	872	939	1000
		c_{lim} (mm)	180	170	160	150	140	130	110	90	90	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	444	475	506	537	568	599	677	782	856	938	1000	1060	1110
300x90x41	575	F_{Rd} (c = 0)	111	147	192	242	284	316	396	476	636	802	875	943	1010
		c_{lim} (mm)	180	170	160	150	140	130	110	90	90	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	412	444	476	508	540	572	652	771	847	934	997	1060	1110
260x90x35	451	F_{Rd} (c = 0)	94.3	127	167	212	247	275	346	417	559	676	739	797	851
		c_{lim} (mm)	160	150	140	130	120	110	80	80	80	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	346	375	403	431	460	488	559	642	708	780	835	887	936
260x75x28	397	F_{Rd} (c = 0)	69.0	98.2	135	196	217	238	290	343	447	508	556	600	641
		c_{lim} (mm)	160	150	140	130	120	110	90	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	255	280	305	329	414	426	455	482	533	579	621	656	656
230x90x32	380	F_{Rd} (c = 0)	91.3	122	159	201	236	262	329	395	528	636	695	749	800
		c_{lim} (mm)	140	130	120	110	100	90	80	80	80	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	333	359	386	413	439	466	532	606	668	733	785	833	879
230x75x26	333	F_{Rd} (c = 0)	69.3	96.1	129	185	206	226	278	330	420	469	514	555	593
		c_{lim} (mm)	140	130	120	110	100	90	80	80	80	80	80	80	80
		F_{Rd} ($c \geq c_{lim}$)	254	277	300	323	384	395	422	447	493	536	575	605	605

Advance® and UKPFC are trademarks of Tata Steel. A fuller description of the relationship between Parallel Flange Channels (PFC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
If $c < c_{lim}$, then use F_{Rd} value for c = 0.
Resistances assume no eccentricity of the applied force relative to the web.
FOR EXPLANATION OF TABLES SEE NOTE 6.

WEB BEARING AND BUCKLING



PARALLEL FLANGE CHANNELS
Advance® UKPFC

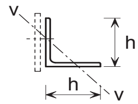


Unstiffened webs

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN	Position of Stiff Bearing	Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
200x90x30	315	F_{Rd} (c = 0)	88.2	116	151	190	224	249	311	373	497	599	655	707	755
		c_{lim} (mm)	120	110	100	90	80	80	80	80	80	90	90	90	90
		F_{Rd} (c ≥ c_{lim})	319	344	369	394	418	443	505	573	632	691	740	786	829
200x75x23	275	F_{Rd} (c = 0)	66.6	91.2	122	156	179	201	267	319	387	432	473	511	546
		c_{lim} (mm)	120	110	100	90	80	70	80	80	80	80	80	80	80
		F_{Rd} (c ≥ c_{lim})	242	263	284	305	352	356	387	411	454	493	530	557	557
180x90x26	267	F_{Rd} (c = 0)	75.9	102	135	172	200	223	280	338	453	540	591	638	682
		c_{lim} (mm)	110	100	90	80	80	80	80	80	80	80	80	80	80
		F_{Rd} (c ≥ c_{lim})	272	295	318	342	365	388	445	508	562	616	662	704	744
180x75x20	247	F_{Rd} (c = 0)	55.9	81.1	113	143	164	186	239	292	398	447	491	531	568
		c_{lim} (mm)	110	100	90	80	70	60	60	60	70	70	70	70	70
		F_{Rd} (c ≥ c_{lim})	203	224	245	267	288	309	363	407	460	502	542	578	604
150x90x24	226	F_{Rd} (c = 0)	72.9	99.5	132	170	195	218	276	334	449	565	652	704	753
		c_{lim} (mm)	90	80	70	70	70	70	70	70	70	70	80	80	80
		F_{Rd} (c ≥ c_{lim})	261	285	308	331	354	377	435	492	608	672	726	774	819
150x75x18	196	F_{Rd} (c = 0)	51.0	74.1	103	131	150	170	219	267	368	413	454	492	526
		c_{lim} (mm)	90	80	70	60	60	60	60	60	70	70	70	70	70
		F_{Rd} (c ≥ c_{lim})	183	203	222	242	261	281	330	375	423	463	500	534	566
125x65x15	166	F_{Rd} (c = 0)	45.1	68.7	98.7	122	142	161	210	259	357	453	498	540	579
		c_{lim} (mm)	80	70	60	60	60	60	60	60	60	60	60	60	60
		F_{Rd} (c ≥ c_{lim})	165	184	204	223	243	262	311	360	454	503	544	583	619
100x50x10	117	F_{Rd} (c = 0)	33.7	55.9	83.2	101	119	136	181	225	314	403	460	500	536
		c_{lim} (mm)	60	50	50	50	50	50	50	50	50	50	50	50	50
		F_{Rd} (c ≥ c_{lim})	126	143	161	179	197	214	259	303	392	455	497	534	568

Advance® and UKPFC are trademarks of Tata Steel. A fuller description of the relationship between Parallel Flange Channels (PFC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
If c < c_{lim}, then use F_{Rd} value for c = 0.
Resistances assume no eccentricity of the applied force relative to the web.
FOR EXPLANATION OF TABLES SEE NOTE 6.

EQUAL ANGLES
Advance® UKA - Equal Angles



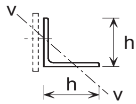
Section Designation h x h mm	t mm	Mass per Metre kg/m	Radius of Gyration Axis v-v cm	Gross Area cm^2	Bolt Size	Holes Deducted From Angle No.	Diameter mm	Tension Resistance $N_{u,Rd}$ kN
200x200	24	71.1	3.90	90.6	Weld	0	-	2680
					M24	1	26	2320
					M24	2	26	2080
					M20	3	22	1960
	20	59.9	3.92	76.3	Weld	0	-	2260
					M24	1	26	1950
					M24	2	26	1750
					M20	3	22	1640
	18	54.3	3.90	69.1	Weld	0	-	2040
					M24	1	26	1760
					M24	2	26	1580
					M20	3	22	1490
	16	48.5	3.94	61.8	Weld	0	-	1880
					M24	1	26	1620
					M24	2	26	1450
					M20	3	22	1370
150x150	18 +	40.1	2.93	51.2	Weld	0	-	1520
					M24	1	26	1260
					M20	2	22	1140
	15	33.8	2.93	43.0	Weld	0	-	1310
					M24	1	26	1090
					M20	2	22	985
	12	27.3	2.95	34.8	Weld	0	-	1060
					M24	1	26	879
					M20	2	22	795
	10	23.0	2.97	29.3	Weld	0	-	888
					M24	1	26	738
					M20	2	22	668
120x120	15 +	26.6	2.34	34.0	Weld	0	-	1040
					M24	1	26	835
					M20	1	22	858
	12	21.6	2.35	27.5	Weld	0	-	837
					M24	1	26	673
					M20	1	22	692
	10	18.2	2.36	23.2	Weld	0	-	704
					M24	1	26	566
					M20	1	22	581
	8 +	14.7	2.38	18.8	Weld	0	-	569
					M24	1	26	457
					M20	1	22	469

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range in BS EN 10056-1.

FOR EXPLANATION OF TABLES SEE NOTE 7.

EQUAL ANGLES
Advance® UKA - Equal Angles



Section Designation		Mass per Metre	Radius of Gyration Axis v-v	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
h x h	t					No.	Diameter	$N_{u,Rd}$
mm	mm	kg/m	cm	cm^2			mm	kN
100x100	15 +	21.9	1.94	28.0	Weld	0	-	856
					M24	1	26	664
					M20	1	22	688
	12	17.8	1.94	22.7	Weld	0	-	692
					M24	1	26	537
					M20	1	22	555
	10	15.0	1.95	19.2	Weld	0	-	584
					M24	1	26	452
					M20	1	22	468
	8	12.2	1.96	15.5	Weld	0	-	470
					M24	1	26	364
					M20	1	22	377
90x90	12 +	15.9	1.75	20.3	Weld	0	-	619
					M20	1	22	487
					M16	1	18	506
	10	13.4	1.75	17.1	Weld	0	-	521
					M20	1	22	409
					M16	1	18	425
	8	10.9	1.76	13.9	Weld	0	-	422
					M20	1	22	331
					M16	1	18	344
	7	9.61	1.77	12.2	Weld	0	-	370
					M20	1	22	291
					M16	1	18	302
80x80	10	11.9	1.55	15.1	Weld	0	-	460
					M20	1	22	353
					M16	1	18	368
	8	9.63	1.56	12.3	Weld	0	-	374
					M20	1	22	286
					M16	1	18	298
75x75	8	8.99	1.46	11.4	Weld	0	-	347
					M20	1	22	261
					M16	1	18	274
	6	6.85	1.47	8.73	Weld	0	-	265
					M20	1	22	199
					M16	1	18	209

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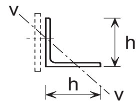
FOR EXPLANATION OF TABLES SEE NOTE 7.

TENSION

EQUAL ANGLES
Advance® UKA - Equal Angles

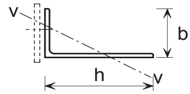


Section Designation		Mass per Metre	Radius of Gyration Axis	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
						No.	Diameter	
h x h	t		v-v					$N_{u,Rd}$
mm	mm	kg/m	cm	cm^2			mm	kN
70x70	7	7.38	1.36	9.40	Weld	0	-	286
					M20	1	22	211
					M16	1	18	222
	6	6.38	1.37	8.13	Weld	0	-	247
					M20	1	22	182
					M16	1	18	192
65x65	7	6.83	1.26	8.73	Weld	0	-	265
					M20	1	22	192
					M16	1	18	203
60x60	8	7.09	1.16	9.03	Weld	0	-	276
					M16	1	18	206
	6	5.42	1.17	6.91	Weld	0	-	210
					M16	1	18	157
	5	4.57	1.17	5.82	Weld	0	-	177
					M16	1	18	132
50x50	6	4.47	0.968	5.69	Weld	0	-	173
					M12	1	14	132
	5	3.77	0.973	4.80	Weld	0	-	146
					M12	1	14	111
	4	3.06	0.979	3.89	Weld	0	-	118
					M12	1	14	89.8
45x45	4.5	3.06	0.870	3.90	Weld	0	-	118
					M12	1	14	87.8
40x40	5	2.97	0.773	3.79	Weld	0	-	115
					M12	1	14	82.5
	4	2.42	0.777	3.08	Weld	0	-	93.6
					M12	1	14	66.9
35x35	4	2.09	0.678	2.67	Weld	0	-	81.3
					M12	1	14	55.3
30x30	4	1.78	0.577	2.27	Weld	0	-	69.2
					M12	1	14	44.0
	3	1.36	0.581	1.74	Weld	0	-	52.8
					M12	1	14	33.7
25x25	4	1.45	0.482	1.85	Weld	0	-	56.6
					M12	1	14	32.3
	3	1.12	0.484	1.42	Weld	0	-	43.3
					M12	1	14	24.8
20x20	3	0.882	0.383	1.12	Weld	0	-	34.2
					M12	1	14	16.3

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in note 12.

FOR EXPLANATION OF TABLES SEE NOTE 7.

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



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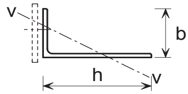
Section Designation h x b (mm)	t (mm)	Mass per Metre (kg/m)	Radius of Gyration Axis v-v (cm)	Gross Area (cm^2)	Bolt Size	Holes Deducted From Angle: No.	Holes Deducted From Angle: Diameter (mm)	Tension Resistance $N_{u,Rd}$ (kN)
200x150	18 +	47.1	3.22	60.1	Weld	0	-	1730
					M24	1	26	1420
					M20	2	22	1300
	15	39.6	3.23	50.5	Weld	0	-	1490
					M24	1	26	1220
					M20	2	22	1120
	12	32.0	3.25	40.8	Weld	0	-	1210
					M24	1	26	986
					M20	2	22	901
200x100	15	33.8	2.12	43.0	Weld	0	-	1230
					M24	1	26	930
					M20	1	22	954
	12	27.3	2.14	34.8	Weld	0	-	993
					M24	1	26	751
					M20	1	22	770
	10	23.0	2.15	29.2	Weld	0	-	832
					M24	1	26	630
					M20	1	22	645
150x90	15	26.6	1.93	33.9	Weld	0	-	986
					M20	1	22	760
					M16	1	18	784
	12	21.6	1.94	27.5	Weld	0	-	798
					M20	1	22	615
					M16	1	18	634
	10	18.2	1.95	23.2	Weld	0	-	672
					M20	1	22	518
					M16	1	18	533
150x75	15	24.8	1.58	31.7	Weld	0	-	908
					M20	1	22	673
					M16	1	18	697
	12	20.2	1.59	25.7	Weld	0	-	734
					M20	1	22	545
					M16	1	18	564
	10	17.0	1.60	21.7	Weld	0	-	619
					M20	1	22	459
					M16	1	18	475

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range in BS EN 10056-1.
FOR EXPLANATION OF TABLES SEE NOTE 7.

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



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Section Designation h x b mm	t mm	Mass per Metre kg/m	Radius of Gyration Axis v-v cm	Gross Area cm^2	Bolt Size	Holes Deducted From Angle No.	Diameter mm	Tension Resistance $N_{u,Rd}$ kN
125x75	12	17.8	1.61	22.7	Weld	0	-	660
					M20	1	22	492
					M16	1	18	510
	10	15.0	1.61	19.1	Weld	0	-	555
					M20	1	22	413
					M16	1	18	428
	8	12.2	1.63	15.5	Weld	0	-	449
					M20	1	22	334
					M16	1	18	347
100x75	12	15.4	1.59	19.7	Weld	0	-	585
					M20	1	22	438
					M16	1	18	457
	10	13.0	1.59	16.6	Weld	0	-	492
					M20	1	22	368
					M16	1	18	384
	8	10.6	1.60	13.5	Weld	0	-	399
					M20	1	22	299
					M16	1	18	311
100x65	10 +	12.3	1.39	15.6	Weld	0	-	457
					M20	1	22	329
					M16	1	18	345
	8 +	9.94	1.40	12.7	Weld	0	-	371
					M20	1	22	267
					M16	1	18	280
	7 +	8.77	1.40	11.2	Weld	0	-	327
					M20	1	22	236
					M16	1	18	247
100x50	8	8.97	1.06	11.4	Weld	0	-	326
					M12	1	14	244
	6	6.84	1.07	8.71	Weld	0	-	248
					M12	1	14	186
80x60	7	7.36	1.28	9.38	Weld	0	-	278
					M16	1	18	207

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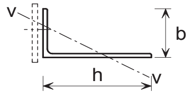
FOR EXPLANATION OF TABLES SEE NOTE 7.

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



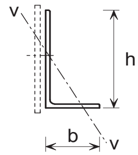
Short leg attached

Section Designation h x b mm	t mm	Mass per Metre kg/m	Radius of Gyration Axis v-v cm	Gross Area cm^2	Bolt Size	Holes Deducted From Angle No.	Diameter mm	Tension Resistance $N_{u,Rd}$ kN
80x40	8	7.07	0.838	9.01	Weld	0	-	258
					M12	1	14	184
	6	5.41	0.845	6.89	Weld	0	-	197
					M12	1	14	141
75x50	8	7.39	1.07	9.41	Weld	0	-	276
					M12	1	14	208
	6	5.65	1.08	7.19	Weld	0	-	211
					M12	1	14	159
70x50	6	5.41	1.07	6.89	Weld	0	-	203
					M12	1	14	153
65x50	5	4.35	1.07	5.54	Weld	0	-	164
					M12	1	14	124
60x40	6	4.46	0.855	5.68	Weld	0	-	167
					M12	1	14	119
	5	3.76	0.860	4.79	Weld	0	-	140
					M12	1	14	100
60x30	5	3.36	0.633	4.28	Weld	0	-	122
					M12	1	14	80.6
50x30	5	2.96	0.639	3.78	Weld	0	-	110
					M12	1	14	71.7
45x30	4	2.25	0.640	2.87	Weld	0	-	84.1
					M12	1	14	54.6
40x25	4	1.93	0.534	2.46	Weld	0	-	71.8
					M12	1	14	43.1
40x20	4	1.77	0.417	2.26	Weld	0	-	64.7
					M12	1	14	35.3
30x20	4	1.46	0.421	1.86	Weld	0	-	54.7
					M12	1	14	28.2
	3	1.12	0.424	1.43	Weld	0	-	41.9
					M12	1	14	21.8

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in note 12.
FOR EXPLANATION OF TABLES SEE NOTE 7.

TENSION

UNEQUAL ANGLES
Advance® UKA - Unequal Angles



Long leg attached

Section Designation h x b mm	t mm	Mass per Metre kg/m	Radius of Gyration Axis v-v cm	Gross Area cm^2	Bolt Size	Holes Deducted From Angle No.	Diameter mm	Tension Resistance $N_{u,Rd}$ kN
200x150	18 +	47.1	3.22	60.1	Weld	0	-	1820
					M24	1	26	1600
					M24	2	26	1430
					M20	3	22	1330
	15	39.6	3.23	50.5	Weld	0	-	1570
					M24	1	26	1380
					M24	2	26	1230
					M20	3	22	1150
	12	32.0	3.25	40.8	Weld	0	-	1270
					M24	1	26	1110
					M24	2	26	992
					M20	3	22	926
200x100	15	33.8	2.12	43.0	Weld	0	-	1390
					M24	1	26	1250
					M24	2	26	1100
					M20	3	22	1020
	12	27.3	2.14	34.8	Weld	0	-	1120
					M24	1	26	1010
					M24	2	26	885
					M20	3	22	820
	10	23.0	2.15	29.2	Weld	0	-	939
					M24	1	26	843
					M24	2	26	741
					M20	3	22	687
150x90	15	26.6	1.93	33.9	Weld	0	-	1080
					M24	1	26	929
					M20	2	22	823
	12	21.6	1.94	27.5	Weld	0	-	875
					M24	1	26	750
					M20	2	22	665
	10	18.2	1.95	23.2	Weld	0	-	736
					M24	1	26	630
					M20	2	22	559
150x75	15	24.8	1.58	31.7	Weld	0	-	1030
					M24	1	26	890
					M20	2	22	784
	12	20.2	1.59	25.7	Weld	0	-	830
					M24	1	26	718
					M20	2	22	633
	10	17.0	1.60	21.7	Weld	0	-	699
					M24	1	26	603
					M20	2	22	533

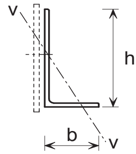
Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range in BS EN 10056-1.

FOR EXPLANATION OF TABLES SEE NOTE 7.

TENSION

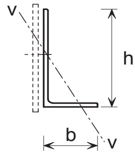
UNEQUAL ANGLES
Advance® UKA - Unequal Angles



Long leg attached

Section Designation		Mass per Metre	Radius of Gyration Axis v-v	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
h x b	t					No.	Diameter	$N_{u,Rd}$
mm	mm	kg/m	cm	cm^2			mm	kN
125x75	12	17.8	1.61	22.7	Weld	0	-	724
					M24	1	26	601
					M20	2	22	516
	10	15.0	1.61	19.1	Weld	0	-	608
					M24	1	26	504
					M20	2	22	433
	8	12.2	1.63	15.5	Weld	0	-	492
					M24	1	26	407
					M20	2	22	351
100x75	12	15.4	1.59	19.7	Weld	0	-	617
					M24	1	26	483
					M20	1	22	502
	10	13.0	1.59	16.6	Weld	0	-	519
					M24	1	26	406
					M20	1	22	422
	8	10.6	1.60	13.5	Weld	0	-	421
					M24	1	26	329
					M20	1	22	341
100x65	10 +	12.3	1.39	15.6	Weld	0	-	494
					M24	1	26	388
					M20	1	22	404
	8 +	9.94	1.40	12.7	Weld	0	-	401
					M24	1	26	315
					M20	1	22	327
	7 +	8.77	1.40	11.2	Weld	0	-	353
					M24	1	26	277
					M20	1	22	288
100x50	8	8.97	1.06	11.4	Weld	0	-	368
					M24	1	26	292
					M20	1	22	304
	6	6.84	1.07	8.71	Weld	0	-	280
					M24	1	26	221
					M20	1	22	231
80x60	7	7.36	1.28	9.38	Weld	0	-	293
					M20	1	22	226
					M16	1	18	237

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range in BS EN 10056-1.
FOR EXPLANATION OF TABLES SEE NOTE 7.



UNEQUAL ANGLES
Advance® UKA - Unequal Angles

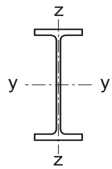
Long leg attached

Section Designation		Mass per Metre	Radius of Gyration Axis v-v	Gross Area	Bolt Size	Holes Deducted From Angle		Tension Resistance
h x b mm	t mm	kg/m	cm	cm^2		No.	Diameter mm	$N_{u,Rd}$ kN
80x40	8	7.07	0.838	9.01	Weld	0	-	292
					M20	1	22	228
					M16	1	18	240
	6	5.41	0.845	6.89	Weld	0	-	222
					M20	1	22	173
					M16	1	18	182
75x50	8	7.39	1.07	9.41	Weld	0	-	298
					M20	1	22	226
					M16	1	18	239
	6	5.65	1.08	7.19	Weld	0	-	227
					M20	1	22	172
					M16	1	18	181
70x50	6	5.41	1.07	6.89	Weld	0	-	216
					M20	1	22	160
					M16	1	18	170
65x50	5	4.35	1.07	5.54	Weld	0	-	172
					M20	1	22	125
					M16	1	18	132
60x40	6	4.46	0.855	5.68	Weld	0	-	179
					M16	1	18	135
	5	3.76	0.860	4.79	Weld	0	-	151
					M16	1	18	114
60x30	5	3.36	0.633	4.28	Weld	0	-	138
					M16	1	18	105
50x30	5	2.96	0.639	3.78	Weld	0	-	121
					M12	1	14	93.0
45x30	4	2.25	0.640	2.87	Weld	0	-	90.5
					M12	1	14	67.4
40x25	4	1.93	0.534	2.46	Weld	0	-	78.2
					M12	1	14	55.9
40x20	4	1.77	0.417	2.26	Weld	0	-	73.2
					M12	1	14	52.3
30x20	4	1.46	0.421	1.86	Weld	0	-	59.0
					M12	1	14	36.7
	3	1.12	0.424	1.43	Weld	0	-	45.1
					M12	1	14	28.2

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in note 12.
FOR EXPLANATION OF TABLES SEE NOTE 7.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m) 2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
1016x305x487 +	$N_{b,y,Rd}$	20800	20800	20800	20800	20800	20600	20400	20200	19900	19700	19400	19200	18900
	$N_{b,z,Rd}$	18800	16500	14100	11600	9400	7610	6220	5140	4310	3660	3140	2720	2380
	$N_{b,T,Rd}$	19600	18200	17000	15900	15100	14400	13800	13400	13000	12800	12500	12400	12200
1016x305x437 +	$N_{b,y,Rd}$	18700	18700	18700	18700	18700	18500	18300	18100	17900	17700	17400	17200	17000
	$N_{b,z,Rd}$	16800	14800	12500	10300	8320	6720	5480	4530	3790	3220	2760	2390	2090
	$N_{b,T,Rd}$	17600	16200	15100	14000	13100	12400	11800	11400	11000	10700	10500	10300	10100
* 1016x305x393 +	$N_{b,y,Rd}$	16500	16500	16500	16500	16500	16500	16400	16200	16000	15800	15600	15400	15200
	$N_{b,z,Rd}$	15100	13200	11100	9110	7330	5910	4810	3970	3320	2820	2420	2090	1830
	$N_{b,T,Rd}$	15400	14200	13100	12100	11200	10500	9950	9490	9130	8830	8590	8400	8240
* 1016x305x349 +	$N_{b,y,Rd}$	*14400*	*14400*	*14400*	*14400*	*14400*	*14400*	*14300*	*14200*	*14100*	*14000*	*13800*	*13700*	*13600*
	$N_{b,z,Rd}$	*13400*	*12200*	11100	9150	7320	5840	4710	3860	3210	2700	2300	1990	1730
	$N_{b,T,Rd}$	*13800*	*13000*	*12200*	11300	10600	9870	9280	8790	8380	8050	7780	7560	7370
* 1016x305x314 +	$N_{b,y,Rd}$	*12600*	*12600*	*12600*	*12600*	*12600*	*12600*	*12500*	*12400*	*12300*	*12200*	*12100*	*12000*	*11900*
	$N_{b,z,Rd}$	*11800*	*10700*	*9350*	8130	6480	5160	4160	3400	2830	2380	2030	1750	1520
	$N_{b,T,Rd}$	*12100*	*11400*	*10600*	*9840*	*9090*	8420	7840	7350	6950	6630	6360	6150	5960
* 1016x305x272 +	$N_{b,y,Rd}$	*10600*	*10600*	*10600*	*10600*	*10600*	*10500*	*10500*	*10400*	*10300*	*10200*	*10200*	*10100*	*10000*
	$N_{b,z,Rd}$	*9860*	*8990*	*7890*	*6620*	5600	4460	3590	2940	2440	2050	1750	1510	1320
	$N_{b,T,Rd}$	*10100*	*9520*	*8860*	*8160*	*7470*	*6830*	*6280*	5810	5430	5120	4860	4650	4480
* 1016x305x249 +	$N_{b,y,Rd}$	*9530*	*9530*	*9530*	*9530*	*9530*	*9500*	*9440*	*9370*	*9300*	*9230*	*9160*	*9080*	*9000*
	$N_{b,z,Rd}$	*8850*	*8010*	*6960*	*5760*	4820	3810	3060	2490	2070	1740	1480	1280	1110
	$N_{b,T,Rd}$	*9120*	*8540*	*7910*	*7240*	*6550*	*5920*	*5370*	4910	4540	4240	3990	3790	3620
* 1016x305x222 +	$N_{b,y,Rd}$	*8320*	*8320*	*8320*	*8320*	*8320*	*8290*	*8230*	*8170*	*8110*	*8050*	*7980*	*7920*	*7840*
	$N_{b,z,Rd}$	*7680*	*6900*	*5930*	*4840*	4020	3150	2520	2050	1690	1420	1210	1040	908
	$N_{b,T,Rd}$	*7940*	*7420*	*6840*	*6200*	*5560*	*4960*	4440	4010	3670	3390	3160	2980	2830
* 914x419x388	$N_{b,y,Rd}$	*16500*	*16500*	*16500*	*16500*	*16500*	*16400*	*16300*	*16100*	*16000*	*15900*	*15700*	*15600*	*15400*
	$N_{b,z,Rd}$	*16100*	*15300*	14800	13600	12300	10800	9360	8050	6910	5960	5170	4510	3970
	$N_{b,T,Rd}$	*16300*	*15700*	15000	14300	13600	12900	12200	11600	11000	10500	10100	9710	9380
* 914x419x343	$N_{b,y,Rd}$	*14300*	*14300*	*14300*	*14300*	*14300*	*14200*	*14100*	*14000*	*13900*	*13700*	*13600*	*13500*	*13400*
	$N_{b,z,Rd}$	*14000*	*13200*	*12400*	*11500*	10700	9440	8150	6990	5990	5160	4470	3900	3430
	$N_{b,T,Rd}$	*14100*	*13500*	*13000*	*12300*	*11700*	11000	10400	9770	9220	8720	8280	7900	7570

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections.

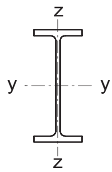
* Section may be Class 4 under axial compression.

Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 914x305x289	$N_{b,y,Rd}$	*11800*	*11800*	*11800*	*11800*	*11800*	*11700*	*11600*	*11500*	*11400*	*11300*	*11200*	*11100*	*11000*
	$N_{b,z,Rd}$	*11000*	*10000*	9250	7650	6140	4910	3970	3250	2700	2280	1940	1680	1460
	$N_{b,T,Rd}$	*11300*	*10600*	*9940*	9200	8480	7820	7250	6760	6370	6040	5770	5550	5370
* 914x305x253	$N_{b,y,Rd}$	*10000*	*10000*	*10000*	*10000*	*10000*	*9940*	*9870*	*9790*	*9710*	*9630*	*9550*	*9460*	*9360*
	$N_{b,z,Rd}$	*9350*	*8520*	*7490*	6590	5290	4220	3400	2780	2310	1950	1660	1430	1250
	$N_{b,T,Rd}$	*9610*	*9030*	*8400*	*7730*	*7060*	6440	5890	5430	5060	4750	4490	4280	4110
* 914x305x224	$N_{b,y,Rd}$	*8620*	*8620*	*8620*	*8620*	*8620*	*8560*	*8490*	*8430*	*8360*	*8290*	*8220*	*8140*	*8060*
	$N_{b,z,Rd}$	*8030*	*7310*	*6410*	*5360*	4530	3600	2900	2370	1960	1650	1410	1220	1060
	$N_{b,T,Rd}$	*8260*	*7760*	*7200*	*6590*	*5970*	*5380*	4860	4430	4070	3780	3550	3350	3190
* 914x305x201	$N_{b,y,Rd}$	*7530*	*7530*	*7530*	*7530*	*7530*	*7470*	*7420*	*7360*	*7300*	*7240*	*7170*	*7100*	*7030*
	$N_{b,z,Rd}$	*6990*	*6340*	*5520*	*4580*	3880	3060	2450	2000	1660	1390	1190	1020	891
	$N_{b,T,Rd}$	*7210*	*6760*	*6250*	*5690*	*5110*	*4560*	*4070*	3670	3340	3070	2860	2680	2530
* 838x292x226	$N_{b,y,Rd}$	*9020*	*9020*	*9020*	*9020*	*8990*	*8920*	*8840*	*8770*	*8690*	*8610*	*8520*	*8430*	*8330*
	$N_{b,z,Rd}$	*8380*	*7610*	*6630*	*5770*	4580	3640	2930	2390	1980	1670	1420	1230	1070
	$N_{b,T,Rd}$	*8610*	*8070*	*7490*	*6870*	*6260*	5710	5230	4840	4510	4250	4040	3860	3720
* 838x292x194	$N_{b,y,Rd}$	*7460*	*7460*	*7460*	*7460*	*7430*	*7370*	*7310*	*7250*	*7180*	*7120*	*7040*	*6970*	*6890*
	$N_{b,z,Rd}$	*6910*	*6250*	*5420*	*4470*	3730	2950	2360	1930	1600	1340	1140	985	857
	$N_{b,T,Rd}$	*7120*	*6650*	*6140*	*5590*	*5030*	*4510*	4060	3690	3390	3150	2960	2800	2670
* 838x292x176	$N_{b,y,Rd}$	*6620*	*6620*	*6620*	*6620*	*6590*	*6540*	*6490*	*6430*	*6370*	*6310*	*6250*	*6180*	*6110*
	$N_{b,z,Rd}$	*6120*	*5520*	*4760*	*3900*	3250	2560	2050	1670	1380	1160	987	850	739
	$N_{b,T,Rd}$	*6310*	*5890*	*5430*	*4910*	*4380*	*3890*	3480	3130	2850	2620	2440	2290	2170
* 762x267x197	$N_{b,y,Rd}$	*7980*	*7980*	*7980*	*7980*	*7910*	*7840*	*7760*	*7680*	*7600*	*7510*	*7420*	*7320*	*7220*
	$N_{b,z,Rd}$	*7280*	*6470*	5700	4480	3470	2720	2170	1760	1460	1220	1040	896	779
	$N_{b,T,Rd}$	*7520*	*6990*	*6420*	5830	5290	4820	4430	4120	3880	3680	3530	3400	3300
* 762x267x173	$N_{b,y,Rd}$	*6800*	*6800*	*6800*	*6800*	*6740*	*6680*	*6620*	*6550*	*6480*	*6410*	*6330*	*6240*	*6150*
	$N_{b,z,Rd}$	*6190*	*5490*	*4600*	3810	2940	2290	1820	1480	1220	1030	873	752	654
	$N_{b,T,Rd}$	*6410*	*5940*	*5420*	*4880*	4370	3920	3550	3260	3030	2850	2700	2580	2480
* 762x267x147	$N_{b,y,Rd}$	*5560*	*5560*	*5560*	*5560*	*5510*	*5460*	*5410*	*5360*	*5300*	*5240*	*5180*	*5110*	*5030*
	$N_{b,z,Rd}$	*5050*	*4460*	*3720*	3030	2370	1840	1460	1190	979	821	698	601	522
	$N_{b,T,Rd}$	*5240*	*4840*	*4390*	*3910*	*3440*	*3040*	2710	2440	2230	2070	1940	1830	1750
* 762x267x134	$N_{b,y,Rd}$	*5090*	*5090*	*5090*	*5090*	*5040*	*5000*	*4950*	*4900*	*4850*	*4790*	*4730*	*4670*	*4600*
	$N_{b,z,Rd}$	*4610*	*4050*	*3350*	*2630*	2120	1640	1300	1050	867	727	618	531	462
	$N_{b,T,Rd}$	*4780*	*4410*	*3980*	*3510*	*3060*	*2660*	2350	2100	1900	1750	1630	1530	1450

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

* Section may be Class 4 under axial compression.

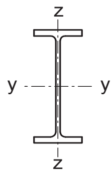
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m) 2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 686x254x170	$N_{b,y,Rd}$	*6980*	*6980*	*6980*	*6950*	*6880*	*6810*	*6730*	*6650*	*6570*	*6480*	*6380*	*6270*	*6150*
	$N_{b,z,Rd}$	*6320*	*5570*	4790	3720	2860	2230	1770	1440	1190	996	847	729	634
	$N_{b,T,Rd}$	*6540*	*6050*	*5530*	5010	4540	4140	3830	3580	3380	3230	3100	3000	2920
* 686x254x152	$N_{b,y,Rd}$	*6090*	*6090*	*6090*	*6060*	*6000*	*5940*	*5870*	*5800*	*5730*	*5650*	*5560*	*5470*	*5370*
	$N_{b,z,Rd}$	*5510*	*4850*	4120	3270	2500	1950	1550	1260	1040	870	740	636	553
	$N_{b,T,Rd}$	*5700*	*5260*	*4780*	*4300*	3850	3470	3170	2930	2740	2590	2470	2370	2300
* 686x254x140	$N_{b,y,Rd}$	*5480*	*5480*	*5480*	*5450*	*5400*	*5340*	*5290*	*5220*	*5160*	*5090*	*5010*	*4930*	*4840*
	$N_{b,z,Rd}$	*4960*	*4360*	*3610*	2950	2250	1750	1390	1130	929	779	662	570	495
	$N_{b,T,Rd}$	*5130*	*4730*	*4290*	*3820*	*3400*	3030	2740	2510	2330	2190	2070	1980	1910
* 686x254x125	$N_{b,y,Rd}$	*4780*	*4780*	*4780*	*4760*	*4710*	*4660*	*4610*	*4560*	*4500*	*4440*	*4370*	*4300*	*4220*
	$N_{b,z,Rd}$	*4310*	*3780*	*3100*	2530	1920	1490	1180	955	788	660	561	483	419
	$N_{b,T,Rd}$	*4470*	*4110*	*3700*	*3270*	*2870*	2530	2250	2040	1870	1740	1630	1550	1480
610x305x238	$N_{b,y,Rd}$	10500	10500	10500	10300	10200	10100	9980	9840	9690	9530	9350	9150	8930
	$N_{b,z,Rd}$	9860	9080	8110	6960	5780	4730	3870	3200	2670	2260	1940	1670	1460
	$N_{b,T,Rd}$	10000	9500	8970	8480	8030	7640	7320	7050	6830	6650	6500	6380	6280
* 610x305x179	$N_{b,y,Rd}$	*7590*	*7590*	*7590*	*7510*	*7430*	*7340*	*7250*	*7150*	*7040*	*6920*	*6790*	6750	6680
	$N_{b,z,Rd}$	*7150*	6750	6030	5140	4230	3440	2810	2320	1940	1640	1400	1210	1060
	$N_{b,T,Rd}$	*7280*	*6850*	6410	5950	5510	5110	4770	4480	4240	4050	3890	3750	3650
* 610x305x149	$N_{b,y,Rd}$	*6100*	*6100*	*6100*	*6040*	*5980*	*5910*	*5830*	*5750*	*5670*	*5570*	*5470*	*5360*	*5230*
	$N_{b,z,Rd}$	*5760*	*5300*	*4740*	4170	3480	2830	2310	1900	1590	1340	1150	990	863
	$N_{b,T,Rd}$	*5850*	*5500*	*5120*	*4720*	*4310*	3940	3610	3340	3110	2920	2770	2650	2540
* 610x229x140	$N_{b,y,Rd}$	*5760*	*5760*	*5760*	*5690*	*5630*	*5560*	*5490*	*5410*	*5320*	*5230*	*5120*	*5010*	*4880*
	$N_{b,z,Rd}$	*5100*	4560	3570	2670	2020	1550	1230	993	818	685	582	500	434
	$N_{b,T,Rd}$	*5310*	4860	4390	3950	3580	3280	3050	2870	2730	2630	2540	2470	2420
* 610x229x125	$N_{b,y,Rd}$	*5010*	*5010*	*5010*	*4960*	*4900*	*4850*	*4780*	*4710*	*4640*	*4560*	*4470*	*4370*	*4270*
	$N_{b,z,Rd}$	*4440*	*3800*	3140	2350	1770	1360	1070	868	714	598	508	437	379
	$N_{b,T,Rd}$	*4620*	*4210*	*3780*	3360	2990	2700	2480	2310	2180	2080	1990	1930	1880
* 610x229x113	$N_{b,y,Rd}$	*4450*	*4450*	*4450*	*4400*	*4350*	*4300*	*4240*	*4180*	*4120*	*4040*	*3970*	*3880*	*3780*
	$N_{b,z,Rd}$	*3930*	*3360*	2750	2070	1550	1190	941	760	626	524	444	382	332
	$N_{b,T,Rd}$	*4100*	*3720*	*3310*	*2910*	2560	2280	2070	1900	1780	1680	1600	1540	1490
* 610x229x101	$N_{b,y,Rd}$	*3990*	*3990*	*3990*	*3950*	*3900*	*3850*	*3800*	*3750*	*3690*	*3620*	*3550*	*3460*	*3370*
	$N_{b,z,Rd}$	*3510*	*2960*	*2310*	1790	1330	1020	805	649	534	447	379	325	283
	$N_{b,T,Rd}$	*3660*	*3310*	*2920*	*2520*	2180	1910	1710	1550	1430	1340	1270	1210	1160

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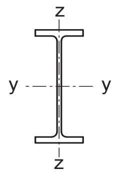
* Section may be Class 4 under axial compression.

Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 610x178x100 +	$N_{b,y,Rd}$	*3910*	*3910*	*3900*	*3860*	*3810*	*3770*	*3710*	*3660*	*3600*	*3530*	*3460*	*3380*	*3290*
	$N_{b,z,Rd}$	*3120*	2430	1620	1120	812	613	478	383	314	261	221	190	164
	$N_{b,T,Rd}$	*3410*	*2960*	2510	2150	1890	1700	1570	1470	1400	1350	1300	1270	1240
* 610x178x92 +	$N_{b,y,Rd}$	*3590*	*3590*	*3580*	*3540*	*3500*	*3450*	*3400*	*3350*	*3290*	*3230*	*3160*	*3080*	*2990*
	$N_{b,z,Rd}$	*2820*	2160	1430	980	707	533	415	332	272	227	192	164	142
	$N_{b,T,Rd}$	*3120*	*2680*	*2230*	1880	1620	1440	1320	1230	1160	1110	1070	1030	1010
* 610x178x82 +	$N_{b,y,Rd}$	*3080*	*3080*	*3080*	*3040*	*3010*	*2970*	*2930*	*2880*	*2840*	*2780*	*2720*	*2660*	*2580*
	$N_{b,z,Rd}$	*2410*	*1730*	1210	828	596	449	349	280	229	191	161	138	120
	$N_{b,T,Rd}$	*2670*	*2270*	*1870*	1540	1310	1140	1030	947	886	840	804	775	753
533x312x272 +	$N_{b,y,Rd}$	12000	12000	12000	11800	11700	11500	11300	11100	10900	10700	10500	10200	9840
	$N_{b,z,Rd}$	11400	10600	9600	8410	7120	5910	4890	4060	3410	2900	2480	2150	1880
	$N_{b,T,Rd}$	11600	11100	10600	10200	9860	9590	9380	9210	9070	8960	8870	8800	8740
533x312x219 +	$N_{b,y,Rd}$	9630	9630	9580	9460	9340	9200	9060	8900	8730	8530	8310	8070	7790
	$N_{b,z,Rd}$	9120	8440	7600	6600	5530	4560	3760	3110	2610	2210	1900	1640	1430
	$N_{b,T,Rd}$	9260	8780	8320	7890	7500	7180	6900	6680	6500	6350	6220	6120	6040
533x312x182 +	$N_{b,y,Rd}$	7970	7970	7930	7830	7720	7610	7490	7360	7210	7050	6860	6660	6420
	$N_{b,z,Rd}$	7540	6960	6260	5410	4530	3720	3060	2530	2120	1800	1540	1330	1160
	$N_{b,T,Rd}$	7650	7220	6790	6360	5960	5600	5300	5040	4830	4660	4520	4410	4310
* 533x312x150 +	$N_{b,y,Rd}$	*6430*	*6430*	*6400*	*6320*	*6230*	*6140*	*6050*	*5940*	5870	5840	5690	5510	5310
	$N_{b,z,Rd}$	*6080*	5770	5170	4460	3720	3050	2500	2070	1730	1470	1250	1090	948
	$N_{b,T,Rd}$	*6170*	5810	5430	5040	4650	4300	4000	3740	3530	3350	3210	3090	3000
533x210x138 +	$N_{b,y,Rd}$	6070	6070	6030	5950	5860	5770	5670	5560	5440	5300	5150	4970	4770
	$N_{b,z,Rd}$	5230	4300	3240	2370	1770	1350	1070	860	707	591	502	431	374
	$N_{b,T,Rd}$	5520	5030	4580	4190	3880	3660	3490	3360	3260	3180	3120	3080	3040
* 533x210x122	$N_{b,y,Rd}$	*5150*	*5150*	*5120*	*5050*	*4980*	*4910*	*4830*	4740	4740	4670	4530	4380	4200
	$N_{b,z,Rd}$	4600	3780	2850	2080	1550	1190	936	754	620	519	440	378	328
	$N_{b,T,Rd}$	4680	4250	3830	3460	3160	2940	2770	2640	2550	2470	2410	2370	2330
* 533x210x109	$N_{b,y,Rd}$	*4520*	*4520*	*4490*	*4430*	*4370*	*4300*	*4230*	*4160*	*4070*	*3970*	*3860*	*3730*	3670
	$N_{b,z,Rd}$	*3900*	3350	2500	1830	1360	1040	816	658	541	452	384	329	286
	$N_{b,T,Rd}$	*4100*	*3700*	3290	2930	2630	2410	2240	2120	2020	1950	1890	1850	1810
* 533x210x101	$N_{b,y,Rd}$	*4120*	*4120*	*4100*	*4040*	*3990*	*3930*	*3870*	*3800*	*3720*	*3630*	*3530*	*3420*	*3290*
	$N_{b,z,Rd}$	*3560*	3020	2300	1680	1240	952	749	603	496	415	352	302	262
	$N_{b,T,Rd}$	*3730*	*3360*	2970	2610	2320	2100	1940	1820	1730	1660	1600	1560	1520
* 533x210x92	$N_{b,y,Rd}$	*3760*	*3760*	*3730*	*3680*	*3630*	*3580*	*3520*	*3450*	*3380*	*3300*	*3210*	*3100*	*2980*
	$N_{b,z,Rd}$	*3230*	*2660*	2080	1500	1110	846	665	535	439	367	311	267	232
	$N_{b,T,Rd}$	*3400*	*3040*	*2650*	2300	2020	1800	1640	1530	1440	1370	1310	1270	1240
* 533x210x82	$N_{b,y,Rd}$	*3310*	*3310*	*3280*	*3240*	*3190*	*3150*	*3090*	*3030*	*2970*	*2890*	*2810*	*2720*	*2610*
	$N_{b,z,Rd}$	*2830*	*2300*	1790	1280	946	721	565	455	373	312	264	227	197
	$N_{b,T,Rd}$	*2980*	*2650*	*2280*	1940	1670	1470	1320	1210	1130	1060	1010	974	942

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+ These sections are in addition to the range of BS 4 sections.

* Section may be Class 4 under axial compression.

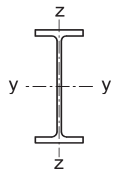
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 533x165x85 +	$N_{b,y,Rd}$	*3370*	*3370*	*3340*	*3300*	*3250*	*3200*	*3150*	*3090*	*3020*	*2950*	*2860*	*2770*	*2660*
	$N_{b,z,Rd}$	*2610*	1940	1270	874	631	475	370	296	243	202	171	146	127
	$N_{b,T,Rd}$	*2890*	*2480*	2110	1820	1620	1480	1380	1310	1260	1220	1190	1170	1150
* 533x165x74 +	$N_{b,y,Rd}$	*2960*	*2960*	*2940*	*2900*	*2860*	*2810*	*2760*	*2710*	*2650*	*2580*	*2500*	*2410*	*2310*
	$N_{b,z,Rd}$	*2250*	1630	1060	719	517	389	302	242	198	165	139	119	103
	$N_{b,T,Rd}$	*2520*	*2120*	1750	1470	1270	1140	1050	985	937	900	872	850	832
* 533x165x66 +	$N_{b,y,Rd}$	*2520*	*2520*	*2500*	*2470*	*2430*	*2390*	*2350*	*2300*	*2250*	*2190*	*2130*	*2050*	*1970*
	$N_{b,z,Rd}$	*1900*	1360	881	598	429	322	251	200	164	136	115	98.8	85.6
	$N_{b,T,Rd}$	*2130*	*1770*	*1430*	1180	1000	885	803	744	701	669	644	624	608
457x191x161 +	$N_{b,y,Rd}$	7110	7110	7010	6900	6780	6660	6510	6350	6170	5950	5710	5440	5140
	$N_{b,z,Rd}$	6060	4920	3660	2660	1970	1510	1190	955	785	657	557	478	415
	$N_{b,T,Rd}$	6500	6100	5800	5590	5450	5350	5270	5220	5180	5150	5130	5110	5090
457x191x133 +	$N_{b,y,Rd}$	5870	5870	5780	5690	5590	5480	5360	5220	5060	4880	4670	4440	4180
	$N_{b,z,Rd}$	4960	3980	2930	2110	1560	1190	936	753	619	517	439	377	327
	$N_{b,T,Rd}$	5300	4890	4560	4310	4130	4000	3910	3840	3780	3740	3710	3690	3670
457x191x106 +	$N_{b,y,Rd}$	4660	4650	4580	4510	4430	4340	4240	4130	3990	3840	3670	3470	3260
	$N_{b,z,Rd}$	3900	3090	2240	1610	1180	901	707	569	467	390	331	284	246
	$N_{b,T,Rd}$	4160	3760	3400	3110	2890	2740	2620	2540	2470	2420	2380	2350	2330
* 457x191x98	$N_{b,y,Rd}$	*4200*	*4200*	*4140*	4120	4100	4020	3930	3820	3700	3560	3400	3230	3030
	$N_{b,z,Rd}$	3620	2870	2080	1490	1100	838	657	529	434	363	308	264	229
	$N_{b,T,Rd}$	3760	3390	3040	2760	2550	2390	2280	2190	2130	2080	2040	2010	1990
* 457x191x89	$N_{b,y,Rd}$	*3770*	*3770*	*3710*	*3650*	*3590*	*3520*	*3440*	*3350*	3300	3240	3100	2930	2750
	$N_{b,z,Rd}$	3290	2590	1870	1340	987	751	589	474	389	325	276	236	205
	$N_{b,T,Rd}$	*3360*	3000	2660	2380	2160	2010	1890	1810	1750	1700	1660	1630	1600
* 457x191x82	$N_{b,y,Rd}$	*3470*	*3470*	*3420*	*3360*	*3300*	*3240*	*3160*	*3080*	*2980*	*2870*	2750	2700	2520
	$N_{b,z,Rd}$	*2900*	2370	1690	1200	882	670	525	422	346	289	245	210	182
	$N_{b,T,Rd}$	*3080*	2730	2390	2100	1880	1730	1610	1530	1460	1420	1380	1350	1320
* 457x191x74	$N_{b,y,Rd}$	*3090*	*3090*	*3040*	*2990*	*2940*	*2880*	*2820*	*2750*	*2660*	*2570*	*2450*	*2330*	*2190*
	$N_{b,z,Rd}$	*2590*	2120	1520	1080	792	602	471	379	311	259	220	189	164
	$N_{b,T,Rd}$	*2730*	*2410*	2080	1800	1590	1440	1330	1240	1180	1140	1100	1070	1050
* 457x191x67	$N_{b,y,Rd}$	*2740*	*2740*	*2700*	*2650*	*2610*	*2560*	*2500*	*2430*	*2360*	*2270*	*2170*	*2060*	*1940*
	$N_{b,z,Rd}$	*2290*	*1800*	1340	946	692	525	411	330	271	226	192	164	143
	$N_{b,T,Rd}$	*2420*	*2120*	*1810*	1540	1340	1190	1090	1010	952	908	874	847	825

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+ These sections are in addition to the range of BS 4 sections.

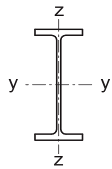
* Section may be Class 4 under axial compression.

Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 457x152x82	$N_{b,y,Rd}$	*3460*	*3460*	*3460*	*3460*	*3450*	*3430*	*3400*	*3350*	*3290*	*3220*	*3150*	*3070*	3040
	$N_{b,z,Rd}$	*3240*	3040	2700	2260	1840	1480	1200	820	591	445	346	277	227
	$N_{b,T,Rd}$	*3320*	*3130*	2940	2740	2560	2390	2250	2030	1880	1780	1710	1660	1620
* 457x152x74	$N_{b,y,Rd}$	*3040*	*3040*	*3040*	*3040*	*3040*	*3020*	*2990*	*2950*	*2890*	*2840*	*2770*	*2700*	*2620*
	$N_{b,z,Rd}$	*2840*	*2600*	2360	2010	1630	1310	1060	722	520	391	305	244	199
	$N_{b,T,Rd}$	*2920*	*2750*	*2570*	*2390*	2210	2050	1910	1700	1550	1450	1380	1330	1290
* 457x152x67	$N_{b,y,Rd}$	*2770*	*2770*	*2770*	*2770*	*2760*	*2740*	*2720*	*2680*	*2630*	*2580*	*2520*	*2450*	*2370*
	$N_{b,z,Rd}$	*2580*	*2350*	*2070*	1810	1450	1160	935	636	457	343	267	214	175
	$N_{b,T,Rd}$	*2650*	*2490*	*2320*	*2140*	*1960*	1790	1650	1430	1280	1190	1120	1070	1030
* 457x152x60	$N_{b,y,Rd}$	*2390*	*2390*	*2390*	*2390*	*2390*	*2370*	*2360*	*2320*	*2280*	*2230*	*2180*	*2120*	*2060*
	$N_{b,z,Rd}$	*2230*	*2040*	*1790*	*1500*	1270	1010	815	554	398	299	232	186	152
	$N_{b,T,Rd}$	*2290*	*2150*	*2000*	*1840*	*1670*	*1510*	1380	1170	1030	938	874	827	793
* 457x152x52	$N_{b,y,Rd}$	*2030*	*2030*	*2030*	*2030*	*2030*	*2020*	*2000*	*1970*	*1930*	*1890*	*1850*	*1800*	*1740*
	$N_{b,z,Rd}$	*1890*	*1720*	*1500*	*1250*	1050	833	668	452	324	243	189	151	123
	$N_{b,T,Rd}$	*1950*	*1820*	*1690*	*1540*	*1380*	*1240*	*1110*	920	793	707	648	607	576
406x178x85 +	$N_{b,y,Rd}$	3760	3760	3760	3760	3740	3710	3670	3610	3530	3440	3340	3220	3090
	$N_{b,z,Rd}$	3610	3370	3090	2760	2390	2020	1690	1200	876	665	521	418	343
	$N_{b,T,Rd}$	3670	3490	3310	3140	2960	2800	2660	2420	2250	2130	2050	1980	1930
* 406x178x74	$N_{b,y,Rd}$	*3220*	*3220*	*3220*	*3220*	*3200*	*3180*	*3150*	*3090*	*3020*	*2950*	*2860*	2850	2730
	$N_{b,z,Rd}$	*3090*	2880	2720	2410	2060	1730	1440	1010	739	560	438	352	289
	$N_{b,T,Rd}$	*3140*	*2980*	2820	2660	2490	2330	2190	1950	1780	1660	1570	1510	1460
* 406x178x67	$N_{b,y,Rd}$	*2860*	*2860*	*2860*	*2860*	*2850*	*2820*	*2800*	*2750*	*2690*	*2620*	*2550*	*2460*	*2350*
	$N_{b,z,Rd}$	*2740*	*2560*	*2340*	2160	1840	1540	1280	897	654	496	388	311	255
	$N_{b,T,Rd}$	*2790*	*2650*	*2500*	*2350*	2190	2030	1890	1660	1490	1370	1280	1220	1170
* 406x178x60	$N_{b,y,Rd}$	*2500*	*2500*	*2500*	*2500*	*2490*	*2470*	*2440*	*2400*	*2350*	*2290*	*2230*	*2150*	*2060*
	$N_{b,z,Rd}$	*2400*	*2240*	*2050*	*1830*	1640	1370	1130	795	580	439	344	276	226
	$N_{b,T,Rd}$	*2430*	*2310*	*2180*	*2040*	*1890*	*1750*	1610	1390	1230	1110	1030	970	926
* 406x178x54	$N_{b,y,Rd}$	*2230*	*2230*	*2230*	*2230*	*2210*	*2190*	*2170*	*2130*	*2090*	*2040*	*1980*	*1910*	*1820*
	$N_{b,z,Rd}$	*2130*	*1980*	*1810*	*1600*	1430	1180	978	681	495	375	293	235	192
	$N_{b,T,Rd}$	*2160*	*2050*	*1930*	*1800*	*1660*	*1520*	1390	1170	1010	902	824	768	726

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+ These sections are in addition to the range of BS 4 sections.

* Section may be Class 4 under axial compression.

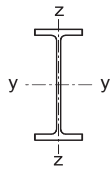
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 406x140x53 +	$N_{b,y,Rd}$	*2200*	*2200*	*2200*	*2200*	*2180*	*2160*	*2140*	*2100*	*2060*	*2010*	*1950*	*1880*	*1790*
	$N_{b,z,Rd}$	*2030*	*1820*	*1570*	1330	1050	827	663	448	321	241	187	149	122
	$N_{b,T,Rd}$	*2090*	*1950*	*1800*	*1640*	1490	1350	1240	1070	964	892	842	807	781
* 406x140x46	$N_{b,y,Rd}$	*1820*	*1820*	*1820*	*1820*	*1810*	*1800*	*1780*	*1750*	*1710*	*1670*	*1620*	*1570*	*1500*
	$N_{b,z,Rd}$	*1690*	*1520*	*1310*	*1080*	892	703	563	380	272	204	158	126	103
	$N_{b,T,Rd}$	*1730*	*1620*	*1490*	*1350*	*1210*	*1080*	*979*	825	724	658	613	581	557
* 406x140x39	$N_{b,y,Rd}$	*1500*	*1500*	*1500*	*1500*	*1490*	*1470*	*1460*	*1430*	*1400*	*1370*	*1330*	*1280*	*1230*
	$N_{b,z,Rd}$	*1370*	*1230*	*1050*	*846*	698	545	434	292	208	156	121	96.7	78.9
	$N_{b,T,Rd}$	*1420*	*1320*	*1200*	*1080*	*952*	*839*	*743*	605	517	459	420	392	372
* 356x171x67	$N_{b,y,Rd}$	3030	3030	3030	3020	2990	2960	2930	2860	2790	2690	2580	2450	2290
	$N_{b,z,Rd}$	2890	2690	2450	2160	1840	1540	1280	897	654	496	388	311	255
	$N_{b,T,Rd}$	2890	2750	2600	2450	2300	2170	2050	1860	1730	1630	1570	1520	1480
* 356x171x57	$N_{b,y,Rd}$	*2470*	*2470*	*2470*	*2460*	*2440*	*2420*	*2390*	*2340*	*2270*	*2200*	2150	2060	1930
	$N_{b,z,Rd}$	*2360*	*2200*	2060	1810	1530	1270	1050	736	536	405	317	254	208
	$N_{b,T,Rd}$	*2400*	*2270*	2140	2000	1860	1730	1610	1420	1280	1190	1120	1070	1040
* 356x171x51	$N_{b,y,Rd}$	*2170*	*2170*	*2170*	*2160*	*2140*	*2120*	*2100*	*2050*	*1990*	*1930*	*1850*	*1760*	1650
	$N_{b,z,Rd}$	*2070*	*1920*	*1750*	1600	1350	1120	923	644	468	354	277	222	182
	$N_{b,T,Rd}$	*2100*	*1990*	*1870*	*1740*	1610	1480	1360	1180	1050	955	890	844	809
* 356x171x45	$N_{b,y,Rd}$	*1880*	*1880*	*1880*	*1870*	*1850*	*1840*	*1820*	*1770*	*1730*	*1670*	*1600*	*1520*	*1420*
	$N_{b,z,Rd}$	*1790*	*1660*	*1510*	1330	1160	952	783	543	394	298	233	186	153
	$N_{b,T,Rd}$	*1820*	*1720*	*1610*	*1490*	*1370*	1250	1140	961	836	750	689	646	613
* 356x127x39	$N_{b,y,Rd}$	*1600*	*1600*	*1600*	*1590*	*1580*	*1560*	*1540*	*1510*	*1470*	*1420*	*1360*	*1290*	*1200*
	$N_{b,z,Rd}$	*1440*	*1260*	1040	825	628	487	386	258	184	137	106	84.9	69.3
	$N_{b,T,Rd}$	*1490*	*1370*	*1240*	*1110*	991	892	813	704	637	593	563	543	527
* 356x127x33	$N_{b,y,Rd}$	*1310*	*1310*	*1310*	*1300*	*1290*	*1270*	*1260*	*1230*	*1200*	*1160*	*1110*	*1050*	*980*
	$N_{b,z,Rd}$	*1170*	*1010*	*823*	661	500	386	305	203	145	108	83.7	66.7	54.4
	$N_{b,T,Rd}$	*1220*	*1110*	*998*	*878*	*768*	677	606	507	447	408	382	364	350

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* Section may be Class 4 under axial compression.

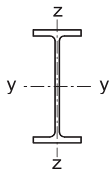
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
305x165x54	$N_{b,y,Rd}$	2440	2440	2440	2410	2390	2360	2330	2250	2170	2060	1940	1780	1610
	$N_{b,z,Rd}$	2320	2160	1960	1720	1460	1210	1010	703	512	388	303	243	199
	$N_{b,T,Rd}$	2360	2230	2100	1980	1860	1750	1650	1500	1400	1320	1270	1240	1210
* 305x165x46	$N_{b,y,Rd}$	*2000*	*2000*	*2000*	*1980*	*1960*	*1930*	*1910*	*1850*	*1790*	*1700*	1650	1520	1380
	$N_{b,z,Rd}$	*1910*	*1770*	1660	1460	1240	1030	848	592	431	326	255	205	168
	$N_{b,T,Rd}$	*1930*	*1830*	*1720*	1600	1490	1390	1290	1140	1040	971	921	885	859
* 305x165x40	$N_{b,y,Rd}$	*1710*	*1710*	*1710*	*1690*	*1670*	*1650*	*1630*	*1590*	*1530*	*1460*	*1370*	*1270*	1190
	$N_{b,z,Rd}$	*1630*	*1520*	*1380*	*1220*	1070	884	730	509	370	280	219	175	144
	$N_{b,T,Rd}$	*1650*	*1560*	*1460*	*1360*	*1250*	1150	1060	912	812	744	695	661	635
305x127x48	$N_{b,y,Rd}$	2170	2170	2170	2140	2120	2090	2060	1990	1910	1810	1680	1530	1370
	$N_{b,z,Rd}$	1940	1680	1360	1050	800	621	493	330	235	176	136	109	88.9
	$N_{b,T,Rd}$	2020	1880	1740	1610	1510	1420	1360	1270	1210	1180	1150	1140	1120
305x127x42	$N_{b,y,Rd}$	1900	1900	1890	1870	1850	1820	1790	1740	1660	1570	1460	1330	1190
	$N_{b,z,Rd}$	1690	1460	1170	894	682	529	419	280	200	149	116	92.4	75.4
	$N_{b,T,Rd}$	1760	1620	1480	1350	1240	1150	1080	985	927	889	864	846	833
* 305x127x37	$N_{b,y,Rd}$	*1610*	*1610*	*1610*	*1590*	*1570*	*1550*	*1530*	*1480*	1460	1380	1280	1160	1040
	$N_{b,z,Rd}$	1460	1280	1020	778	592	459	363	243	173	129	100	79.9	65.2
	$N_{b,T,Rd}$	*1490*	1370	1250	1120	1020	934	868	777	721	685	660	643	631
* 305x102x33	$N_{b,y,Rd}$	*1380*	*1380*	*1380*	*1360*	*1350*	*1330*	*1310*	*1270*	*1220*	*1160*	*1090*	1050	939
	$N_{b,z,Rd}$	*1160*	969	695	496	365	277	218	144	102	75.6	58.5	46.6	37.9
	$N_{b,T,Rd}$	*1240*	*1110*	979	866	778	712	664	601	564	541	525	514	506
* 305x102x28	$N_{b,y,Rd}$	*1150*	*1150*	*1150*	*1130*	*1120*	*1110*	*1090*	*1060*	*1020*	*965*	*903*	*830*	783
	$N_{b,z,Rd}$	*962*	783	570	404	296	224	176	116	81.9	61.0	47.1	37.5	30.5
	$N_{b,T,Rd}$	*1030*	*912*	*792*	684	601	539	493	434	400	378	364	353	346
* 305x102x25	$N_{b,y,Rd}$	*988*	*988*	*986*	*975*	*963*	*951*	*938*	*908*	*872*	*827*	*771*	*706*	648
	$N_{b,z,Rd}$	*815*	648	464	324	236	179	140	92.0	65.0	48.3	37.3	29.7	24.2
	$N_{b,T,Rd}$	*879*	*772*	*657*	556	477	420	379	326	296	276	263	255	248

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* Section may be Class 4 under axial compression.

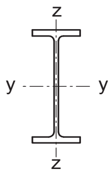
Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNIVERSAL BEAMS
Advance® UKB



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
254x146x43	$N_{b,y,Rd}$	1950	1950	1930	1900	1870	1840	1810	1730	1630	1500	1350	1190	1030
	$N_{b,z,Rd}$	1820	1670	1480	1250	1020	829	675	463	335	252	197	157	129
	$N_{b,T,Rd}$	1850	1740	1640	1530	1440	1370	1310	1210	1150	1110	1090	1070	1050
* 254x146x37	$N_{b,y,Rd}$	*1650*	*1650*	1630	1630	1610	1590	1560	1490	1400	1290	1150	1010	875
	$N_{b,z,Rd}$	1570	1430	1260	1060	869	702	571	391	282	213	166	133	109
	$N_{b,T,Rd}$	1570	1470	1370	1270	1180	1100	1040	938	874	832	802	781	765
* 254x146x31	$N_{b,y,Rd}$	*1370*	*1370*	*1360*	*1340*	*1320*	*1290*	1270	1240	1160	1060	941	819	707
	$N_{b,z,Rd}$	*1280*	1190	1040	865	698	560	453	309	223	168	130	104	85.3
	$N_{b,T,Rd}$	*1300*	1210	1120	1020	934	853	785	685	621	578	548	528	512
* 254x102x28	$N_{b,y,Rd}$	*1240*	*1240*	*1230*	*1210*	1200	1200	1190	1130	1060	963	855	745	642
	$N_{b,z,Rd}$	1080	860	627	451	333	254	199	132	93.3	69.5	53.7	42.8	34.9
	$N_{b,T,Rd}$	1120	1010	899	808	738	687	649	599	569	551	538	530	523
* 254x102x25	$N_{b,y,Rd}$	*1090*	*1090*	*1080*	*1060*	*1040*	*1030*	*1010*	983	927	842	743	644	553
	$N_{b,z,Rd}$	946	741	532	380	279	212	167	110	77.8	57.9	44.8	35.6	29.0
	$N_{b,T,Rd}$	972	867	761	670	600	549	511	463	434	416	404	395	389
* 254x102x22	$N_{b,y,Rd}$	*934*	*934*	*924*	*910*	*896*	*880*	*863*	*821*	793	725	636	548	470
	$N_{b,z,Rd}$	793	623	439	310	227	172	135	88.7	62.7	46.7	36.1	28.7	23.4
	$N_{b,T,Rd}$	*829*	731	629	541	474	426	391	345	319	303	292	284	278
203x133x30	$N_{b,y,Rd}$	1360	1350	1330	1300	1270	1240	1210	1120	994	853	717	599	503
	$N_{b,z,Rd}$	1250	1120	961	782	620	493	396	268	193	145	112	89.9	73.5
	$N_{b,T,Rd}$	1270	1190	1100	1020	958	904	861	801	763	738	721	709	700
203x133x25	$N_{b,y,Rd}$	1140	1130	1110	1090	1060	1040	1010	926	821	700	586	488	409
	$N_{b,z,Rd}$	1040	931	791	639	504	398	319	216	155	116	90.3	72.1	58.9
	$N_{b,T,Rd}$	1060	982	900	820	750	692	646	582	541	515	497	485	475
203x102x23	$N_{b,y,Rd}$	1040	1040	1020	998	976	951	921	846	746	634	529	440	369
	$N_{b,z,Rd}$	897	735	553	404	301	230	181	120	85.3	63.6	49.2	39.2	32.0
	$N_{b,T,Rd}$	940	854	776	714	667	632	607	573	554	541	533	527	522
178x102x19	$N_{b,y,Rd}$	863	851	833	813	790	764	731	647	544	444	361	295	245
	$N_{b,z,Rd}$	742	610	459	336	251	192	151	100	71.1	53.0	41.0	32.7	26.6
	$N_{b,T,Rd}$	774	701	635	581	541	511	490	461	445	434	427	422	418
152x89x16	$N_{b,y,Rd}$	720	703	685	664	638	606	566	469	371	291	232	188	155
	$N_{b,z,Rd}$	595	460	327	232	170	129	101	66.7	47.2	35.1	27.1	21.6	17.6
	$N_{b,T,Rd}$	634	575	528	495	472	456	444	429	421	415	412	409	408
127x76x13	$N_{b,y,Rd}$	580	563	543	519	487	446	399	302	226	173	136	109	89.5
	$N_{b,z,Rd}$	455	325	218	151	109	82.4	64.3	42.2	29.8	22.1	17.1	13.6	11.1
	$N_{b,T,Rd}$	507	468	442	426	416	409	404	398	395	392	391	390	389

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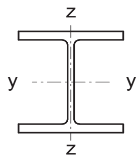
* Section may be Class 4 under axial compression.

Values in italic type indicate that the section is a Class 4 section in pure compression and allowance has been made in calculating the resistance.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

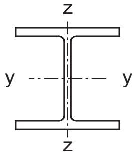
UNIVERSAL COLUMNS
Advance® UKC



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
356x406x634	$N_{b,y,Rd}$	26300	26200	25600	24900	24200	23500	22700	21800	20900	19800	18800	17600	16500
	$N_{b,z,Rd}$	25900	24400	22800	21100	19300	17400	15600	13800	12200	10800	9510	8430	7510
	$N_{b,T,Rd}$	26300	25700	25300	25100	24900	24800	24800	24700	24700	24600	24600	24600	24600
356x406x551	$N_{b,y,Rd}$	22800	22700	22200	21600	21000	20300	19600	18800	17900	17000	16000	15000	14000
	$N_{b,z,Rd}$	22500	21100	19700	18300	16700	15000	13400	11900	10500	9230	8150	7220	6430
	$N_{b,T,Rd}$	22700	22100	21700	21500	21300	21200	21100	21100	21000	21000	21000	21000	20900
356x406x467	$N_{b,y,Rd}$	19900	19800	19300	18700	18200	17500	16900	16100	15300	14400	13500	12600	11700
	$N_{b,z,Rd}$	19600	18300	17100	15700	14300	12800	11300	9980	8760	7690	6770	5990	5320
	$N_{b,T,Rd}$	19700	19100	18600	18400	18200	18100	18000	17900	17900	17800	17800	17800	17800
356x406x393	$N_{b,y,Rd}$	16800	16600	16200	15700	15200	14700	14100	13400	12700	12000	11200	10400	9590
	$N_{b,z,Rd}$	16400	15400	14300	13100	11900	10600	9370	8220	7190	6300	5540	4890	4340
	$N_{b,T,Rd}$	16500	15900	15400	15100	14900	14800	14700	14600	14600	14500	14500	14500	14400
356x406x340	$N_{b,y,Rd}$	14500	14400	14000	13600	13100	12600	12100	11500	10900	10200	9510	8810	8120
	$N_{b,z,Rd}$	14200	13300	12300	11300	10200	9100	8020	7020	6140	5370	4720	4170	3700
	$N_{b,T,Rd}$	14200	13600	13200	12800	12600	12500	12300	12200	12200	12100	12100	12100	12000
356x406x287	$N_{b,y,Rd}$	12600	12500	12100	11700	11300	10900	10400	9870	9290	8670	8040	7410	6800
	$N_{b,z,Rd}$	12300	11500	10600	9720	8740	7750	6800	5930	5170	4510	3960	3490	3090
	$N_{b,T,Rd}$	12300	11700	11200	10900	10600	10400	10300	10200	10100	10000	9940	9900	9860
356x406x235	$N_{b,y,Rd}$	10300	10200	9880	9570	9230	8870	8460	8010	7530	7010	6490	5970	5470
	$N_{b,z,Rd}$	10000	9370	8660	7900	7100	6280	5500	4790	4170	3630	3180	2810	2490
	$N_{b,T,Rd}$	10000	9440	8990	8620	8330	8100	7920	7790	7680	7590	7520	7460	7410
356x368x202	$N_{b,y,Rd}$	8870	8740	8480	8210	7910	7590	7230	6840	6420	5970	5510	5060	4630
	$N_{b,z,Rd}$	8560	7940	7290	6580	5830	5100	4410	3810	3290	2850	2490	2180	1930
	$N_{b,T,Rd}$	8530	8030	7600	7240	6960	6740	6560	6420	6310	6220	6150	6090	6040
356x368x177	$N_{b,y,Rd}$	7800	7680	7450	7200	6940	6650	6330	5970	5590	5190	4780	4390	4010
	$N_{b,z,Rd}$	7520	6970	6390	5760	5110	4450	3850	3320	2860	2480	2170	1900	1680
	$N_{b,T,Rd}$	7490	7010	6600	6240	5950	5710	5510	5360	5230	5130	5050	4980	4920
356x368x153	$N_{b,y,Rd}$	6730	6620	6420	6210	5980	5730	5450	5140	4800	4460	4100	3760	3430
	$N_{b,z,Rd}$	6480	6010	5500	4960	4390	3820	3300	2840	2450	2130	1850	1630	1440
	$N_{b,T,Rd}$	6440	6010	5620	5270	4970	4710	4510	4340	4200	4090	4000	3920	3860
356x368x129	$N_{b,y,Rd}$	5660	5560	5390	5210	5010	4790	4550	4290	4000	3710	3400	3110	2840
	$N_{b,z,Rd}$	5450	5050	4620	4160	3670	3200	2760	2370	2040	1770	1540	1350	1190
	$N_{b,T,Rd}$	5410	5030	4670	4330	4040	3780	3560	3380	3240	3120	3020	2940	2870

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.
FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL COLUMNS
Advance® UKC



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
305x305x283	$N_{b,y,Rd}$	12100	11800	11400	11000	10600	10100	9540	8930	8290	7620	6960	6330	5750
	$N_{b,z,Rd}$	11400	10400	9360	8220	7070	5990	5060	4280	3650	3130	2710	2370	2080
	$N_{b,T,Rd}$	11700	11200	11000	10800	10700	10700	10600	10600	10600	10500	10500	10500	10500
305x305x240	$N_{b,y,Rd}$	10600	10300	9960	9580	9170	8710	8200	7640	7050	6440	5860	5300	4790
	$N_{b,z,Rd}$	9930	9050	8080	7050	6010	5070	4260	3590	3050	2610	2260	1970	1730
	$N_{b,T,Rd}$	10100	9660	9380	9190	9070	8980	8930	8880	8850	8830	8810	8790	8780
305x305x198	$N_{b,y,Rd}$	8690	8470	8180	7860	7510	7120	6680	6200	5700	5190	4700	4250	3830
	$N_{b,z,Rd}$	8160	7420	6610	5740	4880	4100	3440	2900	2460	2110	1820	1590	1390
	$N_{b,T,Rd}$	8260	7830	7520	7310	7170	7070	6990	6940	6900	6870	6840	6820	6810
305x305x158	$N_{b,y,Rd}$	6930	6740	6500	6240	5950	5630	5260	4870	4460	4050	3650	3290	2960
	$N_{b,z,Rd}$	6490	5880	5220	4520	3830	3200	2680	2250	1910	1630	1410	1230	1080
	$N_{b,T,Rd}$	6530	6120	5800	5560	5390	5260	5170	5090	5040	4990	4960	4930	4910
305x305x137	$N_{b,y,Rd}$	6000	5830	5610	5380	5130	4840	4520	4170	3810	3450	3110	2790	2510
	$N_{b,z,Rd}$	5610	5080	4500	3880	3280	2740	2290	1920	1630	1390	1200	1050	918
	$N_{b,T,Rd}$	5630	5240	4920	4670	4480	4340	4230	4140	4080	4030	3990	3950	3930
305x305x118	$N_{b,y,Rd}$	5180	5020	4830	4630	4410	4160	3880	3570	3260	2950	2650	2380	2140
	$N_{b,z,Rd}$	4830	4370	3860	3330	2800	2340	1950	1640	1390	1180	1020	889	780
	$N_{b,T,Rd}$	4830	4460	4150	3890	3680	3520	3400	3300	3230	3170	3120	3080	3050
305x305x97	$N_{b,y,Rd}$	4370	4220	4060	3880	3690	3460	3210	2950	2670	2400	2150	1930	1730
	$N_{b,z,Rd}$	4050	3650	3220	2750	2300	1910	1590	1330	1120	959	826	719	630
	$N_{b,T,Rd}$	4050	3700	3390	3120	2900	2720	2580	2470	2380	2310	2250	2210	2170
254x254x167	$N_{b,y,Rd}$	7300	7020	6710	6360	5960	5510	5010	4500	4000	3540	3130	2780	2470
	$N_{b,z,Rd}$	6680	5910	5060	4200	3420	2780	2270	1880	1580	1340	1150	1000	875
	$N_{b,T,Rd}$	6900	6610	6440	6340	6280	6230	6210	6180	6170	6160	6150	6140	6140
254x254x132	$N_{b,y,Rd}$	5750	5520	5260	4980	4650	4270	3870	3460	3060	2700	2380	2100	1870
	$N_{b,z,Rd}$	5240	4630	3940	3250	2640	2130	1740	1440	1210	1030	881	764	668
	$N_{b,T,Rd}$	5370	5070	4880	4750	4670	4620	4580	4550	4530	4510	4500	4490	4480
254x254x107	$N_{b,y,Rd}$	4640	4450	4240	3990	3720	3400	3060	2720	2400	2100	1850	1630	1450
	$N_{b,z,Rd}$	4230	3720	3160	2590	2090	1690	1380	1140	955	810	694	602	526
	$N_{b,T,Rd}$	4300	4000	3790	3650	3550	3480	3430	3390	3360	3340	3320	3310	3300
254x254x89	$N_{b,y,Rd}$	3860	3690	3510	3310	3070	2810	2520	2240	1970	1730	1520	1340	1180
	$N_{b,z,Rd}$	3510	3080	2610	2140	1720	1390	1130	938	785	665	571	494	432
	$N_{b,T,Rd}$	3540	3250	3030	2870	2760	2670	2610	2560	2530	2500	2480	2460	2450
254x254x73	$N_{b,y,Rd}$	3260	3120	2960	2780	2580	2340	2090	1850	1620	1420	1240	1090	966
	$N_{b,z,Rd}$	2960	2580	2170	1770	1410	1140	925	762	637	540	463	401	350
	$N_{b,T,Rd}$	2960	2680	2440	2260	2120	2020	1950	1890	1840	1810	1780	1760	1750

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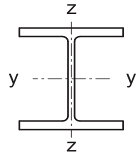
For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.
FOR EXPLANATION OF TABLES SEE NOTE 8.

UNIVERSAL COLUMNS
Advance® UKC



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
203x203x127 +	$N_{b,y,Rd}$	5590	5590	5460	5320	5180	5030	4870	4500	4070	3600	3130	2700	2320
	$N_{b,z,Rd}$	5490	5160	4810	4430	4040	3630	3220	2500	1940	1520	1220	998	829
	$N_{b,T,Rd}$	5540	5340	5210	5120	5060	5020	4980	4950	4920	4910	4900	4890	4890
203x203x113 +	$N_{b,y,Rd}$	5000	5000	4880	4760	4630	4490	4340	4000	3600	3170	2750	2360	2030
	$N_{b,z,Rd}$	4910	4610	4290	3950	3590	3220	2860	2210	1710	1340	1080	879	730
	$N_{b,T,Rd}$	4940	4750	4610	4520	4450	4400	4370	4320	4290	4280	4270	4260	4250
203x203x100 +	$N_{b,y,Rd}$	4380	4370	4270	4160	4040	3920	3780	3470	3120	2740	2360	2020	1740
	$N_{b,z,Rd}$	4290	4030	3750	3450	3130	2800	2480	1910	1470	1160	926	755	627
	$N_{b,T,Rd}$	4310	4130	3990	3890	3820	3770	3730	3680	3650	3630	3610	3600	3590
203x203x86	$N_{b,y,Rd}$	3800	3780	3690	3590	3490	3380	3260	2980	2670	2330	2000	1710	1460
	$N_{b,z,Rd}$	3710	3480	3230	2970	2690	2400	2120	1630	1260	986	789	644	534
	$N_{b,T,Rd}$	3720	3550	3410	3310	3230	3170	3120	3060	3020	3000	2980	2970	2960
203x203x71	$N_{b,y,Rd}$	3120	3110	3030	2950	2860	2770	2670	2440	2170	1890	1620	1390	1180
	$N_{b,z,Rd}$	3050	2860	2650	2430	2200	1960	1730	1330	1020	801	640	522	433
	$N_{b,T,Rd}$	3050	2890	2760	2650	2570	2500	2450	2370	2330	2290	2270	2260	2250
203x203x60	$N_{b,y,Rd}$	2710	2690	2620	2550	2470	2380	2290	2080	1830	1580	1340	1140	968
	$N_{b,z,Rd}$	2640	2470	2280	2080	1870	1660	1450	1100	844	659	526	428	355
	$N_{b,T,Rd}$	2640	2480	2350	2240	2150	2070	2010	1910	1850	1810	1780	1760	1740
203x203x52	$N_{b,y,Rd}$	2350	2340	2270	2210	2140	2070	1980	1800	1580	1360	1160	980	833
	$N_{b,z,Rd}$	2290	2140	1980	1800	1620	1430	1260	952	728	568	453	369	306
	$N_{b,T,Rd}$	2280	2150	2020	1910	1810	1730	1670	1570	1500	1450	1420	1390	1370
203x203x46	$N_{b,y,Rd}$	2080	2070	2010	1950	1890	1820	1750	1580	1390	1190	1010	855	726
	$N_{b,z,Rd}$	2030	1890	1740	1590	1430	1260	1100	832	635	495	395	321	266
	$N_{b,T,Rd}$	2020	1890	1770	1670	1570	1490	1420	1310	1240	1190	1150	1120	1100
152x152x51 +	$N_{b,y,Rd}$	2310	2250	2170	2080	1990	1880	1760	1490	1220	986	803	661	551
	$N_{b,z,Rd}$	2160	1960	1730	1490	1260	1050	879	625	461	352	277	224	184
	$N_{b,T,Rd}$	2190	2080	2000	1950	1910	1880	1870	1840	1830	1820	1810	1810	1810
152x152x44 +	$N_{b,y,Rd}$	1990	1930	1860	1790	1700	1600	1500	1260	1030	831	675	555	463
	$N_{b,z,Rd}$	1860	1680	1480	1280	1070	894	745	529	390	297	234	189	155
	$N_{b,T,Rd}$	1880	1770	1680	1620	1580	1550	1530	1500	1480	1470	1470	1460	1460
152x152x37	$N_{b,y,Rd}$	1670	1620	1560	1490	1420	1340	1250	1050	849	684	555	456	380
	$N_{b,z,Rd}$	1550	1400	1240	1060	889	738	614	435	320	244	192	155	127
	$N_{b,T,Rd}$	1570	1460	1380	1310	1270	1230	1200	1170	1150	1130	1120	1120	1110
152x152x30	$N_{b,y,Rd}$	1360	1320	1270	1210	1150	1080	1010	839	679	545	442	362	302
	$N_{b,z,Rd}$	1260	1140	999	854	714	592	492	347	256	195	153	123	102
	$N_{b,T,Rd}$	1260	1170	1080	1020	963	922	891	847	820	802	790	782	775
152x152x23	$N_{b,y,Rd}$	1040	999	960	916	867	812	751	618	495	395	319	261	217
	$N_{b,z,Rd}$	955	856	746	632	524	431	356	250	183	140	110	88.3	72.6
	$N_{b,T,Rd}$	957	873	795	727	671	626	590	541	510	489	475	465	458

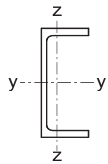
Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections.

For values of the compression cross-sectional resistance $N_{c,Rd}$, see the values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

PARALLEL FLANGE CHANNELS
Advance® UKPFC



Subject to concentric axial compression

Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
430x100x64	$N_{b,y,Rd}$	2830	2830	2830	2830	2780	2720	2660	2550	2430	2300	2170	2030	1890
	$N_{b,z,Rd}$	2490	2140	1750	1390	1100	872	704	481	348	263	205	164	135
	$N_{b,T,Rd}$	2520	2250	2010	1810	1660	1540	1460	1340	1270	1220	1180	1150	1130
380x100x54	$N_{b,y,Rd}$	2370	2370	2370	2350	2300	2240	2190	2080	1970	1850	1720	1590	1460
	$N_{b,z,Rd}$	2100	1820	1500	1210	957	764	619	424	307	232	181	146	119
	$N_{b,T,Rd}$	2100	1870	1660	1490	1370	1270	1200	1110	1040	1000	969	941	914
300x100x46	$N_{b,y,Rd}$	2000	2000	1980	1930	1870	1820	1760	1640	1510	1380	1240	1110	986
	$N_{b,z,Rd}$	1780	1550	1290	1050	834	668	542	373	270	204	160	128	105
	$N_{b,T,Rd}$	1750	1560	1400	1290	1200	1130	1080	1010	959	912	865	816	762
300x90x41	$N_{b,y,Rd}$	1870	1870	1850	1800	1740	1690	1630	1510	1390	1260	1130	1000	887
	$N_{b,z,Rd}$	1610	1350	1070	828	641	504	404	274	197	149	116	92.7	75.9
	$N_{b,T,Rd}$	1600	1410	1260	1140	1060	1010	963	902	859	821	782	740	693
260x90x35	$N_{b,y,Rd}$	1580	1580	1530	1480	1430	1380	1320	1200	1080	956	836	727	633
	$N_{b,z,Rd}$	1360	1150	918	714	555	437	351	238	172	129	101	80.8	66.2
	$N_{b,T,Rd}$	1330	1170	1040	944	877	829	792	737	693	651	606	559	510
260x75x28	$N_{b,y,Rd}$	1250	1250	1210	1170	1130	1080	1040	943	843	742	647	561	487
	$N_{b,z,Rd}$	1000	783	579	425	319	246	195	131	93.3	69.9	54.3	43.4	35.4
	$N_{b,T,Rd}$	1010	863	752	676	625	589	563	526	500	475	450	421	389
230x90x32	$N_{b,y,Rd}$	1460	1450	1390	1340	1290	1230	1170	1050	921	796	682	584	502
	$N_{b,z,Rd}$	1260	1070	859	671	523	413	332	226	163	123	95.6	76.6	62.8
	$N_{b,T,Rd}$	1220	1070	955	877	821	779	746	690	638	585	530	475	423
230x75x26	$N_{b,y,Rd}$	1160	1150	1110	1070	1020	979	932	831	728	627	537	459	394
	$N_{b,z,Rd}$	941	743	554	409	308	238	189	126	90.4	67.8	52.7	42.1	34.4
	$N_{b,T,Rd}$	935	806	715	655	613	584	561	525	491	456	417	376	336

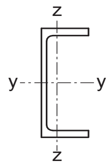
Advance® and UKPFC are trademarks of of Tata Steel. A fuller description of the relationship between Parallel Flange Channels and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$N_{b,T,Rd}$ is the lower of the torsional and the torsional-flexural buckling resiatance.

For values of the compression cross-sectional resistance, $N_{c,Rd}$, see values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

PARALLEL FLANGE CHANNELS
Advance® UKPFC



Subject to concentric axial compression

Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
200x90x30	$N_{b,y,Rd}$	1350	1320	1260	1210	1150	1090	1020	889	756	635	533	449	381
	$N_{b,z,Rd}$	1170	990	800	626	489	386	310	211	152	115	89.6	71.8	58.8
	$N_{b,T,Rd}$	1110	973	879	814	766	728	693	629	564	499	438	382	333
200x75x23	$N_{b,y,Rd}$	1060	1040	995	950	904	856	805	698	593	497	417	351	298
	$N_{b,z,Rd}$	866	689	517	383	289	224	178	119	85.3	64.0	49.7	39.8	32.5
	$N_{b,T,Rd}$	845	735	662	613	579	553	530	487	442	394	347	303	264
180x90x26	$N_{b,y,Rd}$	1180	1140	1090	1030	973	912	849	718	595	490	405	338	285
	$N_{b,z,Rd}$	1020	869	703	551	430	340	273	186	134	101	79.0	63.3	51.8
	$N_{b,T,Rd}$	947	822	735	675	629	593	560	499	439	383	331	287	248
180x75x20	$N_{b,y,Rd}$	919	887	844	800	754	706	655	551	455	373	308	256	216
	$N_{b,z,Rd}$	749	594	445	330	249	193	153	103	73.3	55.0	42.7	34.2	27.9
	$N_{b,T,Rd}$	720	617	548	502	469	444	421	380	337	295	256	221	191
150x90x24	$N_{b,y,Rd}$	1070	1010	955	892	825	754	683	547	433	346	280	230	192
	$N_{b,z,Rd}$	938	796	643	504	394	311	250	170	123	92.7	72.3	58.0	47.5
	$N_{b,T,Rd}$	839	728	653	598	554	515	477	406	341	286	240	203	173
150x75x18	$N_{b,y,Rd}$	804	760	715	668	617	564	510	408	323	257	208	171	143
	$N_{b,z,Rd}$	661	527	396	294	222	172	137	91.6	65.6	49.2	38.2	30.6	25.0
	$N_{b,T,Rd}$	614	526	469	431	400	374	349	300	254	214	180	152	130
125x65x15	$N_{b,y,Rd}$	648	603	556	506	453	399	348	262	200	155	124	101	83.4
	$N_{b,z,Rd}$	510	379	268	192	142	109	85.8	57.1	40.6	30.4	23.6	18.8	15.4
	$N_{b,T,Rd}$	493	434	395	364	334	304	275	220	175	141	115	94.7	79.3
100x50x10	$N_{b,y,Rd}$	432	391	347	300	254	213	178	127	93.5	71.5	56.3	45.4	37.4
	$N_{b,z,Rd}$	297	191	124	85.2	61.8	46.7	36.5	24.0	17.0	12.7	9.79	7.79	6.35
	$N_{b,T,Rd}$	332	299	271	242	211	183	157	116	87.8	68.2	54.3	44.1	36.5

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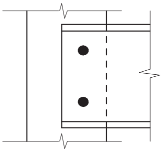
$N_{b,T,Rd}$ is the lower of the torsional and the torsional-flexural buckling resiatance.

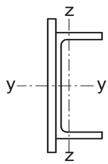
For values of the compression cross-sectional resistance, $N_{c,Rd}$, see values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION



PARALLEL FLANGE CHANNELS
Advance® UKPFC



Connected through web

One row of fasteners with
two or more fasteners across the web

Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Length between intersections, L (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
430x100x64	$N_{b,y,Rd}$	2830	2830	2830	2830	2780	2720	2660	2550	2430	2300	2170	2030	1890
	$N_{b,z,Rd}$	1870	1600	1360	1150	976	834	704	481	348	263	205	164	135
	$N_{b,T,Rd}$	2520	2250	2010	1810	1660	1540	1460	1340	1270	1220	1180	1150	1130
380x100x54	$N_{b,y,Rd}$	2370	2370	2370	2350	2300	2240	2190	2080	1970	1850	1720	1590	1460
	$N_{b,z,Rd}$	1580	1360	1160	986	841	721	619	424	307	232	181	146	119
	$N_{b,T,Rd}$	2100	1870	1660	1490	1370	1270	1200	1110	1040	1000	969	941	914
300x100x46	$N_{b,y,Rd}$	2000	2000	1980	1930	1870	1820	1760	1640	1510	1380	1240	1110	986
	$N_{b,z,Rd}$	1340	1160	994	848	725	623	539	373	270	204	160	128	105
	$N_{b,T,Rd}$	1750	1560	1400	1290	1200	1130	1080	1010	959	912	865	816	762
300x90x41	$N_{b,y,Rd}$	1870	1870	1850	1800	1740	1690	1630	1510	1390	1260	1130	1000	887
	$N_{b,z,Rd}$	1200	1010	847	707	593	502	404	274	197	149	116	92.7	75.9
	$N_{b,T,Rd}$	1600	1410	1260	1140	1060	1010	963	902	859	821	782	740	693
260x90x35	$N_{b,y,Rd}$	1580	1580	1530	1480	1430	1380	1320	1200	1080	956	836	727	633
	$N_{b,z,Rd}$	1020	863	723	605	509	432	351	238	172	129	101	80.8	66.2
	$N_{b,T,Rd}$	1330	1170	1040	944	877	829	792	737	693	651	606	559	510
260x75x28	$N_{b,y,Rd}$	1250	1250	1210	1170	1130	1080	1040	943	843	742	647	561	487
	$N_{b,z,Rd}$	749	605	486	394	319	246	195	131	93.3	69.9	54.3	43.4	35.4
	$N_{b,T,Rd}$	1010	863	752	676	625	589	563	526	500	475	450	421	389
230x90x32	$N_{b,y,Rd}$	1460	1450	1390	1340	1290	1230	1170	1050	921	796	682	584	502
	$N_{b,z,Rd}$	945	802	674	565	477	405	332	226	163	123	95.6	76.6	62.8
	$N_{b,T,Rd}$	1220	1070	955	877	821	779	746	690	638	585	530	475	423
230x75x26	$N_{b,y,Rd}$	1160	1150	1110	1070	1020	979	932	831	728	627	537	459	394
	$N_{b,z,Rd}$	704	572	461	375	308	238	189	126	90.4	67.8	52.7	42.1	34.4
	$N_{b,T,Rd}$	935	806	715	655	613	584	561	525	491	456	417	376	336

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$N_{b,T,Rd}$ is the lower of the torsional and the torsional-flexural buckling resiatance.

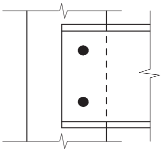
For values of the compression cross-sectional resistance, $N_{c,Rd}$, see values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

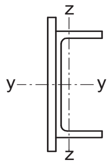
BS EN 1993-1-1:2005
BS 4-1:2005

COMPRESSION

S355 / Advance® 355



PARALLEL FLANGE CHANNELS
Advance® UKPFC



Connected through web

One row of fasteners with
two or more fasteners across the web

Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Length between intersections, L (m)												
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
200x90x30	$N_{b,y,Rd}$	1350	1320	1260	1210	1150	1090	1020	889	756	635	533	449	381
	$N_{b,z,Rd}$	876	744	626	526	444	377	310	211	152	115	89.6	71.8	58.8
	$N_{b,T,Rd}$	1110	973	879	814	766	728	693	629	564	499	438	382	333
200x75x23	$N_{b,y,Rd}$	1060	1040	995	950	904	856	805	698	593	497	417	351	298
	$N_{b,z,Rd}$	648	528	428	349	287	224	178	119	85.3	64.0	49.7	39.8	32.5
	$N_{b,T,Rd}$	845	735	662	613	579	553	530	487	442	394	347	303	264
180x90x26	$N_{b,y,Rd}$	1180	1140	1090	1030	973	912	849	718	595	490	405	338	285
	$N_{b,z,Rd}$	768	653	550	462	390	332	273	186	134	101	79.0	63.3	51.8
	$N_{b,T,Rd}$	947	822	735	675	629	593	560	499	439	383	331	287	248
180x75x20	$N_{b,y,Rd}$	919	887	844	800	754	706	655	551	455	373	308	256	216
	$N_{b,z,Rd}$	560	456	369	301	248	193	153	103	73.3	55.0	42.7	34.2	27.9
	$N_{b,T,Rd}$	720	617	548	502	469	444	421	380	337	295	256	221	191
150x90x24	$N_{b,y,Rd}$	1070	1010	955	892	825	754	683	547	433	346	280	230	192
	$N_{b,z,Rd}$	703	598	503	423	357	304	250	170	123	92.7	72.3	58.0	47.5
	$N_{b,T,Rd}$	839	728	653	598	554	515	477	406	341	286	240	203	173
150x75x18	$N_{b,y,Rd}$	804	760	715	668	617	564	510	408	323	257	208	171	143
	$N_{b,z,Rd}$	495	404	327	267	220	172	137	91.6	65.6	49.2	38.2	30.6	25.0
	$N_{b,T,Rd}$	614	526	469	431	400	374	349	300	254	214	180	152	130
125x65x15	$N_{b,y,Rd}$	648	603	556	506	453	399	348	262	200	155	124	101	83.4
	$N_{b,z,Rd}$	382	300	236	187	142	109	85.8	57.1	40.6	30.4	23.6	18.8	15.4
	$N_{b,T,Rd}$	493	434	395	364	334	304	275	220	175	141	115	94.7	79.3
100x50x10	$N_{b,y,Rd}$	432	391	347	300	254	213	178	127	93.5	71.5	56.3	45.4	37.4
	$N_{b,z,Rd}$	228	166	124	85.2	61.8	46.7	36.5	24.0	17.0	12.7	9.79	7.79	6.35
	$N_{b,T,Rd}$	332	299	271	242	211	183	157	116	87.8	68.2	54.3	44.1	36.5

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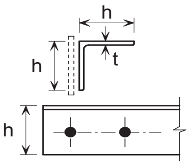
$N_{b,T,Rd}$ is the lower of the torsional and the torsional-flexural buckling resiatance.

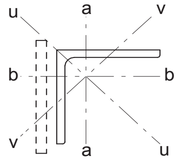
For values of the compression cross-sectional resistance, $N_{c,Rd}$, see values of $N_{pl,Rd}$ in the tables for axial force and bending.

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION



EQUAL ANGLES
Advance® UKA - Equal Angles



Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
			Axis	Axis	Axis														
h x h	t		a-a	b-b	v-v		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
mm	mm	cm²	cm	cm	cm														
200x200	24	90.6	6.06	6.06	3.90	F	2540	2410	2240	2010	1780	1560	1370	1060	836	672	550	459	388
						T	2770	2770	2770	2770	2770	2770	2770	2770	2770	2770	2770	2770	2770
	* 20	76.3	6.11	6.11	3.92	F	*2140*	*2030*	*1890*	*1700*	*1500*	*1320*	*1160*	*899*	*709*	*570*	*467*	*389*	*329*
						T	*2200*	*2200*	*2200*	*2200*	*2200*	*2200*	*2200*	*2200*	*2200*	*2200*	*2200*	*2200*	*2200*
	* 18	69.1	6.13	6.13	3.90	F	*1940*	*1840*	*1710*	*1530*	*1360*	*1190*	*1050*	*809*	*637*	*512*	*420*	*350*	*296*
						T	*1910*	*1910*	*1910*	*1910*	*1910*	*1910*	*1910*	*1910*	*1910*	*1910*	*1910*	*1910*	*1910*
	* 16	61.8	6.16	6.16	3.94	F	*1670*	*1590*	*1480*	*1340*	*1190*	*1050*	*927*	*721*	*571*	*460*	*378*	*315*	*267*
						T	*1560*	*1560*	*1560*	*1560*	*1560*	*1560*	*1560*	*1560*	*1560*	*1560*	*1560*	*1560*	*1560*
150x150	18 +	51.2	4.55	4.55	2.93	F	1390	1270	1090	924	776	653	554	408	312	245	198	163	136
						T	1570	1570	1570	1570	1570	1570	1570	1570	1570	1570	1570	1570	1570
	* 15	43.0	4.57	4.57	2.93	F	*1200*	*1090*	*935*	*788*	*660*	*555*	*470*	*346*	*264*	*207*	*167*	*137*	*115*
						T	*1280*	*1280*	*1280*	*1280*	*1280*	*1280*	*1280*	*1280*	*1280*	*1280*	*1280*	*1280*	*1280*
	* 12	34.8	4.60	4.60	2.95	F	*909*	*836*	*725*	*617*	*521*	*440*	*374*	*277*	*212*	*167*	*135*	*111*	*93.1*
						T	*887*	*887*	*887*	*887*	*887*	*887*	*887*	*887*	*887*	*887*	*887*	*887*	*887*
	* 10	29.3	4.62	4.62	2.97	F	*673*	*630*	*556*	*481*	*412*	*352*	*301*	*226*	*174*	*138*	*112*	*92.4*	*77.6*
						T	*608*	*608*	*608*	*608*	*608*	*608*	*608*	*608*	*608*	*608*	*608*	*608*	*608*
120x120	15 +	34.0	3.63	3.63	2.34	F	909	769	622	499	402	329	273	195	146	113	90.5	73.9	61.4
						T	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080
	* 12	27.5	3.65	3.65	2.35	F	*736*	*624*	*505*	*405*	*327*	*268*	*222*	*159*	*119*	*92.4*	*73.8*	*60.2*	*50.1*
						T	*817*	*817*	*817*	*817*	*817*	*817*	*817*	*817*	*817*	*817*	*817*	*817*	*817*
	* 10	23.2	3.67	3.67	2.36	F	*600*	*513*	*419*	*337*	*273*	*224*	*186*	*134*	*100*	*78.0*	*62.3*	*50.9*	*42.3*
						T	*618*	*618*	*618*	*618*	*618*	*618*	*618*	*618*	*618*	*618*	*618*	*618*	*618*
	* 8 +	18.8	3.71	3.71	2.38	F	*419*	*369*	*309*	*254*	*209*	*173*	*145*	*105*	*79.7*	*62.3*	*49.9*	*40.9*	*34.1*
						T	*389*	*389*	*389*	*389*	*389*	*389*	*389*	*389*	*389*	*389*	*389*	*389*	*389*
100x100	15 +	28.0	2.99	2.99	1.94	F	706	557	427	329	259	208	170	119	88.4	68.0	53.9	43.7	36.2
						T	923	923	923	923	923	923	923	923	923	923	923	923	923
	12	22.7	3.02	3.02	1.94	F	573	452	346	267	210	168	138	96.8	71.6	55.1	43.7	35.5	29.4
						T	715	715	715	715	715	715	715	715	715	715	715	715	715
	* 10	19.2	3.04	3.04	1.95	F	*485*	*384*	*294*	*227*	*179*	*143*	*117*	*82.6*	*61.1*	*47.0*	*37.3*	*30.3*	*25.1*
						T	*573*	*573*	*573*	*573*	*573*	*573*	*573*	*573*	*573*	*573*	*573*	*573*	*573*
	* 8	15.5	3.06	3.06	1.96	F	*372*	*298*	*231*	*180*	*142*	*115*	*94.0*	*66.3*	*49.2*	*37.9*	*30.1*	*24.5*	*20.3*
						T	*398*	*398*	*398*	*398*	*398*	*398*	*398*	*398*	*398*	*398*	*398*	*398*	*398*

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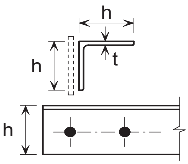
+ These sections are in addition to the range of BS EN 10056-1 sections.

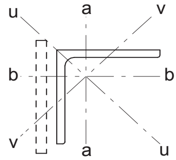
* Section is Class 4 under axial compression.

Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

FOR EXPLANATION OF TABLES SEE NOTE 8.

EQUAL ANGLES
Advance® UKA - Equal Angles





Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
			Axis a-a	Axis b-b	Axis v-v														
h x h mm	t mm	cm^2	cm	cm	cm		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
90x90	12 +	20.3	2.71	2.71	1.75	F	489	371	276	209	162	129	105	73.1	53.8	41.2	32.5	26.4	21.8
						T	655	655	655	655	655	655	655	655	655	655	655	655	655
	10	17.1	2.72	2.72	1.75	F	412	312	232	176	137	109	88.4	61.6	45.3	34.7	27.4	22.2	18.3
						T	528	528	528	528	528	528	528	528	528	528	528	528	528
	* 8	13.9	2.74	2.74	1.76	F	*336*	*255*	*190*	*144*	*112*	*89.1*	*72.5*	*50.5*	*37.2*	*28.5*	*22.5*	*18.2*	*15.1*
						T	*396*	*396*	*396*	*396*	*396*	*396*	*396*	*396*	*396*	*396*	*396*	*396*	*396*
	* 7	12.2	2.75	2.75	1.77	F	*276*	*214*	*162*	*124*	*96.5*	*77.2*	*63.0*	*44.1*	*32.5*	*25.0*	*19.8*	*16.0*	*13.3*
						T	*305*	*305*	*305*	*305*	*305*	*305*	*305*	*305*	*305*	*305*	*305*	*305*	*305*
80x80	10	15.1	2.41	2.41	1.55	F	340	246	177	132	101	79.6	64.3	44.4	32.4	24.7	19.5	15.7	13.0
						T	480	480	480	480	480	480	480	480	480	480	480	480	480
	* 8	12.3	2.43	2.43	1.56	F	*278*	*202*	*146*	*108*	*83.0*	*65.5*	*52.9*	*36.5*	*26.7*	*20.4*	*16.1*	*13.0*	*10.7*
						T	*367*	*367*	*367*	*367*	*367*	*367*	*367*	*367*	*367*	*367*	*367*	*367*	*367*
75x75	* 8	11.4	2.27	2.27	1.46	F	*247*	*174*	*124*	*91.2*	*69.5*	*54.6*	*44.0*	*30.3*	*22.1*	*16.8*	*13.2*	*10.6*	*8.77*
						T	*347*	*347*	*347*	*347*	*347*	*347*	*347*	*347*	*347*	*347*	*347*	*347*	*347*
	* 6	8.73	2.29	2.29	1.47	F	*182*	*130*	*93.4*	*69.2*	*52.9*	*41.7*	*33.7*	*23.2*	*17.0*	*12.9*	*10.2*	*8.21*	*6.77*
						T	*224*	*224*	*224*	*224*	*224*	*224*	*224*	*224*	*224*	*224*	*224*	*224*	*224*
70x70	* 7	9.40	2.12	2.12	1.36	F	*194*	*133*	*93.0*	*67.8*	*51.4*	*40.2*	*32.3*	*22.1*	*16.1*	*12.2*	*9.57*	*7.71*	*6.34*
						T	*281*	*281*	*281*	*281*	*281*	*281*	*281*	*281*	*281*	*281*	*281*	*281*	*281*
	* 6	8.13	2.13	2.13	1.37	F	*167*	*115*	*80.7*	*59.0*	*44.8*	*35.0*	*28.2*	*19.3*	*14.0*	*10.7*	*8.37*	*6.75*	*5.55*
						T	*225*	*225*	*225*	*225*	*225*	*225*	*225*	*225*	*225*	*225*	*225*	*225*	*225*
65x65	7	8.73	1.96	1.96	1.26	F	170	113	77.8	56.2	42.3	32.9	26.4	18.0	13.0	9.86	7.73	6.22	5.11
						T	264	264	264	264	264	264	264	264	264	264	264	264	264
60x60	8	9.03	1.80	1.80	1.16	F	164	106	71.5	51.2	38.3	29.7	23.7	16.1	11.6	8.77	6.86	5.51	4.53
						T	292	292	292	292	292	292	292	292	292	292	292	292	292
	* 6	6.91	1.82	1.82	1.17	F	*127*	*81.8*	*55.4*	*39.7*	*29.7*	*23.1*	*18.4*	*12.5*	*9.02*	*6.82*	*5.33*	*4.29*	*3.52*
						T	*207*	*207*	*207*	*207*	*207*	*207*	*207*	*207*	*207*	*207*	*207*	*207*	*207*
	* 5	5.82	1.82	1.82	1.17	F	*104*	*67.9*	*46.2*	*33.1*	*24.8*	*19.3*	*15.4*	*10.5*	*7.57*	*5.72*	*4.48*	*3.60*	*2.96*
						T	*157*	*157*	*157*	*157*	*157*	*157*	*157*	*157*	*157*	*157*	*157*	*157*	*157*
50x50	6	5.69	1.50	1.50	0.968	F	86.6	52.4	34.4	24.2	17.9	13.8	10.9	7.33	5.26	3.96	3.09	2.47	2.03
						T	180	180	180	180	180	180	180	180	180	180	180	180	180
	* 5	4.80	1.51	1.51	0.973	F	*73.4*	*44.5*	*29.3*	*20.6*	*15.2*	*11.7*	*9.28*	*6.24*	*4.48*	*3.37*	*2.63*	*2.11*	*1.73*
						T	*144*	*144*	*144*	*144*	*144*	*144*	*144*	*144*	*144*	*144*	*144*	*144*	*144*
	* 4	3.89	1.52	1.52	0.979	F	*58.0*	*35.6*	*23.6*	*16.6*	*12.3*	*9.50*	*7.54*	*5.08*	*3.65*	*2.75*	*2.15*	*1.72*	*1.41*
						T	*101*	*101*	*101*	*101*	*101*	*101*	*101*	*101*	*101*	*101*	*101*	*101*	*101*

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in section 12

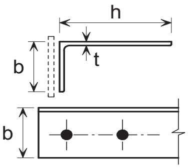
+ These sections are in addition to the range of BS EN 10056-1 sections.

* Section is Class 4 under axial compression.

Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

FOR EXPLANATION OF TABLES SEE NOTE 8.

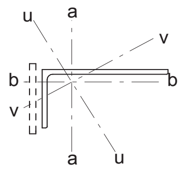
COMPRESSION



UNEQUAL ANGLES
Advance® UKA - Unequal Angles

Short leg attached

Two or more bolts in line
or equivalent welded at each end



Section Designation h x b mm	t mm	Area cm²	Radius of Gyration Axis a-a cm	Axis b-b cm	Axis v-v cm	Buckling mode	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
							Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
200x150	* 18 +	60.1	6.30	4.38	3.22	F	1620	1490	1350	1170	1000	854	731	547	422	334	270	223	187
						T	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710
	* 15	50.5	6.33	4.40	3.23	F	1250	1160	1060	933	804	691	595	449	348	276	224	186	156
						T	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240
	* 12	40.8	6.36	4.44	3.25	F	860	805	745	674	591	515	449	344	270	216	176	146	124
						T	767	767	767	767	767	767	767	767	767	767	767	767	767
200x100	* 15	43.0	6.40	2.64	2.12	F	960	818	675	536	430	350	289	206	154	119	95.0	77.5	64.3
						T	1070	1070	1070	1070	1070	1070	1070	1070	1070	1070	1070	1070	1070
	* 12	34.8	6.43	2.67	2.14	F	669	582	497	405	329	271	226	163	122	95.3	76.2	62.3	51.8
						T	671	671	671	671	671	671	671	671	671	671	671	671	671
	* 10	29.2	6.46	2.68	2.15	F	491	434	377	316	261	217	182	132	100	78.4	62.9	51.5	43.0
						T	446	446	446	446	446	446	446	446	446	446	446	446	446
150x90	15	33.9	4.74	2.46	1.93	F	817	672	514	396	311	249	204	143	106	81.5	64.6	52.5	43.4
						T	1040	1040	1040	1040	1040	1040	1040	1040	1040	1040	1040	1040	1040
	* 12	27.5	4.77	2.49	1.94	F	628	524	406	315	249	200	164	116	85.8	66.1	52.4	42.6	35.3
						T	733	733	733	733	733	733	733	733	733	733	733	733	733
	* 10	23.2	4.80	2.51	1.95	F	472	402	321	253	202	164	135	95.7	71.3	55.1	43.8	35.7	29.6
						T	507	507	507	507	507	507	507	507	507	507	507	507	507
150x75	15	31.7	4.75	1.94	1.58	F	692	526	381	284	218	172	139	96.2	70.4	53.7	42.3	34.2	28.2
						T	974	974	974	974	974	974	974	974	974	974	974	974	974
	* 12	25.7	4.78	1.97	1.59	F	536	414	303	227	175	139	112	78.0	57.2	43.7	34.5	27.9	23.0
						T	686	686	686	686	686	686	686	686	686	686	686	686	686
	* 10	21.7	4.81	1.99	1.60	F	407	326	244	185	144	114	93.2	65.0	47.9	36.7	29.0	23.5	19.4
						T	475	475	475	475	475	475	475	475	475	475	475	475	475
125x75	12	22.7	3.95	2.05	1.61	F	508	384	279	209	160	127	103	71.1	52.1	39.8	31.4	25.3	20.9
						T	688	688	688	688	688	688	688	688	688	688	688	688	688
	* 10	19.1	3.97	2.07	1.61	F	407	311	229	172	133	105	85.3	59.2	43.4	33.2	26.2	21.2	17.5
						T	509	509	509	509	509	509	509	509	509	509	509	509	509
	* 8	15.5	4.00	2.09	1.63	F	289	232	175	134	104	83.4	68.0	47.6	35.1	26.9	21.3	17.3	14.3
						T	323	323	323	323	323	323	323	323	323	323	323	323	323

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in section 12

+ These sections are in addition to the range of BS EN 10056-1 sections.

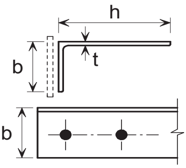
* Section is Class 4 under axial compression.

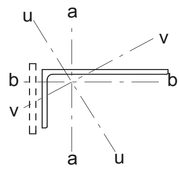
Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

FOR EXPLANATION OF TABLES SEE NOTE 8.

COMPRESSION

UNEQUAL ANGLES
Advance® UKA - Unequal Angles





Short leg attached

Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
			Axis a-a	Axis b-b	Axis v-v														
h x b mm	t mm	cm^2	cm	cm	cm		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
100x75	12	19.7	3.10	2.14	1.59	F	450	329	239	178	137	108	87.4	60.4	44.2	33.8	26.6	21.5	17.7
						T	630	630	630	630	630	630	630	630	630	630	630	630	630
	10	16.6	3.12	2.16	1.59	F	380	277	201	150	115	91.0	73.6	50.9	37.3	28.5	22.4	18.1	14.9
						T	505	505	505	505	505	505	505	505	505	505	505	505	505
	* 8	13.5	3.14	2.18	1.60	F	*294*	*219*	*160*	*120*	*92.9*	*73.6*	*59.7*	*41.4*	*30.4*	*23.2*	*18.3*	*14.8*	*12.2*
						T	*356*	*356*	*356*	*356*	*356*	*356*	*356*	*356*	*356*	*356*	*356*	*356*	*356*
100x65	10 +	15.6	3.14	1.81	1.39	F	327	226	159	116	88.2	69.1	55.5	38.1	27.7	21.0	16.5	13.3	11.0
						T	478	478	478	478	478	478	478	478	478	478	478	478	478
	* 8 +	12.7	3.16	1.83	1.40	F	*256*	*180*	*128*	*93.8*	*71.5*	*56.1*	*45.2*	*31.1*	*22.6*	*17.2*	*13.5*	*10.9*	*9.00*
						T	*338*	*338*	*338*	*338*	*338*	*338*	*338*	*338*	*338*	*338*	*338*	*338*	*338*
	* 7 +	11.2	3.17	1.83	1.40	F	*209*	*151*	*109*	*80.4*	*61.6*	*48.5*	*39.1*	*27.0*	*19.7*	*15.0*	*11.8*	*9.55*	*7.87*
						T	*259*	*259*	*259*	*259*	*259*	*259*	*259*	*259*	*259*	*259*	*259*	*259*	*259*
100x50	* 8	11.4	3.19	1.31	1.06	F	*184*	*116*	*77.7*	*55.3*	*41.2*	*31.9*	*25.4*	*17.2*	*12.4*	*9.33*	*7.29*	*5.85*	*4.80*
						T	*304*	*304*	*304*	*304*	*304*	*304*	*304*	*304*	*304*	*304*	*304*	*304*	*304*
	* 6	8.71	3.21	1.33	1.07	F	*124*	*82.5*	*56.5*	*40.7*	*30.6*	*23.8*	*19.1*	*13.0*	*9.40*	*7.11*	*5.57*	*4.48*	*3.68*
						T	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*
80x60	* 7	9.38	2.51	1.74	1.28	F	*185*	*124*	*85.3*	*61.7*	*46.6*	*36.3*	*29.1*	*19.8*	*14.4*	*10.9*	*8.54*	*6.87*	*5.65*
						T	*270*	*270*	*270*	*270*	*270*	*270*	*270*	*270*	*270*	*270*	*270*	*270*	*270*
80x40	8	9.01	2.53	1.03	0.838	F	116	67.6	43.5	30.2	22.2	16.9	13.4	8.93	6.39	4.79	3.73	2.98	2.44
						T	277	277	277	277	277	277	277	277	277	277	277	277	277
	* 6	6.89	2.55	1.05	0.845	F	*85.6*	*50.6*	*32.9*	*23.0*	*16.9*	*13.0*	*10.2*	*6.86*	*4.92*	*3.69*	*2.88*	*2.30*	*1.88*
						T	*172*	*172*	*172*	*172*	*172*	*172*	*172*	*172*	*172*	*172*	*172*	*172*	*172*
75x50	8	9.41	2.35	1.40	1.07	F	159	99.3	66.2	47.0	35.0	27.0	21.5	14.5	10.4	7.88	6.16	4.94	4.05
						T	293	293	293	293	293	293	293	293	293	293	293	293	293
	* 6	7.19	2.37	1.42	1.08	F	*118*	*74.9*	*50.4*	*35.9*	*26.8*	*20.7*	*16.5*	*11.2*	*8.07*	*6.09*	*4.76*	*3.82*	*3.14*
						T	*191*	*191*	*191*	*191*	*191*	*191*	*191*	*191*	*191*	*191*	*191*	*191*	*191*
70x50	* 6	6.89	2.20	1.43	1.07	F	*115*	*72.2*	*48.2*	*34.3*	*25.5*	*19.7*	*15.7*	*10.6*	*7.64*	*5.76*	*4.50*	*3.61*	*2.96*
						T	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*	*195*
65x50	* 5	5.54	2.05	1.47	1.07	F	*88.7*	*56.5*	*38.0*	*27.1*	*20.2*	*15.7*	*12.5*	*8.45*	*6.10*	*4.60*	*3.60*	*2.89*	*2.37*
						T	*139*	*139*	*139*	*139*	*139*	*139*	*139*	*139*	*139*	*139*	*139*	*139*	*139*
60x40	6	5.68	1.88	1.12	0.855	F	75.1	43.9	28.3	19.7	14.5	11.1	8.74	5.84	4.18	3.14	2.44	1.95	1.60
						T	174	174	174	174	174	174	174	174	174	174	174	174	174
	* 5	4.79	1.89	1.13	0.860	F	*62.8*	*36.9*	*23.9*	*16.7*	*12.3*	*9.38*	*7.41*	*4.96*	*3.55*	*2.67*	*2.08*	*1.66*	*1.36*
						T	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*

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+ These sections are in addition to the range of BS EN 10056-1 sections.

* Section is Class 4 under axial compression.

Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

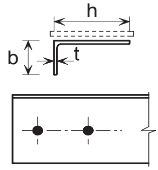
FOR EXPLANATION OF TABLES SEE NOTE 8.

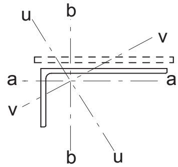
BS EN 1993-1-1:2005
BS EN 10056-1:1999

COMPRESSION

S355 / Advance® 355

UNEQUAL ANGLES
Advance® UKA - Unequal Angles





Long leg attached

Two or more bolts in line
or equivalent welded at each end

Section Designation		Area	Radius of Gyration			Buckling mode	Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)												
			Axis a-a	Axis b-b	Axis v-v														
h x b mm	t mm	cm²	cm	cm	cm		1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
200x150	* 18 +	60.1	4.38	6.30	3.22	F	1620	1490	1350	1170	1000	854	731	547	422	334	270	223	187
						T	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710
	* 15	50.5	4.40	6.33	3.23	F	1250	1160	1060	933	804	691	595	449	348	276	224	186	156
						T	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240	1240
	* 12	40.8	4.44	6.36	3.25	F	860	805	745	674	591	515	449	344	270	216	176	146	124
						T	767	767	767	767	767	767	767	767	767	767	767	767	767
200x100	* 15	43.0	2.64	6.40	2.12	F	960	818	675	536	430	350	289	206	154	119	95.0	77.5	64.3
						T	1070	1070	1070	1070	1070	1070	1070	1070	1070	1070	1070	1070	1070
	* 12	34.8	2.67	6.43	2.14	F	669	582	497	405	329	271	226	163	122	95.3	76.2	62.3	51.8
						T	671	671	671	671	671	671	671	671	671	671	671	671	671
	* 10	29.2	2.68	6.46	2.15	F	491	434	377	316	261	217	182	132	100	78.4	62.9	51.5	43.0
						T	446	446	446	446	446	446	446	446	446	446	446	446	446
150x90	15	33.9	2.46	4.74	1.93	F	817	672	514	396	311	249	204	143	106	81.5	64.6	52.5	43.4
						T	1040	1040	1040	1040	1040	1040	1040	1040	1040	1040	1040	1040	1040
	* 12	27.5	2.49	4.77	1.94	F	628	524	406	315	249	200	164	116	85.8	66.1	52.4	42.6	35.3
						T	733	733	733	733	733	733	733	733	733	733	733	733	733
	* 10	23.2	2.51	4.80	1.95	F	472	402	321	253	202	164	135	95.7	71.3	55.1	43.8	35.7	29.6
						T	507	507	507	507	507	507	507	507	507	507	507	507	507
150x75	15	31.7	1.94	4.75	1.58	F	692	526	381	284	218	172	139	96.2	70.4	53.7	42.3	34.2	28.2
						T	974	974	974	974	974	974	974	974	974	974	974	974	974
	* 12	25.7	1.97	4.78	1.59	F	536	414	303	227	175	139	112	78.0	57.2	43.7	34.5	27.9	23.0
						T	686	686	686	686	686	686	686	686	686	686	686	686	686
	* 10	21.7	1.99	4.81	1.60	F	407	326	244	185	144	114	93.2	65.0	47.9	36.7	29.0	23.5	19.4
						T	475	475	475	475	475	475	475	475	475	475	475	475	475
125x75	12	22.7	2.05	3.95	1.61	F	508	384	279	209	160	127	103	71.1	52.1	39.8	31.4	25.3	20.9
						T	688	688	688	688	688	688	688	688	688	688	688	688	688
	* 10	19.1	2.07	3.97	1.61	F	407	311	229	172	133	105	85.3	59.2	43.4	33.2	26.2	21.2	17.5
						T	509	509	509	509	509	509	509	509	509	509	509	509	509
	* 8	15.5	2.09	4.00	1.63	F	289	232	175	134	104	83.4	68.0	47.6	35.1	26.9	21.3	17.3	14.3
						T	323	323	323	323	323	323	323	323	323	323	323	323	323

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in section 12

+ These sections are in addition to the range of BS EN 10056-1 sections.

* Section is Class 4 under axial compression.

Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

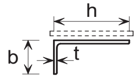
FOR EXPLANATION OF TABLES SEE NOTE 8.

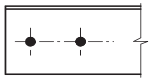
BS EN 1993-1-1:2005
BS EN 10056-1:1999

COMPRESSION

S355 / Advance® 355

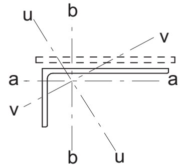
UNEQUAL ANGLES
Advance® UKA - Unequal Angles





Long leg attached

Two or more bolts in line
or equivalent welded at each end



Section Designation h x b mm	t mm	Area cm²	Radius of Gyration Axis a-a cm	Axis b-b cm	Axis v-v cm	Buckling mode	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
100x75	12	19.7	2.14	3.10	1.59	F	450	329	239	178	137	108	87.4	60.4	44.2	33.8	26.6	21.5	17.7
						T	630	630	630	630	630	630	630	630	630	630	630	630	630
	10	16.6	2.16	3.12	1.59	F	380	277	201	150	115	91.0	73.6	50.9	37.3	28.5	22.4	18.1	14.9
						T	505	505	505	505	505	505	505	505	505	505	505	505	505
	* 8	13.5	2.18	3.14	1.60	F	294	219	160	120	92.9	73.6	59.7	41.4	30.4	23.2	18.3	14.8	12.2
						T	356	356	356	356	356	356	356	356	356	356	356	356	356
100x65	10 +	15.6	1.81	3.14	1.39	F	327	226	159	116	88.2	69.1	55.5	38.1	27.7	21.0	16.5	13.3	11.0
						T	478	478	478	478	478	478	478	478	478	478	478	478	478
	* 8 +	12.7	1.83	3.16	1.40	F	256	180	128	93.8	71.5	56.1	45.2	31.1	22.6	17.2	13.5	10.9	9.00
						T	338	338	338	338	338	338	338	338	338	338	338	338	338
	* 7 +	11.2	1.83	3.17	1.40	F	209	151	109	80.4	61.6	48.5	39.1	27.0	19.7	15.0	11.8	9.55	7.87
						T	259	259	259	259	259	259	259	259	259	259	259	259	259
100x50	* 8	11.4	1.31	3.19	1.06	F	184	116	77.7	55.3	41.2	31.9	25.4	17.2	12.4	9.33	7.29	5.85	4.80
						T	304	304	304	304	304	304	304	304	304	304	304	304	304
	* 6	8.71	1.33	3.21	1.07	F	124	82.5	56.5	40.7	30.6	23.8	19.1	13.0	9.40	7.11	5.57	4.48	3.68
						T	168	168	168	168	168	168	168	168	168	168	168	168	168
80x60	* 7	9.38	1.74	2.51	1.28	F	185	124	85.3	61.7	46.6	36.3	29.1	19.8	14.4	10.9	8.54	6.87	5.65
						T	270	270	270	270	270	270	270	270	270	270	270	270	270
80x40	8	9.01	1.03	2.53	0.838	F	116	67.6	43.5	30.2	22.2	16.9	13.4	8.93	6.39	4.79	3.73	2.98	2.44
						T	277	277	277	277	277	277	277	277	277	277	277	277	277
	* 6	6.89	1.05	2.55	0.845	F	85.6	50.6	32.9	23.0	16.9	13.0	10.2	6.86	4.92	3.69	2.88	2.30	1.88
						T	172	172	172	172	172	172	172	172	172	172	172	172	172
75x50	8	9.41	1.40	2.35	1.07	F	159	99.3	66.2	47.0	35.0	27.0	21.5	14.5	10.4	7.88	6.16	4.94	4.05
						T	293	293	293	293	293	293	293	293	293	293	293	293	293
	* 6	7.19	1.42	2.37	1.08	F	118	74.9	50.4	35.9	26.8	20.7	16.5	11.2	8.07	6.09	4.76	3.82	3.14
						T	191	191	191	191	191	191	191	191	191	191	191	191	191
70x50	* 6	6.89	1.43	2.20	1.07	F	115	72.2	48.2	34.3	25.5	19.7	15.7	10.6	7.64	5.76	4.50	3.61	2.96
						T	195	195	195	195	195	195	195	195	195	195	195	195	195
65x50	* 5	5.54	1.47	2.05	1.07	F	88.7	56.5	38.0	27.1	20.2	15.7	12.5	8.45	6.10	4.60	3.60	2.89	2.37
						T	139	139	139	139	139	139	139	139	139	139	139	139	139
60x40	6	5.68	1.12	1.88	0.855	F	75.1	43.9	28.3	19.7	14.5	11.1	8.74	5.84	4.18	3.14	2.44	1.95	1.60
						T	174	174	174	174	174	174	174	174	174	174	174	174	174
	* 5	4.79	1.13	1.89	0.860	F	62.8	36.9	23.9	16.7	12.3	9.38	7.41	4.96	3.55	2.67	2.08	1.66	1.36
						T	133	133	133	133	133	133	133	133	133	133	133	133	133

Flexural buckling resistance (F) and torsional buckling resistance (T) (kN) for System length L (m)

Advance® and UKA are trademarks of Tata Steel. A fuller description of the relationship between Angles and the Advance ® range of sections manufactured by Tata Steel is given in section 12

+ These sections are in addition to the range of BS EN 10056-1 sections.

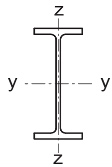
* Section is Class 4 under axial compression.

Values in italic type indicate that the section is Class 4 in pure compression and allowance has been made in calculating the resistance

FOR EXPLANATION OF TABLES SEE NOTE 8.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB

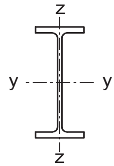


Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1016x305x487 +		$M_{c,y,Rd}$	7770	7770	7770	7770	7770	7770	7770	7770	7770	7770	7770
$N_{pl,Rd}$ = 20800	n/a	$M_{c,z,Rd}$	938	938	938	938	938	938	938	938	938	938	938
	1.00	$M_{N,y,Rd}$	7770	7770	7770	7080	6060	5050	4040	3030	2020	1010	0
		$M_{N,z,Rd}$	938	938	938	938	938	933	876	754	567	316	0
1016x305x437 +		$M_{c,y,Rd}$	6960	6960	6960	6960	6960	5940	5940	5940	5940	5940	5940
$N_{pl,Rd}$ = 18700	1.00	$M_{c,z,Rd}$	826	826	826	826	826	514	514	514	514	514	514
	0.409	$M_{N,y,Rd}$	6960	6960	6960	6340	5430	-	-	-	-	-	-
		$M_{N,z,Rd}$	826	826	826	826	826	-	-	-	-	-	-
1016x305x393 +		$M_{c,y,Rd}$	6210	6210	6210	6210	5330	5330	5330	5330	5330	5330	$
$N_{pl,Rd}$ = 16800	0.983	$M_{c,z,Rd}$	726	726	726	726	453	453	453	453	453	453	$
	0.341	$M_{N,y,Rd}$	6210	6210	6210	5670	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	726	726	726	726	-	-	-	-	-	-	-
1016x305x349 +		$M_{c,y,Rd}$	5720	5720	5720	4950	4950	4950	4950	4950	✖	✖	$
$N_{pl,Rd}$ = 15400	0.764	$M_{c,z,Rd}$	669	669	669	422	422	422	422	422	✖	✖	$
	0.231	$M_{N,y,Rd}$	5720	5720	5720	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	669	669	669	-	-	-	-	-	-	-	-
1016x305x314 +		$M_{c,y,Rd}$	5120	5120	4440	4440	4440	4440	4440	✖	✖	✖	$
$N_{pl,Rd}$ = 13800	0.644	$M_{c,z,Rd}$	591	591	373	373	373	373	373	✖	✖	✖	$
	0.177	$M_{N,y,Rd}$	5120	5120	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	591	591	-	-	-	-	-	-	-	-	-
1016x305x272 +		$M_{c,y,Rd}$	4430	4430	3860	3860	3860	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 12000	0.488	$M_{c,z,Rd}$	507	507	322	322	322	✖	✖	✖	✖	$	$
	0.105	$M_{N,y,Rd}$	4430	4430	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	507	507	-	-	-	-	-	-	-	-	-
1016x305x249 +		$M_{c,y,Rd}$	3920	3920	3390	3390	3390	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 10900	0.488	$M_{c,z,Rd}$	429	429	270	270	270	✖	✖	✖	✖	$	$
	0.115	$M_{N,y,Rd}$	3920	3920	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	429	429	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
1016x305x487 +	1.00	$N_{b,y,Rd}$	20800	20800	20800	20800	20800	20600	20400	20200	19900	19700	19400	19200	18900
$N_{pl,Rd}$ = 20800		$N_{b,z,Rd}$	18800	16500	14100	11600	9400	7610	6220	5140	4310	3660	3140	2720	2380
$f_y W_{el,y}$ = 6610	**1.00**	$M_{b,Rd}$	7770	7240	6380	5650	5030	4520	4090	3740	3440	3190	2970	2780	2620
$f_y W_{el,z}$ = 580															
1016x305x437 +	1.00	$N_{b,y,Rd}$	18700	18700	18700	18700	18700	18500	18300	18100	17900	17700	17400	17200	17000
$N_{pl,Rd}$ = 18700		$N_{b,z,Rd}$	16800	14800	12500	10300	8320	6720	5480	4530	3790	3220	2760	2390	2090
$f_y W_{el,y}$ = 5940	1.00	$M_{b,Rd}$	5940	5670	5030	4480	4010	3610	3280	3000	2760	2560	2380	2230	2100
$f_y W_{el,z}$ = 514	**0.409**	$M_{b,Rd}$	6960	6430	5630	4950	4380	3910	3520	3200	2930	2700	2510	2340	2200
* 1016x305x393 +	0.983	$N_{b,y,Rd}$	16800	16800	16800	16800	16800	16600	16400	16200	16000	15800	15600	15400	15200
$N_{pl,Rd}$ = 16800		$N_{b,z,Rd}$	15100	13200	11100	9110	7330	5910	4810	3970	3320	2820	2420	2090	1830
$f_y W_{el,y}$ = 5330	0.983	$M_{b,Rd}$	5330	5040	4440	3930	3490	3120	2820	2560	2340	2160	2010	1870	1760
$f_y W_{el,z}$ = 453	**0.341**	$M_{b,Rd}$	6210	5690	4950	4320	3800	3360	3010	2720	2480	2270	2100	1960	1830
* 1016x305x349 +	0.764	$N_{b,y,Rd}$	15400	15400	15400	15400	15400	15300	15200	15000	14900	14800	14700	14600	14400
$N_{pl,Rd}$ = 15400		$N_{b,z,Rd}$	14200	12800	11100	9150	7320	5840	4710	3860	3210	2700	2300	1990	1730
$f_y W_{el,y}$ = 4950	0.764	$M_{b,Rd}$	4950	4640	4070	3570	3140	2790	2500	2250	2050	1880	1740	1610	1510
$f_y W_{el,z}$ = 422	**0.231**	$M_{b,Rd}$	5720	5190	4500	3900	3400	2980	2650	2380	2150	1970	1810	1680	1560
* 1016x305x314 +	0.644	$N_{b,y,Rd}$	13800	13800	13800	13800	13800	13700	13600	13500	13400	13300	13200	13100	13000
$N_{pl,Rd}$ = 13800		$N_{b,z,Rd}$	12800	11500	9910	8130	6480	5160	4160	3400	2830	2380	2030	1750	1520
$f_y W_{el,y}$ = 4440	0.644	$M_{b,Rd}$	4440	4130	3610	3150	2750	2430	2160	1940	1750	1600	1470	1360	1270
$f_y W_{el,z}$ = 373	**0.177**	$M_{b,Rd}$	5120	4610	3980	3420	2960	2590	2280	2030	1830	1670	1530	1410	1310
* 1016x305x272 +	0.488	$N_{b,y,Rd}$	12000	12000	12000	12000	12000	11900	11800	11700	11600	11500	11400	11300	11200
$N_{pl,Rd}$ = 12000		$N_{b,z,Rd}$	11100	9960	8580	7030	5600	4460	3590	2940	2440	2050	1750	1510	1320
$f_y W_{el,y}$ = 3860	0.488	$M_{b,Rd}$	3860	3570	3100	2690	2340	2040	1800	1600	1440	1310	1200	1100	1020
$f_y W_{el,z}$ = 322	**0.105**	$M_{b,Rd}$	4430	3970	3400	2910	2500	2170	1900	1680	1500	1360	1240	1140	1050
* 1016x305x249 +	0.488	$N_{b,y,Rd}$	10900	10900	10900	10900	10900	10900	10800	10700	10600	10500	10400	10300	10200
$N_{pl,Rd}$ = 10900		$N_{b,z,Rd}$	10000	8950	7600	6120	4820	3810	3060	2490	2070	1740	1480	1280	1110
$f_y W_{el,y}$ = 3390	0.488	$M_{b,Rd}$	3390	3100	2670	2300	1980	1720	1500	1330	1190	1070	975	894	826
$f_y W_{el,z}$ = 270	**0.115**	$M_{b,Rd}$	3920	3460	2940	2500	2130	1820	1580	1390	1240	1110	1010	924	851

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

n = N_{Ed} / $N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.

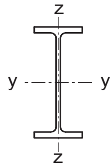
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

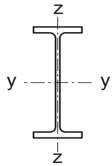
Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1016x305x222 +		$M_{c,y,Rd}$	3380	3380	2900	2900	2900	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 9760	0.458	$M_{c,z,Rd}$	352	352	219	219	219	✖	✖	✖	✖	$	$
	0.108	$M_{N,y,Rd}$	3380	3380	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	352	352	-	-	-	-	-	-	-	-	-
914x419x388		$M_{c,y,Rd}$	6090	6090	6090	5390	5390	5390	5390	5390	5390	✖	$
$N_{pl,Rd}$ = 17000	0.892	$M_{c,z,Rd}$	1150	1150	1150	746	746	746	746	746	746	✖	$
	0.244	$M_{N,y,Rd}$	6090	6090	6010	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	1150	1150	1150	-	-	-	-	-	-	-	-
914x419x343		$M_{c,y,Rd}$	5340	5340	4740	4740	4740	4740	4740	4740	✖	✖	$
$N_{pl,Rd}$ = 15100	0.762	$M_{c,z,Rd}$	997	997	645	645	645	645	645	645	✖	✖	$
	0.198	$M_{N,y,Rd}$	5340	5340	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	997	997	-	-	-	-	-	-	-	-	-
914x305x289		$M_{c,y,Rd}$	4340	4340	4340	3750	3750	3750	3750	3750	✖	✖	$
$N_{pl,Rd}$ = 12700	0.730	$M_{c,z,Rd}$	552	552	552	350	350	350	350	350	✖	✖	$
	0.229	$M_{N,y,Rd}$	4340	4340	4340	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	552	552	552	-	-	-	-	-	-	-	-
914x305x253		$M_{c,y,Rd}$	3770	3770	3280	3280	3280	3280	✖	✖	✖	$	$
$N_{pl,Rd}$ = 11100	0.591	$M_{c,z,Rd}$	473	473	300	300	300	300	✖	✖	✖	$	$
	0.163	$M_{N,y,Rd}$	3770	3770	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	473	473	-	-	-	-	-	-	-	-	-
914x305x224		$M_{c,y,Rd}$	3290	3290	2850	2850	2850	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 9870	0.503	$M_{c,z,Rd}$	401	401	255	255	255	✖	✖	✖	✖	$	$
	0.124	$M_{N,y,Rd}$	3290	3290	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	401	401	-	-	-	-	-	-	-	-	-
914x305x201		$M_{c,y,Rd}$	2880	2880	2490	2490	2490	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 8830	0.452	$M_{c,z,Rd}$	339	339	214	214	214	✖	✖	✖	✖	$	$
	0.104	$M_{N,y,Rd}$	2880	2880	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	339	339	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

S355 / Advance® 355

UNIVERSAL BEAMS
Advance® UKB

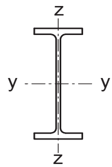


Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 1016x305x222 +	0.458	$N_{b,y,Rd}$	9760	9760	9760	9760	9760	9680	9610	9530	9450	9370	9280	9190	9100
$N_{pl,Rd}$ = 9760		$N_{b,z,Rd}$	8870	7830	6530	5160	4020	3150	2520	2050	1690	1420	1210	1040	908
$f_y W_{el,y}$ = 2900	0.458	$M_{b,Rd}$	2900	2610	2240	1910	1630	1400	1220	1070	949	851	770	703	647
$f_y W_{el,z}$ = 219	**0.108**	$M_{b,Rd}$	3380	2930	2470	2080	1750	1490	1280	1120	989	884	798	726	667
* 914x419x388	0.892	$N_{b,y,Rd}$	17000	17000	17000	17000	17000	16900	16800	16600	16500	16400	16200	16100	15900
$N_{pl,Rd}$ = 17000		$N_{b,z,Rd}$	16600	15800	14800	13600	12300	10800	9360	8050	6910	5960	5170	4510	3970
$f_y W_{el,y}$ = 5390	0.892	$M_{b,Rd}$	5390	5390	5260	4950	4640	4330	4040	3750	3490	3240	3020	2820	2640
$f_y W_{el,z}$ = 746	**0.244**	$M_{b,Rd}$	6090	6090	5860	5470	5100	4720	4360	4020	3710	3430	3180	2950	2760
* 914x419x343	0.762	$N_{b,y,Rd}$	15100	15100	15100	15100	15100	14900	14800	14700	14600	14500	14300	14200	14000
$N_{pl,Rd}$ = 15100		$N_{b,z,Rd}$	14700	13900	13000	12000	10700	9440	8150	6990	5990	5160	4470	3900	3430
$f_y W_{el,y}$ = 4740	0.762	$M_{b,Rd}$	4740	4740	4600	4320	4030	3750	3470	3210	2960	2740	2540	2360	2200
$f_y W_{el,z}$ = 645	**0.198**	$M_{b,Rd}$	5340	5340	5110	4760	4420	4070	3740	3430	3140	2890	2660	2460	2280
* 914x305x289	0.730	$N_{b,y,Rd}$	12700	12700	12700	12700	12700	12600	12500	12400	12300	12200	12000	11900	11800
$N_{pl,Rd}$ = 12700		$N_{b,z,Rd}$	11800	10700	9250	7650	6140	4910	3970	3250	2700	2280	1940	1680	1460
$f_y W_{el,y}$ = 3750	0.730	$M_{b,Rd}$	3750	3600	3290	2970	2660	2380	2130	1910	1730	1570	1440	1330	1230
$f_y W_{el,z}$ = 350	**0.229**	$M_{b,Rd}$	4340	4080	3680	3280	2900	2560	2260	2010	1810	1640	1490	1370	1270
* 914x305x253	0.591	$N_{b,y,Rd}$	11100	11100	11100	11100	11100	11000	10900	10900	10800	10700	10600	10400	10300
$N_{pl,Rd}$ = 11100		$N_{b,z,Rd}$	10300	9310	8050	6620	5290	4220	3400	2780	2310	1950	1660	1430	1250
$f_y W_{el,y}$ = 3280	0.591	$M_{b,Rd}$	3280	3130	2840	2550	2270	2010	1780	1590	1430	1290	1170	1080	993
$f_y W_{el,z}$ = 300	**0.163**	$M_{b,Rd}$	3770	3530	3170	2810	2460	2150	1890	1670	1490	1340	1210	1110	1020
* 914x305x224	0.503	$N_{b,y,Rd}$	9870	9870	9870	9870	9840	9760	9680	9600	9510	9420	9330	9230	9130
$N_{pl,Rd}$ = 9870		$N_{b,z,Rd}$	9090	8170	7010	5710	4530	3600	2900	2370	1960	1650	1410	1220	1060
$f_y W_{el,y}$ = 2850	0.503	$M_{b,Rd}$	2850	2710	2450	2190	1930	1690	1490	1310	1170	1050	951	867	797
$f_y W_{el,z}$ = 255	**0.124**	$M_{b,Rd}$	3290	3050	2730	2400	2080	1800	1570	1370	1220	1090	980	891	817
* 914x305x201	0.452	$N_{b,y,Rd}$	8830	8830	8830	8830	8800	8730	8660	8580	8500	8420	8330	8240	8150
$N_{pl,Rd}$ = 8830		$N_{b,z,Rd}$	8090	7220	6120	4930	3880	3060	2450	2000	1660	1390	1190	1020	891
$f_y W_{el,y}$ = 2490	0.452	$M_{b,Rd}$	2490	2340	2110	1870	1640	1420	1240	1090	962	859	773	702	642
$f_y W_{el,z}$ = 214	**0.104**	$M_{b,Rd}$	2880	2650	2350	2050	1770	1520	1310	1140	999	887	796	721	654

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
n = N_{Ed} / $N_{pl,Rd}$
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.
For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
838x292x226		$M_{c,y,Rd}$	3160	3160	2750	2750	2750	2750	✖	✖	✖	✖	$
$N_{pl,Rd}$ = 9970	0.599	$M_{c,z,Rd}$	418	418	267	267	267	267	✖	✖	✖	✖	$
	0.160	$M_{N,y,Rd}$	3160	3160	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	418	418	-	-	-	-	-	-	-	-	-
838x292x194		$M_{c,y,Rd}$	2640	2640	2290	2290	2290	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 8520	0.503	$M_{c,z,Rd}$	336	336	214	214	214	✖	✖	✖	✖	$	$
	0.123	$M_{N,y,Rd}$	2640	2640	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	336	336	-	-	-	-	-	-	-	-	-
838x292x176		$M_{c,y,Rd}$	2350	2350	2030	2030	2030	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 7730	0.456	$M_{c,z,Rd}$	290	290	185	185	185	✖	✖	✖	✖	$	$
	0.104	$M_{N,y,Rd}$	2350	2350	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	290	290	-	-	-	-	-	-	-	-	-
762x267x197		$M_{c,y,Rd}$	2470	2470	2470	2150	2150	2150	2150	✖	✖	✖	$
$N_{pl,Rd}$ = 8660	0.682	$M_{c,z,Rd}$	331	331	331	210	210	210	210	✖	✖	✖	$
	0.201	$M_{N,y,Rd}$	2470	2470	2470	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	331	331	331	-	-	-	-	-	-	-	-
762x267x173		$M_{c,y,Rd}$	2140	2140	1860	1860	1860	1860	✖	✖	✖	$	$
$N_{pl,Rd}$ = 7590	0.584	$M_{c,z,Rd}$	278	278	177	177	177	177	✖	✖	✖	$	$
	0.161	$M_{N,y,Rd}$	2140	2140	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	278	278	-	-	-	-	-	-	-	-	-
762x267x147		$M_{c,y,Rd}$	1780	1780	1540	1540	1540	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 6450	0.470	$M_{c,z,Rd}$	223	223	142	142	142	✖	✖	✖	✖	$	$
	0.110	$M_{N,y,Rd}$	1780	1780	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	223	223	-	-	-	-	-	-	-	-	-
762x267x134		$M_{c,y,Rd}$	1650	1430	1430	1430	✖	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 6070	0.397	$M_{c,z,Rd}$	202	129	129	129	✖	✖	✖	✖	✖	$	$
	0.073	$M_{N,y,Rd}$	1650	-	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	202	-	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

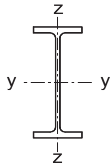
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$												
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 838x292x226	0.599	$N_{b,y,Rd}$	9970	9970	9970	9970	9910	9830	9740	9650	9560	9460	9360	9250	9130
$N_{pl,Rd}$ = 9970		$N_{b,z,Rd}$	9190	8260	7080	5770	4580	3640	2930	2390	1980	1670	1420	1230	1070
$f_y W_{el,y}$ = 2750	0.599	$M_{b,Rd}$	2750	2610	2360	2110	1870	1660	1470	1310	1170	1060	966	887	819
$f_y W_{el,z}$ = 267	**0.160**	$M_{b,Rd}$	3160	2930	2620	2310	2020	1760	1540	1360	1220	1100	996	912	841
* 838x292x194	0.503	$N_{b,y,Rd}$	8520	8520	8520	8520	8460	8390	8320	8240	8150	8070	7980	7880	7770
$N_{pl,Rd}$ = 8520		$N_{b,z,Rd}$	7800	6960	5900	4740	3730	2950	2360	1930	1600	1340	1140	985	857
$f_y W_{el,y}$ = 2290	0.503	$M_{b,Rd}$	2290	2150	1930	1710	1500	1310	1150	1010	898	805	728	664	610
$f_y W_{el,z}$ = 214	**0.123**	$M_{b,Rd}$	2640	2420	2150	1870	1620	1390	1200	1050	930	831	749	681	624
* 838x292x176	0.456	$N_{b,y,Rd}$	7730	7730	7730	7730	7670	7600	7530	7460	7380	7300	7220	7130	7030
$N_{pl,Rd}$ = 7730		$N_{b,z,Rd}$	7040	6240	5230	4170	3250	2560	2050	1670	1380	1160	987	850	739
$f_y W_{el,y}$ = 2030	0.456	$M_{b,Rd}$	2030	1900	1700	1500	1300	1130	979	857	757	675	608	552	505
$f_y W_{el,z}$ = 185	**0.104**	$M_{b,Rd}$	2350	2140	1890	1630	1400	1200	1030	892	784	696	625	566	510
* 762x267x197	0.682	$N_{b,y,Rd}$	8660	8660	8660	8640	8560	8480	8390	8300	8210	8110	8000	7880	7760
$N_{pl,Rd}$ = 8660		$N_{b,z,Rd}$	7840	6890	5700	4480	3470	2720	2170	1760	1460	1220	1040	896	779
$f_y W_{el,y}$ = 2150	0.682	$M_{b,Rd}$	2150	1980	1770	1570	1370	1200	1060	945	849	769	703	647	599
$f_y W_{el,z}$ = 210	**0.201**	$M_{b,Rd}$	2470	2220	1960	1700	1470	1280	1110	985	880	794	723	664	614
* 762x267x173	0.584	$N_{b,y,Rd}$	7590	7590	7590	7570	7500	7430	7350	7270	7180	7090	7000	6890	6780
$N_{pl,Rd}$ = 7590		$N_{b,z,Rd}$	6830	5980	4900	3810	2940	2290	1820	1480	1220	1030	873	752	654
$f_y W_{el,y}$ = 1860	0.584	$M_{b,Rd}$	1860	1700	1510	1320	1150	994	868	766	682	614	557	510	471
$f_y W_{el,z}$ = 177	**0.161**	$M_{b,Rd}$	2140	1910	1670	1430	1220	1050	908	795	705	632	572	523	478
* 762x267x147	0.470	$N_{b,y,Rd}$	6450	6450	6450	6430	6370	6300	6240	6170	6090	6020	5930	5840	5740
$N_{pl,Rd}$ = 6450		$N_{b,z,Rd}$	5770	4990	4030	3100	2370	1840	1460	1190	979	821	698	601	522
$f_y W_{el,y}$ = 1540	0.470	$M_{b,Rd}$	1540	1400	1230	1060	911	781	674	588	519	463	417	379	345
$f_y W_{el,z}$ = 142	**0.110**	$M_{b,Rd}$	1770	1570	1360	1150	971	821	702	609	535	475	427	383	345
* 762x267x134	0.397	$N_{b,y,Rd}$	6070	6070	6070	6040	5980	5920	5860	5790	5720	5640	5550	5460	5360
$N_{pl,Rd}$ = 6070		$N_{b,z,Rd}$	5380	4610	3670	2790	2120	1640	1300	1050	867	727	618	531	462
$f_y W_{el,y}$ = 1430	0.397	$M_{b,Rd}$	1430	1280	1120	956	811	688	589	510	448	397	357	321	289
$f_y W_{el,z}$ = 129	**0.073**	$M_{b,Rd}$	1630	1430	1230	1030	861	722	612	527	461	408	361	321	289

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

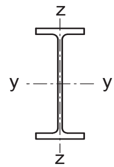
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
686x254x170		$M_{c,y,Rd}$	1940	1940	1940	1700	1700	1700	1700	1700	✖	✖	$
$N_{pl,Rd}$ = 7490	0.726	$M_{c,z,Rd}$	280	280	280	179	179	179	179	179	✖	✖	$
	0.213	$M_{N,y,Rd}$	1940	1940	1940	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	280	280	280	-	-	-	-	-	-	-	-
686x254x152		$M_{c,y,Rd}$	1730	1730	1510	1510	1510	1510	1510	✖	✖	✖	$
$N_{pl,Rd}$ = 6690	0.616	$M_{c,z,Rd}$	245	245	157	157	157	157	157	✖	✖	✖	$
	0.166	$M_{N,y,Rd}$	1730	1730	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	245	245	-	-	-	-	-	-	-	-	-
686x254x140		$M_{c,y,Rd}$	1570	1570	1380	1380	1380	1380	✖	✖	✖	$	$
$N_{pl,Rd}$ = 6140	0.548	$M_{c,z,Rd}$	220	220	141	141	141	141	✖	✖	✖	$	$
	0.138	$M_{N,y,Rd}$	1570	1570	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	220	220	-	-	-	-	-	-	-	-	-
686x254x125		$M_{c,y,Rd}$	1380	1380	1200	1200	1200	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 5490	0.489	$M_{c,z,Rd}$	187	187	119	119	119	✖	✖	✖	✖	$	$
	0.115	$M_{N,y,Rd}$	1380	1380	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	187	187	-	-	-	-	-	-	-	-	-
610x305x238		$M_{c,y,Rd}$	2580	2580	2580	2580	2580	2580	2580	2580	2580	2580	2580
$N_{pl,Rd}$ = 10500	n/a	$M_{c,z,Rd}$	543	543	543	543	543	543	543	543	543	543	543
	1.00	$M_{N,y,Rd}$	2580	2580	2510	2200	1880	1570	1260	942	628	314	0
		$M_{N,z,Rd}$	543	543	543	543	540	515	465	387	284	155	0
610x305x179		$M_{c,y,Rd}$	1910	1910	1910	1700	1700	1700	1700	1700	1700	✖	$
$N_{pl,Rd}$ = 7870	0.858	$M_{c,z,Rd}$	395	395	395	256	256	256	256	256	256	✖	$
	0.222	$M_{N,y,Rd}$	1910	1910	1870	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	395	395	395	-	-	-	-	-	-	-	-
610x305x149		$M_{c,y,Rd}$	1580	1580	1420	1420	1420	1420	1420	✖	✖	✖	$
$N_{pl,Rd}$ = 6560	0.636	$M_{c,z,Rd}$	323	323	211	211	211	211	211	✖	✖	✖	$
	0.141	$M_{N,y,Rd}$	1580	1580	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	323	323	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

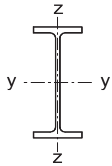
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 686x254x170	0.726	$N_{b,y,Rd}$	7490	7490	7490	7440	7360	7280	7190	7100	7010	6900	6790	6670	6530
$N_{pl,Rd}$ = 7490		$N_{b,z,Rd}$	6730	5870	4790	3720	2860	2230	1770	1440	1190	996	847	729	634
$f_y W_{el,y}$ = 1700	0.726	$M_{b,Rd}$	1700	1550	1370	1210	1060	925	816	727	654	593	543	500	464
$f_y W_{el,z}$ = 179	**0.213**	$M_{b,Rd}$	1940	1730	1510	1310	1130	976	854	755	676	611	558	513	475
* 686x254x152	0.616	$N_{b,y,Rd}$	6690	6690	6690	6650	6580	6500	6430	6350	6260	6160	6060	5950	5820
$N_{pl,Rd}$ = 6690		$N_{b,z,Rd}$	6000	5210	4230	3270	2500	1950	1550	1260	1040	870	740	636	553
$f_y W_{el,y}$ = 1510	0.616	$M_{b,Rd}$	1510	1370	1210	1050	913	792	693	613	548	494	450	413	382
$f_y W_{el,z}$ = 157	**0.166**	$M_{b,Rd}$	1720	1520	1330	1140	971	833	723	635	565	508	462	423	388
* 686x254x140	0.548	$N_{b,y,Rd}$	6140	6140	6140	6100	6030	5960	5890	5820	5740	5650	5550	5450	5330
$N_{pl,Rd}$ = 6140		$N_{b,z,Rd}$	5490	4750	3830	2950	2250	1750	1390	1130	929	779	662	570	495
$f_y W_{el,y}$ = 1380	0.548	$M_{b,Rd}$	1380	1240	1090	946	814	701	610	536	477	428	389	355	328
$f_y W_{el,z}$ = 141	**0.138**	$M_{b,Rd}$	1560	1380	1200	1020	864	736	635	555	491	440	398	362	329
* 686x254x125	0.489	$N_{b,y,Rd}$	5490	5490	5490	5440	5380	5320	5260	5190	5110	5030	4940	4850	4740
$N_{pl,Rd}$ = 5490		$N_{b,z,Rd}$	4870	4180	3330	2530	1920	1490	1180	955	788	660	561	483	419
$f_y W_{el,y}$ = 1200	0.489	$M_{b,Rd}$	1200	1070	938	806	686	586	505	440	389	347	314	286	259
$f_y W_{el,z}$ = 119	**0.115**	$M_{b,Rd}$	1360	1200	1030	868	728	614	525	455	400	356	320	286	259
610x305x238	1.00	$N_{b,y,Rd}$	10500	10500	10500	10300	10200	10100	9980	9840	9690	9530	9350	9150	8930
$N_{pl,Rd}$ = 10500		$N_{b,z,Rd}$	9860	9080	8110	6960	5780	4730	3870	3200	2670	2260	1940	1670	1460
$f_y W_{el,y}$ = 2270	**1.00**	$M_{b,Rd}$	2580	2490	2290	2090	1910	1740	1590	1450	1340	1240	1150	1070	1010
$f_y W_{el,z}$ = 351															
* 610x305x179	0.858	$N_{b,y,Rd}$	7870	7870	7870	7780	7690	7600	7500	7390	7270	7150	7010	6850	6680
$N_{pl,Rd}$ = 7870		$N_{b,z,Rd}$	7390	6780	6030	5140	4230	3440	2810	2320	1940	1640	1400	1210	1060
$f_y W_{el,y}$ = 1700	0.858	$M_{b,Rd}$	1700	1650	1520	1380	1250	1130	1020	924	841	770	709	657	611
$f_y W_{el,z}$ = 256	**0.222**	$M_{b,Rd}$	1910	1830	1660	1500	1350	1200	1080	968	876	798	733	677	628
* 610x305x149	0.636	$N_{b,y,Rd}$	6560	6560	6550	6480	6410	6330	6240	6150	6050	5950	5830	5700	5550
$N_{pl,Rd}$ = 6560		$N_{b,z,Rd}$	6150	5640	5000	4240	3480	2830	2310	1900	1590	1340	1150	990	863
$f_y W_{el,y}$ = 1420	0.636	$M_{b,Rd}$	1420	1370	1250	1130	1010	905	808	723	652	591	540	496	459
$f_y W_{el,z}$ = 211	**0.141**	$M_{b,Rd}$	1580	1510	1360	1220	1080	957	847	753	675	610	555	509	470

 A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$n = N_{Ed} / N_{pl,Rd}$

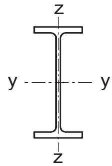
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
610x229x140		$M_{c,y,Rd}$	1430	1430	1430	1250	1250	1250	1250	1250	✖	✖	$
$N_{pl,Rd}$ = 6140	0.744	$M_{c,z,Rd}$	211	211	211	135	135	135	135	135	✖	✖	$
	0.217	$M_{N,y,Rd}$	1430	1430	1430	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	211	211	211	-	-	-	-	-	-	-	-
610x229x125		$M_{c,y,Rd}$	1270	1270	1110	1110	1110	1110	1110	✖	✖	✖	$
$N_{pl,Rd}$ = 5490	0.630	$M_{c,z,Rd}$	185	185	118	118	118	118	118	✖	✖	✖	$
	0.169	$M_{N,y,Rd}$	1270	1270	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	185	185	-	-	-	-	-	-	-	-	-
610x229x113		$M_{c,y,Rd}$	1130	1130	992	992	992	992	✖	✖	✖	$	$
$N_{pl,Rd}$ = 4970	0.554	$M_{c,z,Rd}$	162	162	104	104	104	104	✖	✖	✖	$	$
	0.138	$M_{N,y,Rd}$	1130	1130	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	162	162	-	-	-	-	-	-	-	-	-
610x229x101		$M_{c,y,Rd}$	1020	1020	893	893	893	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 4580	0.483	$M_{c,z,Rd}$	142	142	90.9	90.9	90.9	✖	✖	✖	✖	$	$
	0.111	$M_{N,y,Rd}$	1020	1020	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	142	142	-	-	-	-	-	-	-	-	-
610x178x100 +		$M_{c,y,Rd}$	961	961	824	824	824	824	✖	✖	✖	$	$
$N_{pl,Rd}$ = 4420	0.573	$M_{c,z,Rd}$	102	102	63.8	63.8	63.8	63.8	✖	✖	✖	$	$
	0.169	$M_{N,y,Rd}$	961	961	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	102	102	-	-	-	-	-	-	-	-	-
610x178x92 +		$M_{c,y,Rd}$	891	891	760	760	760	760	✖	✖	✖	$	$
$N_{pl,Rd}$ = 4150	0.520	$M_{c,z,Rd}$	91.6	91.6	57.2	57.2	57.2	57.2	✖	✖	✖	$	$
	0.148	$M_{N,y,Rd}$	891	891	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	91.6	91.6	-	-	-	-	-	-	-	-	-
610x178x82 +		$M_{c,y,Rd}$	779	779	663	663	663	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 3690	0.436	$M_{c,z,Rd}$	77.4	77.4	48.3	48.3	48.3	✖	✖	✖	✖	$	$
	0.103	$M_{N,y,Rd}$	779	779	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	77.4	77.4	-	-	-	-	-	-	-	-	-

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+ These sections are in addition to the range of BS 4 sections

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

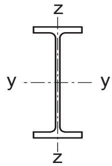
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 610x229x140	0.744	$N_{b,y,Rd}$	6140	6140	6130	6060	5990	5910	5830	5740	5640	5540	5420	5290	5140
$N_{pl,Rd}$ = 6140		$N_{b,z,Rd}$	5390	4560	3570	2670	2020	1550	1230	993	818	685	582	500	434
$f_y W_{el,y}$ = 1250	0.744	$M_{b,Rd}$	1240	1100	963	834	721	628	553	492	443	403	369	341	316
$f_y W_{el,z}$ = 135	**0.217**	$M_{b,Rd}$	1390	1220	1050	896	764	659	575	509	457	414	378	349	321
* 610x229x125	0.630	$N_{b,y,Rd}$	5490	5490	5480	5410	5350	5280	5210	5130	5040	4940	4840	4720	4580
$N_{pl,Rd}$ = 5490		$N_{b,z,Rd}$	4800	4040	3140	2350	1770	1360	1070	868	714	598	508	437	379
$f_y W_{el,y}$ = 1110	0.630	$M_{b,Rd}$	1100	971	844	724	619	534	466	412	369	333	304	280	259
$f_y W_{el,z}$ = 118	**0.169**	$M_{b,Rd}$	1230	1080	919	775	654	558	484	425	379	342	311	284	259
* 610x229x113	0.554	$N_{b,y,Rd}$	4970	4970	4960	4900	4840	4780	4710	4630	4550	4460	4360	4250	4130
$N_{pl,Rd}$ = 4970		$N_{b,z,Rd}$	4330	3620	2790	2070	1550	1190	941	760	626	524	444	382	332
$f_y W_{el,y}$ = 992	0.554	$M_{b,Rd}$	976	859	742	630	534	457	395	347	308	277	252	231	210
$f_y W_{el,z}$ = 104	**0.138**	$M_{b,Rd}$	1100	952	807	673	563	476	409	357	317	284	256	231	210
* 610x229x101	0.483	$N_{b,y,Rd}$	4580	4580	4560	4510	4450	4390	4320	4250	4170	4080	3990	3880	3750
$N_{pl,Rd}$ = 4580		$N_{b,z,Rd}$	3940	3240	2440	1790	1330	1020	805	649	534	447	379	325	283
$f_y W_{el,y}$ = 893	0.483	$M_{b,Rd}$	871	761	649	544	455	384	329	286	253	226	203	182	165
$f_y W_{el,z}$ = 90.9	**0.111**	$M_{b,Rd}$	980	843	705	579	477	399	340	294	259	229	203	182	165
* 610x178x100 +	0.573	$N_{b,y,Rd}$	4420	4420	4400	4350	4290	4230	4170	4100	4020	3940	3840	3730	3610
$N_{pl,Rd}$ = 4420		$N_{b,z,Rd}$	3420	2430	1620	1120	812	613	478	383	314	261	221	190	164
$f_y W_{el,y}$ = 824	0.573	$M_{b,Rd}$	717	560	439	353	292	248	215	190	170	155	142	131	122
$f_y W_{el,z}$ = 63.8	**0.169**	$M_{b,Rd}$	803	611	470	372	305	258	223	196	175	159	145	134	124
* 610x178x92 +	0.520	$N_{b,y,Rd}$	4150	4150	4130	4080	4020	3970	3900	3830	3760	3670	3580	3470	3340
$N_{pl,Rd}$ = 4150		$N_{b,z,Rd}$	3140	2170	1430	980	707	533	415	332	272	227	192	164	142
$f_y W_{el,y}$ = 760	0.520	$M_{b,Rd}$	649	500	387	307	251	212	182	160	143	129	118	109	101
$f_y W_{el,z}$ = 57.2	**0.148**	$M_{b,Rd}$	728	545	413	323	262	220	189	165	147	133	121	111	103
* 610x178x82 +	0.436	$N_{b,y,Rd}$	3690	3690	3670	3620	3580	3520	3470	3400	3330	3260	3170	3070	2960
$N_{pl,Rd}$ = 3690		$N_{b,z,Rd}$	2740	1860	1210	828	596	449	349	280	229	191	161	138	120
$f_y W_{el,y}$ = 663	0.436	$M_{b,Rd}$	559	426	325	255	207	173	148	129	115	103	93.7	86.0	79.5
$f_y W_{el,z}$ = 48.3	**0.103**	$M_{b,Rd}$	627	464	347	268	216	179	153	133	118	106	96.0	87.9	80.2

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+ These sections are in addition to the range of BS 4 sections

$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

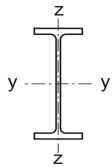
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



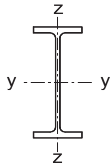
Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
533x312x272 +		$M_{c,y,Rd}$	2710	2710	2710	2710	2710	2710	2710	2710	2710	2710	2710
$N_{pl,Rd}$ = 12000	n/a	$M_{c,z,Rd}$	685	685	685	685	685	685	685	685	685	685	685
	1.00	$M_{N,y,Rd}$	2710	2710	2570	2250	1920	1600	1280	962	642	321	0
		$M_{N,z,Rd}$	685	685	685	685	673	632	563	465	339	184	0
533x312x219 +		$M_{c,y,Rd}$	2110	2110	2110	2110	2110	2110	2110	2110	2110	2110	2110
$N_{pl,Rd}$ = 9630	n/a	$M_{c,z,Rd}$	522	522	522	522	522	522	522	522	522	522	522
	1.00	$M_{N,y,Rd}$	2110	2110	2030	1770	1520	1270	1010	761	507	254	0
		$M_{N,z,Rd}$	522	522	522	522	517	490	440	365	267	145	0
533x312x182 +		$M_{c,y,Rd}$	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740
$N_{pl,Rd}$ = 7970	n/a	$M_{c,z,Rd}$	427	427	427	427	427	427	427	427	427	427	427
	1.00	$M_{N,y,Rd}$	1740	1740	1670	1460	1250	1040	835	626	418	209	0
		$M_{N,z,Rd}$	427	427	427	427	423	401	359	298	218	119	0
533x312x150 +		$M_{c,y,Rd}$	1430	1430	1430	1280	1280	1280	1280	1280	1280	✖	$
$N_{pl,Rd}$ = 6620	0.886	$M_{c,z,Rd}$	348	348	348	227	227	227	227	227	227	✖	$
	0.220	$M_{N,y,Rd}$	1430	1430	1380	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	348	348	348	-	-	-	-	-	-	-	-
533x210x138 +		$M_{c,y,Rd}$	1250	1250	1250	1250	1080	1080	1080	1080	1080	1080	1080
$N_{pl,Rd}$ = 6070	1.00	$M_{c,z,Rd}$	196	196	196	196	125	125	125	125	125	125	125
	0.374	$M_{N,y,Rd}$	1250	1250	1250	1110	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	196	196	196	196	-	-	-	-	-	-	-
533x210x122		$M_{c,y,Rd}$	1100	1100	1100	964	964	964	964	964	964	✖	$
$N_{pl,Rd}$ = 5350	0.886	$M_{c,z,Rd}$	173	173	173	110	110	110	110	110	110	✖	$
	0.272	$M_{N,y,Rd}$	1100	1100	1100	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	173	173	173	-	-	-	-	-	-	-	-
533x210x109		$M_{c,y,Rd}$	976	976	976	855	855	855	855	855	✖	✖	$
$N_{pl,Rd}$ = 4800	0.766	$M_{c,z,Rd}$	150	150	150	96.3	96.3	96.3	96.3	96.3	✖	✖	$
	0.224	$M_{N,y,Rd}$	976	976	976	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	150	150	150	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
533x312x272 +	1.00	$N_{b,y,Rd}$	12000	12000	12000	11800	11700	11500	11300	11100	10900	10700	10500	10200	9840
$N_{pl,Rd}$ = 12000		$N_{b,z,Rd}$	11400	10600	9600	8410	7120	5910	4890	4060	3410	2900	2480	2150	1880
$f_y W_{el,y}$ = 2380	**1.00**	$M_{b,Rd}$	2710	2680	2550	2410	2280	2150	2030	1910	1790	1690	1590	1510	1430
$f_y W_{el,z}$ = 444															
533x312x219 +	1.00	$N_{b,y,Rd}$	9630	9630	9580	9460	9340	9200	9060	8900	8730	8530	8310	8070	7790
$N_{pl,Rd}$ = 9630		$N_{b,z,Rd}$	9120	8440	7600	6600	5530	4560	3760	3110	2610	2210	1900	1640	1430
$f_y W_{el,y}$ = 1860	**1.00**	$M_{b,Rd}$	2110	2070	1950	1830	1710	1590	1470	1360	1260	1180	1100	1020	962
$f_y W_{el,z}$ = 339															
533x312x182 +	1.00	$N_{b,y,Rd}$	7970	7970	7930	7830	7720	7610	7490	7360	7210	7050	6860	6660	6420
$N_{pl,Rd}$ = 7970		$N_{b,z,Rd}$	7540	6960	6260	5410	4530	3720	3060	2530	2120	1800	1540	1330	1160
$f_y W_{el,y}$ = 1550	**1.00**	$M_{b,Rd}$	1740	1700	1600	1490	1370	1260	1150	1050	965	887	819	760	709
$f_y W_{el,z}$ = 278															
* 533x312x150 +	0.886	$N_{b,y,Rd}$	6620	6620	6590	6500	6410	6320	6220	6110	5980	5840	5690	5510	5310
$N_{pl,Rd}$ = 6620		$N_{b,z,Rd}$	6260	5770	5170	4460	3720	3050	2500	2070	1730	1470	1250	1090	948
$f_y W_{el,y}$ = 1280	0.886	$M_{b,Rd}$	1280	1260	1190	1110	1020	939	856	778	709	649	596	550	511
$f_y W_{el,z}$ = 227	**0.220**	$M_{b,Rd}$	1430	1390	1300	1210	1100	1000	903	815	737	670	613	565	520
533x210x138 +	1.00	$N_{b,y,Rd}$	6070	6070	6030	5950	5860	5770	5670	5560	5440	5300	5150	4970	4770
$N_{pl,Rd}$ = 6070		$N_{b,z,Rd}$	5230	4300	3240	2370	1770	1350	1070	860	707	591	502	431	374
$f_y W_{el,y}$ = 1080	1.00	$M_{b,Rd}$	1060	937	821	715	626	552	492	444	403	370	342	318	297
$f_y W_{el,z}$ = 125	**0.374**	$M_{b,Rd}$	1200	1040	899	771	665	581	514	461	417	382	352	326	304
* 533x210x122	0.886	$N_{b,y,Rd}$	5350	5350	5310	5240	5160	5080	5000	4900	4790	4670	4530	4380	4200
$N_{pl,Rd}$ = 5350		$N_{b,z,Rd}$	4600	3780	2850	2080	1550	1190	936	754	620	519	440	378	328
$f_y W_{el,y}$ = 964	0.886	$M_{b,Rd}$	939	827	717	618	535	467	413	369	334	305	281	260	242
$f_y W_{el,z}$ = 110	**0.272**	$M_{b,Rd}$	1060	916	781	662	565	489	429	382	344	313	288	266	246
* 533x210x109	0.766	$N_{b,y,Rd}$	4800	4800	4760	4690	4630	4550	4470	4390	4290	4180	4050	3910	3750
$N_{pl,Rd}$ = 4800		$N_{b,z,Rd}$	4110	3350	2500	1830	1360	1040	816	658	541	452	384	329	286
$f_y W_{el,y}$ = 855	0.766	$M_{b,Rd}$	829	725	623	531	454	392	344	306	275	250	229	211	196
$f_y W_{el,z}$ = 96.3	**0.224**	$M_{b,Rd}$	930	801	676	566	478	409	356	315	282	256	234	213	196

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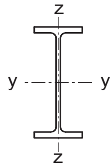
+ These sections are in addition to the range of BS 4 sections
n = N_{Ed} / $N_{pl,Rd}$
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.
For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
533x210x101		$M_{c,y,Rd}$	901	901	791	791	791	791	791	✖	✖	✖	$
$N_{pl,Rd}$ = 4450	0.678	$M_{c,z,Rd}$	138	138	88.3	88.3	88.3	88.3	88.3	✖	✖	✖	$
	0.186	$M_{N,y,Rd}$	901	901	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	138	138	-	-	-	-	-	-	-	-	-
533x210x92		$M_{c,y,Rd}$	838	838	736	736	736	736	✖	✖	✖	✖	$
$N_{pl,Rd}$ = 4150	0.586	$M_{c,z,Rd}$	126	126	80.9	80.9	80.9	80.9	✖	✖	✖	✖	$
	0.150	$M_{N,y,Rd}$	838	838	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	126	126	-	-	-	-	-	-	-	-	-
533x210x82		$M_{c,y,Rd}$	731	731	639	639	639	639	✖	✖	✖	$	$
$N_{pl,Rd}$ = 3730	0.533	$M_{c,z,Rd}$	107	107	68.2	68.2	68.2	68.2	✖	✖	✖	$	$
	0.132	$M_{N,y,Rd}$	731	731	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	107	107	-	-	-	-	-	-	-	-	-
533x165x85 +		$M_{c,y,Rd}$	726	726	627	627	627	627	627	✖	✖	✖	$
$N_{pl,Rd}$ = 3730	0.624	$M_{c,z,Rd}$	83.8	83.8	52.8	52.8	52.8	52.8	52.8	✖	✖	✖	$
	0.184	$M_{N,y,Rd}$	726	726	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	83.8	83.8	-	-	-	-	-	-	-	-	-
533x165x74 +		$M_{c,y,Rd}$	642	642	551	551	551	551	✖	✖	✖	$	$
$N_{pl,Rd}$ = 3380	0.543	$M_{c,z,Rd}$	71.0	71.0	44.4	44.4	44.4	44.4	✖	✖	✖	$	$
	0.153	$M_{N,y,Rd}$	642	642	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	71.0	71.0	-	-	-	-	-	-	-	-	-
533x165x66 +		$M_{c,y,Rd}$	554	554	474	474	474	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 2970	0.457	$M_{c,z,Rd}$	58.9	58.9	36.9	36.9	36.9	✖	✖	✖	✖	$	$
	0.111	$M_{N,y,Rd}$	554	554	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	58.9	58.9	-	-	-	-	-	-	-	-	-
457x191x161 +		$M_{c,y,Rd}$	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
$N_{pl,Rd}$ = 7110	n/a	$M_{c,z,Rd}$	232	232	232	232	232	232	232	232	232	232	232
	1.00	$M_{N,y,Rd}$	1300	1300	1290	1130	966	805	644	483	322	161	0
		$M_{N,z,Rd}$	232	232	232	232	232	223	203	170	126	68.8	0

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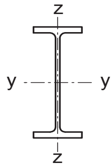
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
* 533x210x101	0.678	$N_{b,y,Rd}$	4450	4450	4420	4360	4290	4230	4150	4070	3980	3880	3760	3630	3480
$N_{pl,Rd}$ = 4450		$N_{b,z,Rd}$	3800	3090	2300	1680	1240	952	749	603	496	415	352	302	262
$f_y W_{el,y}$ = 791	0.678	$M_{b,Rd}$	765	667	570	482	409	352	307	271	243	220	201	185	169
$f_y W_{el,z}$ = 88.3	**0.186**	$M_{b,Rd}$	856	735	617	513	429	366	317	279	249	225	204	185	169
* 533x210x92	0.586	$N_{b,y,Rd}$	4150	4150	4120	4060	4000	3930	3860	3780	3690	3590	3470	3340	3200
$N_{pl,Rd}$ = 4150		$N_{b,z,Rd}$	3520	2820	2080	1500	1110	846	665	535	439	367	311	267	232
$f_y W_{el,y}$ = 736	0.586	$M_{b,Rd}$	706	611	516	431	361	307	266	233	208	187	170	154	140
$f_y W_{el,z}$ = 80.9	**0.150**	$M_{b,Rd}$	790	672	557	456	378	319	274	240	213	190	170	154	140
* 533x210x82	0.533	$N_{b,y,Rd}$	3730	3730	3690	3640	3580	3520	3450	3380	3300	3200	3090	2970	2830
$N_{pl,Rd}$ = 3730		$N_{b,z,Rd}$	3120	2470	1790	1280	946	721	565	455	373	312	264	227	197
$f_y W_{el,y}$ = 639	0.533	$M_{b,Rd}$	610	524	438	361	299	251	215	188	166	149	132	119	109
$f_y W_{el,z}$ = 68.2	**0.132**	$M_{b,Rd}$	684	577	472	381	312	260	222	193	170	149	132	119	109
* 533x165x85 +	0.624	$N_{b,y,Rd}$	3730	3730	3690	3640	3580	3520	3460	3390	3300	3210	3100	2980	2850
$N_{pl,Rd}$ = 3730		$N_{b,z,Rd}$	2810	1940	1270	874	631	475	370	296	243	202	171	146	127
$f_y W_{el,y}$ = 627	0.624	$M_{b,Rd}$	530	410	321	258	215	183	160	142	128	116	107	98.9	92.1
$f_y W_{el,z}$ = 52.8	**0.184**	$M_{b,Rd}$	589	444	341	271	224	190	165	146	131	119	109	101	94.2
* 533x165x74 +	0.543	$N_{b,y,Rd}$	3380	3380	3340	3290	3240	3180	3120	3050	2970	2880	2770	2650	2520
$N_{pl,Rd}$ = 3380		$N_{b,z,Rd}$	2460	1630	1060	719	517	389	302	242	198	165	139	119	103
$f_y W_{el,y}$ = 551	0.543	$M_{b,Rd}$	455	344	264	209	171	144	125	110	98.4	89.2	81.6	75.2	69.9
$f_y W_{el,z}$ = 44.4	**0.153**	$M_{b,Rd}$	506	372	280	219	178	149	129	113	101	91.4	83.5	76.9	71.1
* 533x165x66 +	0.457	$N_{b,y,Rd}$	2970	2970	2930	2890	2840	2790	2740	2670	2600	2520	2420	2310	2190
$N_{pl,Rd}$ = 2970		$N_{b,z,Rd}$	2120	1380	881	598	429	322	251	200	164	136	115	98.8	85.6
$f_y W_{el,y}$ = 474	0.457	$M_{b,Rd}$	385	287	217	170	137	115	98.6	86.4	76.9	69.3	63.2	58.1	53.8
$f_y W_{el,z}$ = 36.9	**0.111**	$M_{b,Rd}$	428	311	230	177	143	119	102	88.7	78.8	70.9	64.6	58.8	53.8
457x191x161 +	1.00	$N_{b,y,Rd}$	7110	7110	7010	6900	6780	6660	6510	6350	6170	5950	5710	5440	5140
$N_{pl,Rd}$ = 7110		$N_{b,z,Rd}$	6060	4920	3660	2660	1970	1510	1190	955	785	657	557	478	415
$f_y W_{el,y}$ = 1120	**1.00**	$M_{b,Rd}$	1250	1110	985	876	785	708	644	590	544	505	471	441	415
$f_y W_{el,z}$ = 147															

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+ These sections are in addition to the range of BS 4 sections

n = N_{Ed} / $N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 N_{Ed} / $N_{pl,Rd}$ limit is exceeded.

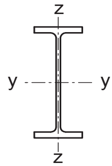
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance n = N_{Ed} / $N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
457x191x133 +		$M_{c,y,Rd}$	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060
$N_{pl,Rd}$ = 5870	n/a	$M_{c,z,Rd}$	185	185	185	185	185	185	185	185	185	185	185
	1.00	$M_{N,y,Rd}$	1060	1060	1050	922	790	658	527	395	263	132	0
		$M_{N,z,Rd}$	185	185	185	185	185	179	163	137	101	55.7	0
457x191x106 +		$M_{c,y,Rd}$	824	824	824	824	719	719	719	719	719	719	719
$N_{pl,Rd}$ = 4660	1.00	$M_{c,z,Rd}$	140	140	140	140	89.4	89.4	89.4	89.4	89.4	89.4	89.4
	0.359	$M_{N,y,Rd}$	824	824	824	725	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	140	140	140	140	-	-	-	-	-	-	-
457x191x98		$M_{c,y,Rd}$	770	770	770	675	675	675	675	675	675	675	$
$N_{pl,Rd}$ = 4310	0.954	$M_{c,z,Rd}$	131	131	131	83.8	83.8	83.8	83.8	83.8	83.8	83.8	$
	0.287	$M_{N,y,Rd}$	770	770	768	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	131	131	131	-	-	-	-	-	-	-	-
457x191x89		$M_{c,y,Rd}$	695	695	695	611	611	611	611	611	611	✖	$
$N_{pl,Rd}$ = 3930	0.839	$M_{c,z,Rd}$	117	117	117	75.2	75.2	75.2	75.2	75.2	75.2	✖	$
	0.242	$M_{N,y,Rd}$	695	695	695	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	117	117	117	-	-	-	-	-	-	-	-
457x191x82		$M_{c,y,Rd}$	650	650	650	572	572	572	572	572	✖	✖	$
$N_{pl,Rd}$ = 3690	0.745	$M_{c,z,Rd}$	108	108	108	69.6	69.6	69.6	69.6	69.6	✖	✖	$
	0.210	$M_{N,y,Rd}$	650	650	650	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	108	108	108	-	-	-	-	-	-	-	-
457x191x74		$M_{c,y,Rd}$	587	587	518	518	518	518	518	✖	✖	✖	$
$N_{pl,Rd}$ = 3360	0.632	$M_{c,z,Rd}$	96.6	96.6	62.5	62.5	62.5	62.5	62.5	✖	✖	✖	$
	0.161	$M_{N,y,Rd}$	587	587	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	96.6	96.6	-	-	-	-	-	-	-	-	-
457x191x67		$M_{c,y,Rd}$	522	522	460	460	460	460	✖	✖	✖	✖	$
$N_{pl,Rd}$ = 3040	0.569	$M_{c,z,Rd}$	84.1	84.1	54.3	54.3	54.3	54.3	✖	✖	✖	✖	$
	0.139	$M_{N,y,Rd}$	522	522	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	84.1	84.1	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

\+ These sections are in addition to the range of BS 4 sections

N_{Ed} = Design value of the axial force.

n = N_{Ed} / $N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

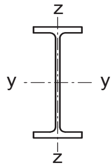
$ For these values of N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

\- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
457x191x133 +	1.00	$N_{b,y,Rd}$	5870	5870	5780	5690	5590	5480	5360	5220	5060	4880	4670	4440	4180
$N_{pl,Rd}$ = 5870		$N_{b,z,Rd}$	4960	3980	2930	2110	1560	1190	936	753	619	517	439	377	327
$f_y W_{el,y}$ = 917	**1.00**	$M_{b,Rd}$	1010	880	765	667	586	521	468	424	388	358	332	310	291
$f_y W_{el,z}$ = 118															
457x191x106 +	1.00	$N_{b,y,Rd}$	4660	4650	4580	4510	4430	4340	4240	4130	3990	3840	3670	3470	3260
$N_{pl,Rd}$ = 4660		$N_{b,z,Rd}$	3900	3090	2240	1610	1180	901	707	569	467	390	331	284	246
$f_y W_{el,y}$ = 719	1.00	$M_{b,Rd}$	688	601	519	448	389	342	305	274	249	229	211	197	184
$f_y W_{el,z}$ = 89.4	**0.359**	$M_{b,Rd}$	774	665	564	478	411	358	317	284	257	235	217	201	187
* 457x191x98	0.954	$N_{b,y,Rd}$	4310	4310	4250	4180	4100	4020	3930	3820	3700	3560	3400	3230	3030
$N_{pl,Rd}$ = 4310		$N_{b,z,Rd}$	3620	2870	2080	1490	1100	838	657	529	434	363	308	264	229
$f_y W_{el,y}$ = 675	0.954	$M_{b,Rd}$	645	561	482	413	356	312	276	248	225	206	190	176	164
$f_y W_{el,z}$ = 83.8	**0.287**	$M_{b,Rd}$	721	618	521	439	375	325	286	256	231	211	194	180	165
* 457x191x89	0.839	$N_{b,y,Rd}$	3930	3930	3870	3810	3740	3660	3580	3480	3370	3240	3100	2930	2750
$N_{pl,Rd}$ = 3930		$N_{b,z,Rd}$	3290	2590	1870	1340	987	751	589	474	389	325	276	236	205
$f_y W_{el,y}$ = 611	0.839	$M_{b,Rd}$	581	502	427	362	309	268	236	211	190	173	159	148	136
$f_y W_{el,z}$ = 75.2	**0.242**	$M_{b,Rd}$	648	551	460	384	324	279	244	217	195	177	163	148	136
* 457x191x82	0.745	$N_{b,y,Rd}$	3690	3680	3630	3570	3500	3430	3340	3250	3140	3010	2860	2700	2520
$N_{pl,Rd}$ = 3690		$N_{b,z,Rd}$	3060	2370	1690	1200	882	670	525	422	346	289	245	210	182
$f_y W_{el,y}$ = 572	0.745	$M_{b,Rd}$	539	462	388	324	274	235	205	182	164	149	136	124	114
$f_y W_{el,z}$ = 69.6	**0.210**	$M_{b,Rd}$	601	506	416	342	285	243	211	187	167	152	136	124	114
* 457x191x74	0.632	$N_{b,y,Rd}$	3360	3350	3300	3240	3180	3120	3040	2950	2850	2740	2600	2450	2290
$N_{pl,Rd}$ = 3360		$N_{b,z,Rd}$	2770	2140	1520	1080	792	602	471	379	311	259	220	189	164
$f_y W_{el,y}$ = 518	0.632	$M_{b,Rd}$	486	414	345	285	238	203	176	155	139	126	114	103	94.5
$f_y W_{el,z}$ = 62.5	**0.161**	$M_{b,Rd}$	540	452	368	300	248	210	181	159	142	126	114	103	94.5
* 457x191x67	0.569	$N_{b,y,Rd}$	3040	3030	2980	2930	2870	2810	2740	2660	2560	2450	2330	2190	2040
$N_{pl,Rd}$ = 3040		$N_{b,z,Rd}$	2490	1900	1340	946	692	525	411	330	271	226	192	164	143
$f_y W_{el,y}$ = 460	0.569	$M_{b,Rd}$	430	364	299	245	202	171	147	129	114	102	91.6	82.9	75.8
$f_y W_{el,z}$ = 54.3	**0.139**	$M_{b,Rd}$	478	397	319	257	210	176	151	132	116	102	91.6	82.9	75.8

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

$n = N_{Ed} / N_{pl,Rd}$

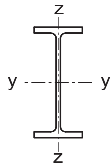
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
457x152x82		$M_{c,y,Rd}$	625	625	625	542	542	542	542	542	542	✖	$
$N_{pl,Rd}$ = 3620	0.839	$M_{c,z,Rd}$	82.8	82.8	82.8	52.8	52.8	52.8	52.8	52.8	52.8	✖	$
	0.263	$M_{N,y,Rd}$	625	625	625	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	82.8	82.8	82.8	-	-	-	-	-	-	-	-
457x152x74		$M_{c,y,Rd}$	561	561	561	488	488	488	488	488	✖	✖	$
$N_{pl,Rd}$ = 3260	0.725	$M_{c,z,Rd}$	73.5	73.5	73.5	46.9	46.9	46.9	46.9	46.9	✖	✖	$
	0.214	$M_{N,y,Rd}$	561	561	561	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	73.5	73.5	73.5	-	-	-	-	-	-	-	-
457x152x67		$M_{c,y,Rd}$	516	516	448	448	448	448	448	✖	✖	✖	$
$N_{pl,Rd}$ = 3040	0.632	$M_{c,z,Rd}$	66.4	66.4	42.2	42.2	42.2	42.2	42.2	✖	✖	✖	$
	0.177	$M_{N,y,Rd}$	516	516	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	66.4	66.4	-	-	-	-	-	-	-	-	-
457x152x60		$M_{c,y,Rd}$	457	457	398	398	398	398	✖	✖	✖	$	$
$N_{pl,Rd}$ = 2710	0.519	$M_{c,z,Rd}$	57.9	57.9	36.9	36.9	36.9	36.9	✖	✖	✖	$	$
	0.125	$M_{N,y,Rd}$	457	457	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	57.9	57.9	-	-	-	-	-	-	-	-	-
457x152x52		$M_{c,y,Rd}$	389	389	337	337	337	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 2360	0.456	$M_{c,z,Rd}$	47.2	47.2	30.2	30.2	30.2	✖	✖	✖	✖	$	$
	0.101	$M_{N,y,Rd}$	389	389	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	47.2	47.2	-	-	-	-	-	-	-	-	-
406x178x85 +		$M_{c,y,Rd}$	598	598	598	598	524	524	524	524	524	524	524
$N_{pl,Rd}$ = 3760	1.00	$M_{c,z,Rd}$	108	108	108	108	69.3	69.3	69.3	69.3	69.3	69.3	69.3
	0.326	$M_{N,y,Rd}$	598	598	595	521	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	108	108	108	108	-	-	-	-	-	-	-
406x178x74		$M_{c,y,Rd}$	533	533	533	470	470	470	470	470	470	✖	$
$N_{pl,Rd}$ = 3350	0.851	$M_{c,z,Rd}$	94.8	94.8	94.8	61.1	61.1	61.1	61.1	61.1	61.1	✖	$
	0.239	$M_{N,y,Rd}$	533	533	530	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	94.8	94.8	94.8	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

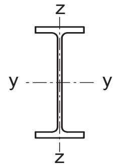
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 457x152x82	0.839	$N_{b,y,Rd}$	3620	3620	3620	3620	3620	3590	3560	3500	3440	3370	3290	3190	3090
$N_{pl,Rd}$ = 3620		$N_{b,z,Rd}$	3380	3080	2700	2260	1840	1480	1200	820	591	445	346	277	227
$f_y W_{el,y}$ = 542	0.839	$M_{b,Rd}$	542	525	481	439	398	359	325	270	228	198	174	156	141
$f_y W_{el,z}$ = 52.8	**0.263**	$M_{b,Rd}$	625	593	539	485	434	388	347	283	238	204	179	160	144
* 457x152x74	0.725	$N_{b,y,Rd}$	3260	3260	3260	3260	3250	3230	3200	3150	3090	3030	2950	2870	2770
$N_{pl,Rd}$ = 3260		$N_{b,z,Rd}$	3040	2760	2410	2010	1630	1310	1060	722	520	391	305	244	199
$f_y W_{el,y}$ = 488	0.725	$M_{b,Rd}$	488	470	430	390	351	315	283	232	194	167	146	130	117
$f_y W_{el,z}$ = 46.9	**0.214**	$M_{b,Rd}$	561	530	480	430	382	339	301	243	201	172	150	133	118
* 457x152x67	0.632	$N_{b,y,Rd}$	3040	3040	3040	3040	3030	3010	2980	2930	2870	2810	2740	2660	2560
$N_{pl,Rd}$ = 3040		$N_{b,z,Rd}$	2810	2540	2200	1810	1450	1160	935	636	457	343	267	214	175
$f_y W_{el,y}$ = 448	0.632	$M_{b,Rd}$	448	428	389	350	312	278	247	199	164	140	122	108	95.1
$f_y W_{el,z}$ = 42.2	**0.177**	$M_{b,Rd}$	516	483	434	385	338	297	261	207	170	144	125	108	95.1
* 457x152x60	0.519	$N_{b,y,Rd}$	2710	2710	2710	2710	2700	2670	2650	2610	2560	2500	2440	2360	2270
$N_{pl,Rd}$ = 2710		$N_{b,z,Rd}$	2500	2250	1940	1590	1270	1010	815	554	398	299	232	186	152
$f_y W_{el,y}$ = 398	0.519	$M_{b,Rd}$	398	379	343	307	272	240	212	168	137	116	99.9	87.0	76.3
$f_y W_{el,z}$ = 36.9	**0.125**	$M_{b,Rd}$	457	425	381	336	293	255	223	174	142	119	101	87.0	76.3
* 457x152x52	0.456	$N_{b,y,Rd}$	2360	2360	2360	2360	2350	2330	2320	2270	2230	2180	2120	2050	1970
$N_{pl,Rd}$ = 2360		$N_{b,z,Rd}$	2170	1940	1650	1330	1050	833	668	452	324	243	189	151	123
$f_y W_{el,y}$ = 337	0.456	$M_{b,Rd}$	337	318	287	254	223	195	170	132	107	89.0	75.6	64.5	56.3
$f_y W_{el,z}$ = 30.2	**0.101**	$M_{b,Rd}$	389	359	319	279	241	207	179	137	110	91.1	75.6	64.5	56.3
406x178x85 +	1.00	$N_{b,y,Rd}$	3760	3760	3760	3760	3740	3710	3670	3610	3530	3440	3340	3220	3090
$N_{pl,Rd}$ = 3760		$N_{b,z,Rd}$	3610	3370	3090	2760	2390	2020	1690	1200	876	665	521	418	343
$f_y W_{el,y}$ = 524	1.00	$M_{b,Rd}$	524	524	494	460	427	395	364	312	269	236	210	189	171
$f_y W_{el,z}$ = 69.3	**0.326**	$M_{b,Rd}$	598	594	552	509	468	429	393	330	282	246	217	194	176
* 406x178x74	0.851	$N_{b,y,Rd}$	3350	3350	3350	3350	3330	3300	3270	3210	3140	3060	2970	2850	2730
$N_{pl,Rd}$ = 3350		$N_{b,z,Rd}$	3200	2990	2720	2410	2060	1730	1440	1010	739	560	438	352	289
$f_y W_{el,y}$ = 470	0.851	$M_{b,Rd}$	470	470	437	404	372	341	312	261	222	192	169	151	136
$f_y W_{el,z}$ = 61.1	**0.239**	$M_{b,Rd}$	533	525	485	445	406	368	333	275	231	199	174	155	139

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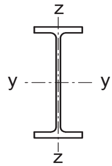
+ These sections are in addition to the range of BS 4 sections
$n = N_{Ed} / N_{pl,Rd}$
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.
For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



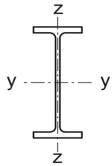
Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
406x178x67		$M_{c,y,Rd}$	478	478	478	422	422	422	422	422	✖	✖	$
$N_{pl,Rd}$ = 3040	0.752	$M_{c,z,Rd}$	84.1	84.1	84.1	54.3	54.3	54.3	54.3	54.3	✖	✖	$
	0.203	$M_{N,y,Rd}$	478	478	478	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	84.1	84.1	84.1	-	-	-	-	-	-	-	-
406x178x60		$M_{c,y,Rd}$	426	426	377	377	377	377	377	✖	✖	✖	$
$N_{pl,Rd}$ = 2720	0.624	$M_{c,z,Rd}$	74.2	74.2	47.9	47.9	47.9	47.9	47.9	✖	✖	✖	$
	0.151	$M_{N,y,Rd}$	426	426	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	74.2	74.2	-	-	-	-	-	-	-	-	-
406x178x54		$M_{c,y,Rd}$	375	375	330	330	330	330	✖	✖	✖	✖	$
$N_{pl,Rd}$ = 2450	0.595	$M_{c,z,Rd}$	63.2	63.2	40.8	40.8	40.8	40.8	✖	✖	✖	✖	$
	0.150	$M_{N,y,Rd}$	375	375	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	63.2	63.2	-	-	-	-	-	-	-	-	-
406x140x53 +		$M_{c,y,Rd}$	366	366	319	319	319	319	319	✖	✖	✖	$
$N_{pl,Rd}$ = 2410	0.624	$M_{c,z,Rd}$	49.3	49.3	31.6	31.6	31.6	31.6	31.6	✖	✖	✖	$
	0.170	$M_{N,y,Rd}$	366	366	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	49.3	49.3	-	-	-	-	-	-	-	-	-
406x140x46		$M_{c,y,Rd}$	315	276	276	276	276	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 2080	0.467	$M_{c,z,Rd}$	41.9	27.0	27.0	27.0	27.0	✖	✖	✖	✖	$	$
	0.097	$M_{N,y,Rd}$	315	-	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	41.9	-	-	-	-	-	-	-	-	-	-
406x140x39		$M_{c,y,Rd}$	257	223	223	223	223	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 1760	0.410	$M_{c,z,Rd}$	32.3	20.6	20.6	20.6	20.6	✖	✖	✖	✖	$	$
	0.078	$M_{N,y,Rd}$	257	-	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	32.3	-	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 406x178x67	0.752	$N_{b,y,Rd}$	3040	3040	3040	3040	3010	2990	2960	2900	2840	2760	2680	2580	2460
$N_{pl,Rd}$ = 3040		$N_{b,z,Rd}$	2890	2690	2450	2160	1840	1540	1280	897	654	496	388	311	255
$f_y W_{el,y}$ = 422	0.752	$M_{b,Rd}$	422	421	391	360	330	301	273	226	190	163	142	126	114
$f_y W_{el,z}$ = 54.3	**0.203**	$M_{b,Rd}$	478	470	433	396	359	323	291	237	198	168	146	129	116
* 406x178x60	0.624	$N_{b,y,Rd}$	2720	2720	2720	2720	2700	2670	2650	2590	2540	2470	2390	2300	2190
$N_{pl,Rd}$ = 2720		$N_{b,z,Rd}$	2590	2410	2190	1930	1640	1370	1130	795	580	439	344	276	226
$f_y W_{el,y}$ = 377	0.624	$M_{b,Rd}$	377	375	347	319	291	264	239	195	162	138	120	105	94.3
$f_y W_{el,z}$ = 47.9	**0.151**	$M_{b,Rd}$	426	418	384	350	316	283	253	204	168	142	122	108	95.5
* 406x178x54	0.595	$N_{b,y,Rd}$	2450	2450	2450	2450	2430	2410	2380	2340	2280	2220	2150	2060	1960
$N_{pl,Rd}$ = 2450		$N_{b,z,Rd}$	2330	2160	1950	1700	1430	1180	978	681	495	375	293	235	192
$f_y W_{el,y}$ = 330	0.595	$M_{b,Rd}$	330	327	302	276	251	226	202	163	134	113	97.0	85.0	75.3
$f_y W_{el,z}$ = 40.8	**0.150**	$M_{b,Rd}$	375	365	334	303	272	242	215	170	139	116	99.3	86.6	75.3
* 406x140x53 +	0.624	$N_{b,y,Rd}$	2410	2410	2410	2410	2390	2370	2350	2300	2240	2180	2110	2020	1920
$N_{pl,Rd}$ = 2410		$N_{b,z,Rd}$	2210	1970	1660	1330	1050	827	663	448	321	241	187	149	122
$f_y W_{el,y}$ = 319	0.624	$M_{b,Rd}$	319	299	269	239	211	185	164	130	108	91.4	79.4	69.5	61.3
$f_y W_{el,z}$ = 31.6	**0.170**	$M_{b,Rd}$	366	335	298	261	226	197	172	135	111	93.7	80.3	69.5	61.3
* 406x140x46	0.467	$N_{b,y,Rd}$	2080	2080	2080	2080	2060	2040	2020	1980	1940	1880	1820	1750	1660
$N_{pl,Rd}$ = 2080		$N_{b,z,Rd}$	1900	1690	1420	1140	892	703	563	380	272	204	158	126	103
$f_y W_{el,y}$ = 276	0.467	$M_{b,Rd}$	276	257	230	203	177	155	135	106	86.2	72.4	62.0	53.3	46.8
$f_y W_{el,z}$ = 27.0	**0.097**	$M_{b,Rd}$	315	287	254	220	190	163	141	110	88.5	74.0	62.0	53.3	46.8
* 406x140x39	0.410	$N_{b,y,Rd}$	1760	1760	1760	1760	1750	1730	1710	1680	1630	1590	1530	1460	1380
$N_{pl,Rd}$ = 1760		$N_{b,z,Rd}$	1590	1400	1150	903	698	545	434	292	208	156	121	96.7	78.9
$f_y W_{el,y}$ = 223	0.410	$M_{b,Rd}$	223	205	182	159	137	117	101	77.7	62.1	51.3	42.6	36.4	31.7
$f_y W_{el,z}$ = 20.6	**0.078**	$M_{b,Rd}$	257	230	201	172	146	124	106	80.2	63.7	51.3	42.6	36.4	31.7

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

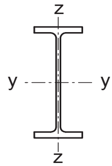
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
356x171x67		$M_{c,y,Rd}$	430	430	430	380	380	380	380	380	380	380	$
$N_{pl,Rd}$ = 3040	0.997	$M_{c,z,Rd}$	86.3	86.3	86.3	55.7	55.7	55.7	55.7	55.7	55.7	55.7	$
	0.272	$M_{N,y,Rd}$	430	430	420	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	86.3	86.3	86.3	-	-	-	-	-	-	-	-
356x171x57		$M_{c,y,Rd}$	359	359	359	318	318	318	318	318	318	✖	$
$N_{pl,Rd}$ = 2580	0.832	$M_{c,z,Rd}$	70.6	70.6	70.6	45.8	45.8	45.8	45.8	45.8	45.8	✖	$
	0.222	$M_{N,y,Rd}$	359	359	355	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	70.6	70.6	70.6	-	-	-	-	-	-	-	-
356x171x51		$M_{c,y,Rd}$	318	318	283	283	283	283	283	283	✖	✖	$
$N_{pl,Rd}$ = 2300	0.717	$M_{c,z,Rd}$	61.8	61.8	40.1	40.1	40.1	40.1	40.1	40.1	✖	✖	$
	0.181	$M_{N,y,Rd}$	318	318	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	61.8	61.8	-	-	-	-	-	-	-	-	-
356x171x45		$M_{c,y,Rd}$	275	275	244	244	244	244	244	✖	✖	✖	$
$N_{pl,Rd}$ = 2030	0.651	$M_{c,z,Rd}$	52.2	52.2	33.7	33.7	33.7	33.7	33.7	✖	✖	✖	$
	0.166	$M_{N,y,Rd}$	275	275	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	52.2	52.2	-	-	-	-	-	-	-	-	-
356x127x39		$M_{c,y,Rd}$	234	234	204	204	204	204	✖	✖	✖	✖	$
$N_{pl,Rd}$ = 1770	0.586	$M_{c,z,Rd}$	31.6	31.6	20.2	20.2	20.2	20.2	✖	✖	✖	✖	$
	0.150	$M_{N,y,Rd}$	234	234	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	31.6	31.6	-	-	-	-	-	-	-	-	-
356x127x33		$M_{c,y,Rd}$	193	193	168	168	168	✖	✖	✖	✖	$	$
$N_{pl,Rd}$ = 1490	0.487	$M_{c,z,Rd}$	24.9	24.9	16.0	16.0	16.0	✖	✖	✖	✖	$	$
	0.112	$M_{N,y,Rd}$	193	193	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	24.9	24.9	-	-	-	-	-	-	-	-	-

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

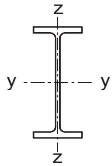
- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 356x171x67	0.997	$N_{b,y,Rd}$	3040	3040	3040	3020	2990	2960	2930	2860	2790	2690	2580	2450	2290
$N_{pl,Rd}$ = 3040		$N_{b,z,Rd}$	2890	2690	2450	2160	1840	1540	1280	897	654	496	388	311	255
$f_y W_{el,y}$ = 380	0.997	$M_{b,Rd}$	380	379	352	326	300	276	253	215	184	161	142	128	116
$f_y W_{el,z}$ = 55.7	**0.272**	$M_{b,Rd}$	430	422	390	358	327	297	271	226	192	166	147	131	119
* 356x171x57	0.832	$N_{b,y,Rd}$	2580	2580	2580	2570	2540	2510	2490	2430	2360	2280	2180	2060	1930
$N_{pl,Rd}$ = 2580		$N_{b,z,Rd}$	2450	2280	2060	1810	1530	1270	1050	736	536	405	317	254	208
$f_y W_{el,y}$ = 318	0.832	$M_{b,Rd}$	318	315	292	268	245	223	203	168	142	122	107	95.1	85.7
$f_y W_{el,z}$ = 45.8	**0.222**	$M_{b,Rd}$	359	350	322	294	266	239	215	176	147	126	110	97.3	87.5
* 356x171x51	0.717	$N_{b,y,Rd}$	2300	2300	2300	2290	2270	2250	2220	2170	2110	2030	1940	1840	1710
$N_{pl,Rd}$ = 2300		$N_{b,z,Rd}$	2190	2030	1830	1600	1350	1120	923	644	468	354	277	222	182
$f_y W_{el,y}$ = 283	0.717	$M_{b,Rd}$	283	279	258	236	215	194	175	143	119	102	88.5	78.3	70.2
$f_y W_{el,z}$ = 40.1	**0.181**	$M_{b,Rd}$	318	310	284	258	232	208	186	150	124	105	90.7	80.0	71.0
* 356x171x45	0.651	$N_{b,y,Rd}$	2030	2030	2030	2020	2000	1980	1960	1910	1850	1780	1700	1600	1490
$N_{pl,Rd}$ = 2030		$N_{b,z,Rd}$	1920	1780	1600	1380	1160	952	783	543	394	298	233	186	153
$f_y W_{el,y}$ = 244	0.651	$M_{b,Rd}$	244	240	221	201	182	163	146	117	96.6	81.4	70.2	61.6	54.5
$f_y W_{el,z}$ = 33.7	**0.166**	$M_{b,Rd}$	275	266	243	220	196	174	154	122	99.7	83.5	71.7	62.5	54.5
* 356x127x39	0.586	$N_{b,y,Rd}$	1770	1770	1770	1760	1740	1720	1700	1660	1610	1540	1470	1380	1280
$N_{pl,Rd}$ = 1770		$N_{b,z,Rd}$	1570	1350	1080	825	628	487	386	258	184	137	106	84.9	69.3
$f_y W_{el,y}$ = 204	0.586	$M_{b,Rd}$	204	183	161	139	120	104	90.7	71.5	58.7	49.8	42.5	36.9	32.7
$f_y W_{el,z}$ = 20.2	**0.150**	$M_{b,Rd}$	231	204	176	150	128	109	94.4	73.7	60.2	50.2	42.5	36.9	32.7
* 356x127x33	0.487	$N_{b,y,Rd}$	1490	1490	1490	1480	1470	1450	1430	1400	1350	1300	1230	1150	1060
$N_{pl,Rd}$ = 1490		$N_{b,z,Rd}$	1320	1120	878	661	500	386	305	203	145	108	83.7	66.7	54.4
$f_y W_{el,y}$ = 168	0.487	$M_{b,Rd}$	167	148	129	110	93.5	79.7	68.6	53.0	42.8	35.3	29.7	25.6	22.6
$f_y W_{el,z}$ = 16.0	**0.112**	$M_{b,Rd}$	189	165	141	118	98.9	83.3	71.2	54.5	43.5	35.3	29.7	25.6	22.6

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

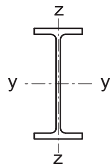
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
305x165x54		$M_{c,y,Rd}$	300	300	300	268	268	268	268	268	268	268	268
$N_{pl,Rd}$ = 2440	1.00	$M_{c,z,Rd}$	69.6	69.6	69.6	45.1	45.1	45.1	45.1	45.1	45.1	45.1	45.1
	0.260	$M_{N,y,Rd}$	300	300	289	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	69.6	69.6	69.6	-	-	-	-	-	-	-	-
305x165x46		$M_{c,y,Rd}$	256	256	229	229	229	229	229	229	✖	✖	$
$N_{pl,Rd}$ = 2080	0.795	$M_{c,z,Rd}$	58.9	58.9	38.3	38.3	38.3	38.3	38.3	38.3	✖	✖	$
	0.180	$M_{N,y,Rd}$	256	256	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	58.9	58.9	-	-	-	-	-	-	-	-	-
305x165x40		$M_{c,y,Rd}$	221	221	199	199	199	199	199	✖	✖	✖	$
$N_{pl,Rd}$ = 1820	0.660	$M_{c,z,Rd}$	50.4	50.4	33.0	33.0	33.0	33.0	33.0	✖	✖	✖	$
	0.138	$M_{N,y,Rd}$	221	221	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	50.4	50.4	-	-	-	-	-	-	-	-	-
305x127x48		$M_{c,y,Rd}$	252	252	252	252	252	252	252	252	252	252	252
$N_{pl,Rd}$ = 2170	n/a	$M_{c,z,Rd}$	41.2	41.2	41.2	41.2	41.2	41.2	41.2	41.2	41.2	41.2	41.2
	1.00	$M_{N,y,Rd}$	252	252	252	225	193	160	128	96.3	64.2	32.1	0
		$M_{N,z,Rd}$	41.2	41.2	41.2	41.2	41.2	40.5	37.4	31.8	23.7	13.1	0
305x127x42		$M_{c,y,Rd}$	218	218	218	218	190	190	190	190	190	190	190
$N_{pl,Rd}$ = 1900	1.00	$M_{c,z,Rd}$	34.8	34.8	34.8	34.8	22.4	22.4	22.4	22.4	22.4	22.4	22.4
	0.348	$M_{N,y,Rd}$	218	218	218	195	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	34.8	34.8	34.8	34.8	-	-	-	-	-	-	-
305x127x37		$M_{c,y,Rd}$	191	191	191	167	167	167	167	167	167	✖	$
$N_{pl,Rd}$ = 1680	0.872	$M_{c,z,Rd}$	30.2	30.2	30.2	19.2	19.2	19.2	19.2	19.2	19.2	✖	$
	0.272	$M_{N,y,Rd}$	191	191	191	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	30.2	30.2	30.2	-	-	-	-	-	-	-	-

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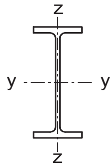
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
✖ Section becomes Class 4, see note 10.
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

BS EN 1993-1-1:2005
BS 4-1:2005

AXIAL FORCE & BENDING

S355 / Advance® 355

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
305x165x54	1.00	$N_{b,y,Rd}$	2440	2440	2440	2410	2390	2360	2330	2250	2170	2060	1940	1780	1610
$N_{pl,Rd}$ = 2440		$N_{b,z,Rd}$	2320	2160	1960	1720	1460	1210	1010	703	512	388	303	243	199
$f_y W_{el,y}$ = 268	1.00	$M_{b,Rd}$	268	266	252	238	223	207	192	164	141	123	108	96.3	85.2
$f_y W_{el,z}$ = 45.1	**0.260**	$M_{b,Rd}$	300	296	279	261	242	223	205	172	146	126	111	96.3	85.2
* 305x165x46	0.795	$N_{b,y,Rd}$	2080	2080	2080	2060	2040	2010	1980	1920	1850	1760	1650	1520	1380
$N_{pl,Rd}$ = 2080		$N_{b,z,Rd}$	1980	1840	1670	1460	1240	1030	848	592	431	326	255	205	168
$f_y W_{el,y}$ = 229	0.795	$M_{b,Rd}$	229	227	215	202	188	173	159	133	112	96.3	83.9	72.5	63.9
$f_y W_{el,z}$ = 38.3	**0.180**	$M_{b,Rd}$	256	251	236	220	203	185	168	138	116	98.7	83.9	72.5	63.9
* 305x165x40	0.660	$N_{b,y,Rd}$	1820	1820	1820	1800	1780	1760	1730	1680	1610	1530	1440	1320	1190
$N_{pl,Rd}$ = 1820		$N_{b,z,Rd}$	1730	1600	1450	1260	1070	884	730	509	370	280	219	175	144
$f_y W_{el,y}$ = 199	0.660	$M_{b,Rd}$	199	196	185	173	160	147	133	109	90.9	77.1	65.2	56.0	49.2
$f_y W_{el,z}$ = 33.0	**0.138**	$M_{b,Rd}$	221	216	203	188	173	156	141	114	93.4	78.0	65.2	56.0	49.2
305x127x48	1.00	$N_{b,y,Rd}$	2170	2170	2170	2140	2120	2090	2060	1990	1910	1810	1680	1530	1370
$N_{pl,Rd}$ = 2170		$N_{b,z,Rd}$	1940	1680	1360	1050	800	621	493	330	235	176	136	109	88.9
$f_y W_{el,y}$ = 219	**1.00**	$M_{b,Rd}$	251	224	199	175	154	136	121	99.5	84.3	73.1	64.6	57.8	51.5
$f_y W_{el,z}$ = 26.3															
305x127x42	1.00	$N_{b,y,Rd}$	1900	1900	1890	1870	1850	1820	1790	1740	1660	1570	1460	1330	1190
$N_{pl,Rd}$ = 1900		$N_{b,z,Rd}$	1690	1460	1170	894	682	529	419	280	200	149	116	92.4	75.4
$f_y W_{el,y}$ = 190	1.00	$M_{b,Rd}$	190	171	152	134	118	105	93.4	76.2	64.2	55.5	49.0	43.7	38.9
$f_y W_{el,z}$ = 22.4	**0.348**	$M_{b,Rd}$	216	192	168	146	127	111	97.9	79.0	66.2	57.0	49.9	43.7	38.9
* 305x127x37	0.872	$N_{b,y,Rd}$	1680	1680	1670	1650	1630	1610	1580	1530	1470	1380	1280	1160	1040
$N_{pl,Rd}$ = 1680		$N_{b,z,Rd}$	1490	1280	1020	778	592	459	363	243	173	129	100	79.9	65.2
$f_y W_{el,y}$ = 167	0.872	$M_{b,Rd}$	167	150	132	116	101	88.3	78.0	62.7	52.3	44.9	39.4	34.5	30.6
$f_y W_{el,z}$ = 19.2	**0.272**	$M_{b,Rd}$	189	167	145	125	107	92.9	81.4	64.8	53.8	46.0	39.4	34.5	30.6

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$n = N_{Ed} / N_{pl,Rd}$

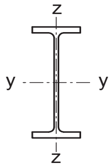
* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance n = N_{Ed} / $N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
305x102x33		$M_{c,y,Rd}$	171	171	171	148	148	148	148	148	✖	✖	$
$N_{pl,Rd}$ = 1480	0.726	$M_{c,z,Rd}$	21.3	21.3	21.3	13.5	13.5	13.5	13.5	13.5	✖	✖	$
	0.226	$M_{N,y,Rd}$	171	171	171	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	21.3	21.3	21.3	-	-	-	-	-	-	-	-
305x102x28		$M_{c,y,Rd}$	143	143	124	124	124	124	124	✖	✖	$	$
$N_{pl,Rd}$ = 1270	0.615	$M_{c,z,Rd}$	17.0	17.0	11.0	11.0	11.0	11.0	11.0	✖	✖	$	$
	0.182	$M_{N,y,Rd}$	143	143	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	17.0	17.0	-	-	-	-	-	-	-	-	-
305x102x25		$M_{c,y,Rd}$	121	121	104	104	104	104	✖	✖	✖	$	$
$N_{pl,Rd}$ = 1120	0.578	$M_{c,z,Rd}$	13.8	13.8	8.52	8.52	8.52	8.52	✖	✖	✖	$	$
	0.179	$M_{N,y,Rd}$	121	121	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	13.8	13.8	-	-	-	-	-	-	-	-	-
254x146x43		$M_{c,y,Rd}$	201	201	201	201	201	201	201	201	201	201	201
$N_{pl,Rd}$ = 1950	n/a	$M_{c,z,Rd}$	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1
	1.00	$M_{N,y,Rd}$	201	201	191	167	143	119	95.5	71.6	47.8	23.9	0
		$M_{N,z,Rd}$	50.1	50.1	50.1	50.1	49.3	46.5	41.5	34.3	25.0	13.6	0
254x146x37		$M_{c,y,Rd}$	171	171	171	154	154	154	154	154	154	154	$
$N_{pl,Rd}$ = 1680	0.975	$M_{c,z,Rd}$	42.2	42.2	42.2	27.7	27.7	27.7	27.7	27.7	27.7	27.7	$
	0.233	$M_{N,y,Rd}$	171	171	164	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	42.2	42.2	42.2	-	-	-	-	-	-	-	-
254x146x31		$M_{c,y,Rd}$	140	140	140	125	125	125	125	125	125	125	$
$N_{pl,Rd}$ = 1410	0.904	$M_{c,z,Rd}$	33.4	33.4	33.4	21.7	21.7	21.7	21.7	21.7	21.7	21.7	$
	0.238	$M_{N,y,Rd}$	140	140	137	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	33.4	33.4	33.4	-	-	-	-	-	-	-	-
254x102x28		$M_{c,y,Rd}$	125	125	125	109	109	109	109	109	109	109	$
$N_{pl,Rd}$ = 1280	0.934	$M_{c,z,Rd}$	19.5	19.5	19.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4	$
	0.295	$M_{N,y,Rd}$	125	125	125	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	19.5	19.5	19.5	-	-	-	-	-	-	-	-

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N_{Ed} = Design value of the axial force.

n = N_{Ed} / $N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

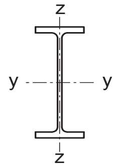
$ For these values of N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 305x102x33	0.726	$N_{b,y,Rd}$	1480	1480	1480	1460	1450	1430	1410	1360	1300	1230	1150	1050	939
$N_{pl,Rd}$ = 1480		$N_{b,z,Rd}$	1240	969	695	496	365	277	218	144	102	75.6	58.5	46.6	37.9
$f_y W_{el,y}$ = 148	0.726	$M_{b,Rd}$	141	122	103	87.0	73.8	63.5	55.5	44.2	36.8	31.0	26.6	23.4	20.8
$f_y W_{el,z}$ = 13.5	**0.226**	$M_{b,Rd}$	159	135	112	92.7	77.6	66.1	57.5	45.4	37.2	31.0	26.6	23.4	20.8
* 305x102x28	0.615	$N_{b,y,Rd}$	1270	1270	1270	1260	1240	1220	1200	1160	1110	1050	970	879	783
$N_{pl,Rd}$ = 1270		$N_{b,z,Rd}$	1050	807	570	404	296	224	176	116	81.9	61.0	47.1	37.5	30.5
$f_y W_{el,y}$ = 124	0.615	$M_{b,Rd}$	117	99.9	83.3	68.8	57.4	48.7	42.0	32.9	26.7	22.1	18.9	16.5	14.7
$f_y W_{el,z}$ = 11.0	**0.182**	$M_{b,Rd}$	132	111	90.2	73.1	60.1	50.5	43.4	33.7	26.7	22.1	18.9	16.5	14.7
* 305x102x25	0.578	$N_{b,y,Rd}$	1120	1120	1120	1100	1090	1070	1060	1020	971	911	838	755	669
$N_{pl,Rd}$ = 1120		$N_{b,z,Rd}$	901	672	464	324	236	179	140	92.0	65.0	48.3	37.3	29.7	24.2
$f_y W_{el,y}$ = 104	0.578	$M_{b,Rd}$	97.0	82.0	67.3	54.7	44.9	37.7	32.2	24.9	19.6	16.1	13.7	12.0	10.6
$f_y W_{el,z}$ = 8.52	**0.179**	$M_{b,Rd}$	111	91.3	72.9	58.0	47.0	39.1	33.2	25.0	19.6	16.1	13.7	12.0	10.6
254x146x43	1.00	$N_{b,y,Rd}$	1950	1950	1930	1900	1870	1840	1810	1730	1630	1500	1350	1190	1030
$N_{pl,Rd}$ = 1950		$N_{b,z,Rd}$	1820	1670	1480	1250	1020	829	675	463	335	252	197	157	129
$f_y W_{el,y}$ = 179	**1.00**	$M_{b,Rd}$	201	194	181	168	155	142	130	109	92.8	80.7	70.5	61.6	54.8
$f_y W_{el,z}$ = 32.7															
* 254x146x37	0.975	$N_{b,y,Rd}$	1680	1680	1660	1640	1610	1590	1560	1490	1400	1290	1150	1010	875
$N_{pl,Rd}$ = 1680		$N_{b,z,Rd}$	1570	1430	1260	1060	869	702	571	391	282	213	166	133	109
$f_y W_{el,y}$ = 154	0.975	$M_{b,Rd}$	154	149	140	130	120	110	100	83.4	70.6	61.1	52.9	46.1	40.9
$f_y W_{el,z}$ = 27.7	**0.233**	$M_{b,Rd}$	171	165	154	141	129	117	105	86.5	72.7	62.1	52.9	46.1	40.9
* 254x146x31	0.904	$N_{b,y,Rd}$	1410	1410	1390	1370	1350	1330	1300	1240	1160	1060	941	819	707
$N_{pl,Rd}$ = 1410		$N_{b,z,Rd}$	1310	1190	1040	865	698	560	453	309	223	168	130	104	85.3
$f_y W_{el,y}$ = 125	0.904	$M_{b,Rd}$	125	120	112	103	94.1	84.8	76.0	61.6	51.2	42.9	36.2	31.4	27.7
$f_y W_{el,z}$ = 21.7	**0.238**	$M_{b,Rd}$	140	133	123	112	101	89.8	79.7	63.7	52.4	42.9	36.2	31.4	27.7
* 254x102x28	0.934	$N_{b,y,Rd}$	1280	1280	1270	1250	1230	1210	1190	1130	1060	963	855	745	642
$N_{pl,Rd}$ = 1280		$N_{b,z,Rd}$	1080	860	627	451	333	254	199	132	93.3	69.5	53.7	42.8	34.9
$f_y W_{el,y}$ = 109	0.934	$M_{b,Rd}$	105	91.5	78.5	67.1	57.6	50.2	44.3	35.8	30.0	25.9	22.4	19.7	17.6
$f_y W_{el,z}$ = 12.4	**0.295**	$M_{b,Rd}$	118	101	85.2	71.5	60.7	52.3	45.9	36.8	30.8	26.0	22.4	19.7	17.6

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

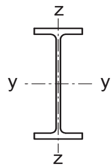
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL BEAMS
Advance® UKB



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
254x102x25		$M_{c,y,Rd}$	109	109	109	94.4	94.4	94.4	94.4	94.4	94.4	✖	$
$N_{pl,Rd}$ = 1140	0.866	$M_{c,z,Rd}$	16.3	16.3	16.3	10.3	10.3	10.3	10.3	10.3	10.3	✖	$
	0.285	$M_{N,y,Rd}$	109	109	109	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	16.3	16.3	16.3	-	-	-	-	-	-	-	-
254x102x22		$M_{c,y,Rd}$	91.9	91.9	91.9	79.5	79.5	79.5	79.5	79.5	✖	✖	$
$N_{pl,Rd}$ = 994	0.797	$M_{c,z,Rd}$	13.1	13.1	13.1	8.17	8.17	8.17	8.17	8.17	✖	✖	$
	0.274	$M_{N,y,Rd}$	91.9	91.9	91.9	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	13.1	13.1	13.1	-	-	-	-	-	-	-	-
203x133x30		$M_{c,y,Rd}$	111	111	111	111	111	111	111	111	111	111	111
$N_{pl,Rd}$ = 1360	n/a	$M_{c,z,Rd}$	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2
	1.00	$M_{N,y,Rd}$	111	111	107	93.3	80.0	66.6	53.3	40.0	26.7	13.3	0
		$M_{N,z,Rd}$	31.2	31.2	31.2	31.2	30.9	29.2	26.1	21.6	15.8	8.59	0
203x133x25		$M_{c,y,Rd}$	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6
$N_{pl,Rd}$ = 1140	n/a	$M_{c,z,Rd}$	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
	1.00	$M_{N,y,Rd}$	91.6	91.6	88.8	77.7	66.6	55.5	44.4	33.3	22.2	11.1	0
		$M_{N,z,Rd}$	25.2	25.2	25.2	25.2	25.1	23.9	21.5	17.9	13.1	7.17	0
203x102x23		$M_{c,y,Rd}$	83.1	83.1	83.1	83.1	73.5	73.5	73.5	73.5	73.5	73.5	73.5
$N_{pl,Rd}$ = 1040	1.00	$M_{c,z,Rd}$	17.8	17.8	17.8	17.8	11.4	11.4	11.4	11.4	11.4	11.4	11.4
	0.303	$M_{N,y,Rd}$	83.1	83.1	80.8	70.7	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	17.8	17.8	17.8	17.8	-	-	-	-	-	-	-
178x102x19		$M_{c,y,Rd}$	60.7	60.7	60.7	60.7	60.7	60.7	60.7	60.7	60.7	60.7	60.7
$N_{pl,Rd}$ = 863	n/a	$M_{c,z,Rd}$	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
	1.00	$M_{N,y,Rd}$	60.7	60.7	58.6	51.3	43.9	36.6	29.3	22.0	14.6	7.32	0
		$M_{N,z,Rd}$	14.9	14.9	14.9	14.9	14.8	14.1	12.6	10.5	7.69	4.19	0
152x89x16		$M_{c,y,Rd}$	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7
$N_{pl,Rd}$ = 721	n/a	$M_{c,z,Rd}$	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
	1.00	$M_{N,y,Rd}$	43.7	43.7	41.8	36.5	31.3	26.1	20.9	15.7	10.4	5.22	0
		$M_{N,z,Rd}$	11.0	11.0	11.0	11.0	10.9	10.3	9.19	7.63	5.57	3.03	0
127x76x13		$M_{c,y,Rd}$	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8
$N_{pl,Rd}$ = 586	n/a	$M_{c,z,Rd}$	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17
	1.00	$M_{N,y,Rd}$	29.8	29.8	28.1	24.6	21.0	17.5	14.0	10.5	7.02	3.51	0
		$M_{N,z,Rd}$	8.17	8.17	8.17	8.16	8.00	7.50	6.66	5.50	4.00	2.17	0

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

✖ Section becomes Class 4, see note 10.

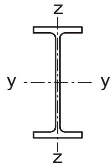
$ For these values of $N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL BEAMS
Advance® UKB



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
* 254x102x25	0.866	$N_{b,y,Rd}$	1140	1140	1120	1110	1090	1070	1050	995	927	842	743	644	553
$N_{pl,Rd}$ = 1140		$N_{b,z,Rd}$	946	741	532	380	279	212	167	110	77.8	57.9	44.8	35.6	29.0
$f_y W_{el,y}$ = 94.4	0.866	$M_{b,Rd}$	90.0	77.7	65.8	55.3	46.9	40.3	35.3	28.1	23.4	19.7	16.9	14.8	13.2
$f_y W_{el,z}$ = 10.3	**0.285**	$M_{b,Rd}$	101	86.0	71.3	58.9	49.2	42.0	36.5	28.9	23.6	19.7	16.9	14.8	13.2
* 254x102x22	0.797	$N_{b,y,Rd}$	994	994	981	966	950	932	913	866	803	725	636	548	470
$N_{pl,Rd}$ = 994		$N_{b,z,Rd}$	814	623	439	310	227	172	135	88.7	62.7	46.7	36.1	28.7	23.4
$f_y W_{el,y}$ = 79.5	0.797	$M_{b,Rd}$	75.1	64.1	53.4	44.2	36.9	31.4	27.1	21.3	17.4	14.4	12.3	10.8	9.59
$f_y W_{el,z}$ = 8.17	**0.274**	$M_{b,Rd}$	84.8	71.0	57.8	46.9	38.6	32.5	28.0	21.8	17.4	14.4	12.3	10.8	9.59
203x133x30	1.00	$N_{b,y,Rd}$	1360	1350	1330	1300	1270	1240	1210	1120	994	853	717	599	503
$N_{pl,Rd}$ = 1360		$N_{b,z,Rd}$	1250	1120	961	782	620	493	396	268	193	145	112	89.9	73.5
$f_y W_{el,y}$ = 99.4	**1.00**	$M_{b,Rd}$	111	105	97.6	89.4	81.1	73.3	66.3	55.0	46.6	40.2	34.5	30.2	26.9
$f_y W_{el,z}$ = 20.2															
203x133x25	1.00	$N_{b,y,Rd}$	1140	1130	1110	1090	1060	1040	1010	926	821	700	586	488	409
$N_{pl,Rd}$ = 1140		$N_{b,z,Rd}$	1040	931	791	639	504	398	319	216	155	116	90.3	72.1	58.9
$f_y W_{el,y}$ = 81.7	**1.00**	$M_{b,Rd}$	91.6	85.9	78.9	71.4	63.8	56.7	50.5	40.8	34.0	28.1	24.0	20.9	18.6
$f_y W_{el,z}$ = 16.3															
203x102x23	1.00	$N_{b,y,Rd}$	1040	1040	1020	998	976	951	921	846	746	634	529	440	369
$N_{pl,Rd}$ = 1040		$N_{b,z,Rd}$	897	735	553	404	301	230	181	120	85.3	63.6	49.2	39.2	32.0
$f_y W_{el,y}$ = 73.5	1.00	$M_{b,Rd}$	71.9	65.6	59.0	52.3	46.2	41.0	36.6	30.0	24.9	20.9	18.1	16.0	14.3
$f_y W_{el,z}$ = 11.4	**0.303**	$M_{b,Rd}$	80.4	72.5	64.2	56.0	48.8	42.8	37.9	30.7	24.9	20.9	18.1	16.0	14.3
178x102x19	1.00	$N_{b,y,Rd}$	863	851	833	813	790	764	731	647	544	444	361	295	245
$N_{pl,Rd}$ = 863		$N_{b,z,Rd}$	742	610	459	336	251	192	151	100	71.1	53.0	41.0	32.7	26.6
$f_y W_{el,y}$ = 54.3	**1.00**	$M_{b,Rd}$	58.7	53.0	46.9	40.9	35.5	31.1	27.6	22.3	18.1	15.2	13.1	11.6	10.3
$f_y W_{el,z}$ = 9.59															
152x89x16	1.00	$N_{b,y,Rd}$	720	703	685	664	638	606	566	469	371	291	232	188	155
$N_{pl,Rd}$ = 721		$N_{b,z,Rd}$	595	460	327	232	170	129	101	66.7	47.2	35.1	27.1	21.6	17.6
$f_y W_{el,y}$ = 38.7	**1.00**	$M_{b,Rd}$	41.3	36.8	32.2	28.0	24.4	21.5	19.2	15.6	12.8	10.8	9.39	8.31	7.45
$f_y W_{el,z}$ = 7.10															
127x76x13	1.00	$N_{b,y,Rd}$	580	563	543	519	487	446	399	302	226	173	136	109	89.5
$N_{pl,Rd}$ = 586		$N_{b,z,Rd}$	455	325	218	151	109	82.4	64.3	42.2	29.8	22.1	17.1	13.6	11.1
$f_y W_{el,y}$ = 26.6	**1.00**	$M_{b,Rd}$	27.5	24.3	21.2	18.6	16.3	14.5	13.0	10.7	8.83	7.52	6.55	5.81	5.22
$f_y W_{el,z}$ = 5.33															

Advance® and UKB are trademarks of Tata Steel. A fuller description of the relationship between Universal Beams (UB) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$n = N_{Ed} / N_{pl,Rd}$

* The section can become Class 4 under axial compression only. Under combined axial compression and bending the section becomes Class 4 when the Class 3 $N_{Ed} / N_{pl,Rd}$ limit is exceeded.

Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

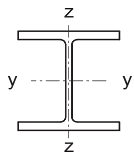
FOR EXPLANATION OF TABLES SEE NOTE 10.

BS EN 1993-1-1:2005
BS 4-1:2005

AXIAL FORCE & BENDING

S355 / Advance® 355

UNIVERSAL COLUMNS
Advance® UKC



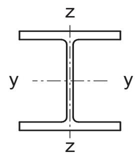
Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
356x406x634		$M_{c,y,Rd}$	4630	4630	4630	4630	4630	4630	4630	4630	4630	4630	4630
$N_{pl,Rd}$ = 26300	n/a	$M_{c,z,Rd}$	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310
	1.00	$M_{N,y,Rd}$	4630	4610	4090	3580	3070	2560	2050	1540	1020	512	0
		$M_{N,z,Rd}$	2310	2310	2310	2270	2160	1970	1720	1400	1000	536	0
356x406x551		$M_{c,y,Rd}$	3920	3920	3920	3920	3920	3920	3920	3920	3920	3920	3920
$N_{pl,Rd}$ = 22800	n/a	$M_{c,z,Rd}$	1970	1970	1970	1970	1970	1970	1970	1970	1970	1970	1970
	1.00	$M_{N,y,Rd}$	3920	3910	3480	3040	2610	2170	1740	1300	870	435	0
		$M_{N,z,Rd}$	1970	1970	1970	1940	1840	1690	1470	1190	857	459	0
356x406x467		$M_{c,y,Rd}$	3350	3350	3350	3350	3350	3350	3350	3350	3350	3350	3350
$N_{pl,Rd}$ = 19900	n/a	$M_{c,z,Rd}$	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690
	1.00	$M_{N,y,Rd}$	3350	3340	2970	2600	2230	1860	1490	1110	743	372	0
		$M_{N,z,Rd}$	1690	1690	1690	1660	1580	1450	1260	1020	735	394	0
356x406x393		$M_{c,y,Rd}$	2750	2750	2750	2750	2750	2750	2750	2750	2750	2750	2750
$N_{pl,Rd}$ = 16800	n/a	$M_{c,z,Rd}$	1390	1390	1390	1390	1390	1390	1390	1390	1390	1390	1390
	1.00	$M_{N,y,Rd}$	2750	2750	2450	2140	1840	1530	1220	919	612	306	0
		$M_{N,z,Rd}$	1390	1390	1390	1370	1300	1200	1040	848	609	326	0
356x406x340		$M_{c,y,Rd}$	2340	2340	2340	2340	2340	2340	2340	2340	2340	2340	2340
$N_{pl,Rd}$ = 14500	n/a	$M_{c,z,Rd}$	1190	1190	1190	1190	1190	1190	1190	1190	1190	1190	1190
	1.00	$M_{N,y,Rd}$	2340	2340	2090	1830	1560	1300	1040	782	521	261	0
		$M_{N,z,Rd}$	1190	1190	1190	1170	1110	1020	891	724	520	279	0
356x406x287		$M_{c,y,Rd}$	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
$N_{pl,Rd}$ = 12600	n/a	$M_{c,z,Rd}$	1020	1020	1020	1020	1020	1020	1020	1020	1020	1020	1020
	1.00	$M_{N,y,Rd}$	2010	2010	1790	1560	1340	1120	893	670	447	223	0
		$M_{N,z,Rd}$	1020	1020	1020	1000	956	877	766	623	447	240	0
356x406x235		$M_{c,y,Rd}$	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620
$N_{pl,Rd}$ = 10300	n/a	$M_{c,z,Rd}$	822	822	822	822	822	822	822	822	822	822	822
	1.00	$M_{N,y,Rd}$	1620	1620	1440	1260	1080	900	720	540	360	180	0
		$M_{N,z,Rd}$	822	822	822	810	772	708	618	502	361	193	0

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



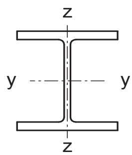
Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
356x406x634	1.00	$N_{b,y,Rd}$	26300	26200	25600	24900	24200	23500	22700	21800	20900	19800	18800	17600	16500
$N_{pl,Rd}$ = 26300		$N_{b,z,Rd}$	25900	24400	22800	21100	19300	17400	15600	13800	12200	10800	9510	8430	7510
$f_y W_{el,y}$ = 3760	**1.00**	$M_{b,Rd}$	4630	4630	4630	4630	4610	4540	4470	4410	4350	4300	4240	4190	4130
$f_y W_{el,z}$ = 1500															
356x406x551	1.00	$N_{b,y,Rd}$	22800	22700	22200	21600	21000	20300	19600	18800	17900	17000	16000	15000	14000
$N_{pl,Rd}$ = 22800		$N_{b,z,Rd}$	22500	21100	19700	18300	16700	15000	13400	11900	10500	9230	8150	7220	6430
$f_y W_{el,y}$ = 3240	**1.00**	$M_{b,Rd}$	3920	3920	3920	3920	3880	3810	3750	3690	3640	3590	3530	3480	3430
$f_y W_{el,z}$ = 1280															
356x406x467	1.00	$N_{b,y,Rd}$	19900	19800	19300	18700	18200	17500	16900	16100	15300	14400	13500	12600	11700
$N_{pl,Rd}$ = 19900		$N_{b,z,Rd}$	19600	18300	17100	15700	14300	12800	11300	9980	8760	7690	6770	5990	5320
$f_y W_{el,y}$ = 2810	**1.00**	$M_{b,Rd}$	3350	3350	3350	3330	3260	3200	3140	3090	3030	2980	2930	2880	2830
$f_y W_{el,z}$ = 1100															
356x406x393	1.00	$N_{b,y,Rd}$	16800	16600	16200	15700	15200	14700	14100	13400	12700	12000	11200	10400	9590
$N_{pl,Rd}$ = 16800		$N_{b,z,Rd}$	16400	15400	14300	13100	11900	10600	9370	8220	7190	6300	5540	4890	4340
$f_y W_{el,y}$ = 2340	**1.00**	$M_{b,Rd}$	2750	2750	2750	2710	2650	2590	2540	2490	2430	2380	2340	2290	2240
$f_y W_{el,z}$ = 911															
356x406x340	1.00	$N_{b,y,Rd}$	14500	14400	14000	13600	13100	12600	12100	11500	10900	10200	9510	8810	8120
$N_{pl,Rd}$ = 14500		$N_{b,z,Rd}$	14200	13300	12300	11300	10200	9100	8020	7020	6140	5370	4720	4170	3700
$f_y W_{el,y}$ = 2020	**1.00**	$M_{b,Rd}$	2340	2340	2340	2290	2230	2180	2130	2070	2030	1980	1930	1890	1840
$f_y W_{el,z}$ = 779															
356x406x287	1.00	$N_{b,y,Rd}$	12600	12500	12100	11700	11300	10900	10400	9870	9290	8670	8040	7410	6800
$N_{pl,Rd}$ = 12600		$N_{b,z,Rd}$	12300	11500	10600	9720	8740	7750	6800	5930	5170	4510	3960	3490	3090
$f_y W_{el,y}$ = 1750	**1.00**	$M_{b,Rd}$	2010	2010	2000	1930	1880	1820	1770	1720	1670	1620	1570	1530	1480
$f_y W_{el,z}$ = 669															
356x406x235	1.00	$N_{b,y,Rd}$	10300	10200	9880	9570	9230	8870	8460	8010	7530	7010	6490	5970	5470
$N_{pl,Rd}$ = 10300		$N_{b,z,Rd}$	10000	9370	8660	7900	7100	6280	5500	4790	4170	3630	3180	2810	2490
$f_y W_{el,y}$ = 1430	**1.00**	$M_{b,Rd}$	1620	1620	1600	1540	1490	1440	1390	1340	1290	1250	1200	1160	1120
$f_y W_{el,z}$ = 542															

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
$n = N_{Ed} / N_{pl,Rd}$
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.
For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
356x368x202		$M_{c,y,Rd}$	1370	1370	1370	1370	1370	1370	1370	1370	1370	1370	1370
$N_{pl,Rd}$ = 8870	n/a	$M_{c,z,Rd}$	662	662	662	662	662	662	662	662	662	662	662
	1.00	$M_{N,y,Rd}$	1370	1370	1230	1070	920	767	613	460	307	153	0
		$M_{N,z,Rd}$	662	662	662	654	625	574	502	409	294	158	0
356x368x177		$M_{c,y,Rd}$	1190	1190	1190	1190	1190	1190	1190	1190	1190	1190	1190
$N_{pl,Rd}$ = 7800	n/a	$M_{c,z,Rd}$	576	576	576	576	576	576	576	576	576	576	576
	1.00	$M_{N,y,Rd}$	1190	1190	1070	935	802	668	534	401	267	134	0
		$M_{N,z,Rd}$	576	576	576	570	544	500	438	356	256	138	0
356x368x153		$M_{c,y,Rd}$	1020	1020	1020	1020	1020	1020	1020	1020	1020	1020	1020
$N_{pl,Rd}$ = 6730	n/a	$M_{c,z,Rd}$	495	495	495	495	495	495	495	495	495	495	495
	1.00	$M_{N,y,Rd}$	1020	1020	916	802	687	573	458	344	229	115	0
		$M_{N,z,Rd}$	495	495	495	489	467	429	375	306	220	118	0
356x368x129		$M_{c,y,Rd}$	781	781	781	781	781	781	781	781	781	781	781
$N_{pl,Rd}$ = 5660	1.00	$M_{c,z,Rd}$	274	274	274	274	274	274	274	274	274	274	274
	0.00	$M_{N,y,Rd}$	-	-	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	-	-	-	-	-	-	-	-	-	-	-
305x305x283		$M_{c,y,Rd}$	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710	1710
$N_{pl,Rd}$ = 12100	n/a	$M_{c,z,Rd}$	785	785	785	785	785	785	785	785	785	785	785
	1.00	$M_{N,y,Rd}$	1710	1710	1530	1340	1150	956	765	573	382	191	0
		$M_{N,z,Rd}$	785	785	785	775	739	679	594	483	347	186	0
305x305x240		$M_{c,y,Rd}$	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470	1470
$N_{pl,Rd}$ = 10600	n/a	$M_{c,z,Rd}$	673	673	673	673	673	673	673	673	673	673	673
	1.00	$M_{N,y,Rd}$	1470	1470	1310	1150	985	821	657	493	328	164	0
		$M_{N,z,Rd}$	673	673	673	665	636	584	511	416	299	161	0
305x305x198		$M_{c,y,Rd}$	1190	1190	1190	1190	1190	1190	1190	1190	1190	1190	1190
$N_{pl,Rd}$ = 8690	n/a	$M_{c,z,Rd}$	545	545	545	545	545	545	545	545	545	545	545
	1.00	$M_{N,y,Rd}$	1190	1190	1060	932	798	665	532	399	266	133	0
		$M_{N,z,Rd}$	545	545	545	539	515	474	415	338	243	130	0

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

N_{Ed} = Design value of the axial force.

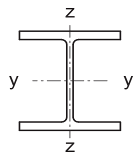
$n = N_{Ed} / N_{pl,Rd}$

- Not applicable for Class 3 and Class 4 sections.

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL COLUMNS
Advance® UKC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
356x368x202	1.00	$N_{b,y,Rd}$	8870	8740	8480	8210	7910	7590	7230	6840	6420	5970	5510	5060	4630
$N_{pl,Rd}$ = 8870		$N_{b,z,Rd}$	8560	7940	7290	6580	5830	5100	4410	3810	3290	2850	2490	2180	1930
$f_y W_{el,y}$ = 1220	**1.00**	$M_{b,Rd}$	1370	1370	1340	1290	1240	1190	1140	1090	1050	1000	960	920	881
$f_y W_{el,z}$ = 436															
356x368x177	1.00	$N_{b,y,Rd}$	7800	7680	7450	7200	6940	6650	6330	5970	5590	5190	4780	4390	4010
$N_{pl,Rd}$ = 7800		$N_{b,z,Rd}$	7520	6970	6390	5760	5110	4450	3850	3320	2860	2480	2170	1900	1680
$f_y W_{el,y}$ = 1070	**1.00**	$M_{b,Rd}$	1190	1190	1160	1110	1060	1020	970	924	880	838	797	760	724
$f_y W_{el,z}$ = 380															
356x368x153	1.00	$N_{b,y,Rd}$	6730	6620	6420	6210	5980	5730	5450	5140	4800	4460	4100	3760	3430
$N_{pl,Rd}$ = 6730		$N_{b,z,Rd}$	6480	6010	5500	4960	4390	3820	3300	2840	2450	2130	1850	1630	1440
$f_y W_{el,y}$ = 926	**1.00**	$M_{b,Rd}$	1020	1020	990	946	902	857	812	769	727	687	649	614	582
$f_y W_{el,z}$ = 327															
356x368x129	1.00	$N_{b,y,Rd}$	5660	5560	5390	5210	5010	4790	4550	4290	4000	3710	3400	3110	2840
$N_{pl,Rd}$ = 5660		$N_{b,z,Rd}$	5450	5050	4620	4160	3670	3200	2760	2370	2040	1770	1540	1350	1190
$f_y W_{el,y}$ = 781	1.00	$M_{b,Rd}$	781	781	760	726	691	656	621	586	551	519	489	461	435
$f_y W_{el,z}$ = 274															
305x305x283	1.00	$N_{b,y,Rd}$	12100	11800	11400	11000	10600	10100	9540	8930	8290	7620	6960	6330	5750
$N_{pl,Rd}$ = 12100		$N_{b,z,Rd}$	11400	10400	9360	8220	7070	5990	5060	4280	3650	3130	2710	2370	2080
$f_y W_{el,y}$ = 1450	**1.00**	$M_{b,Rd}$	1710	1710	1680	1640	1590	1550	1510	1480	1440	1400	1370	1330	1300
$f_y W_{el,z}$ = 512															
305x305x240	1.00	$N_{b,y,Rd}$	10600	10300	9960	9580	9170	8710	8200	7640	7050	6440	5860	5300	4790
$N_{pl,Rd}$ = 10600		$N_{b,z,Rd}$	9930	9050	8080	7050	6010	5070	4260	3590	3050	2610	2260	1970	1730
$f_y W_{el,y}$ = 1260	**1.00**	$M_{b,Rd}$	1470	1470	1430	1380	1340	1300	1260	1220	1180	1150	1110	1080	1040
$f_y W_{el,z}$ = 440															
305x305x198	1.00	$N_{b,y,Rd}$	8690	8470	8180	7860	7510	7120	6680	6200	5700	5190	4700	4250	3830
$N_{pl,Rd}$ = 8690		$N_{b,z,Rd}$	8160	7420	6610	5740	4880	4100	3440	2900	2460	2110	1820	1590	1390
$f_y W_{el,y}$ = 1030	**1.00**	$M_{b,Rd}$	1190	1190	1140	1100	1060	1020	982	946	911	877	844	813	783
$f_y W_{el,z}$ = 358															

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

$n = N_{Ed} / N_{pl,Rd}$

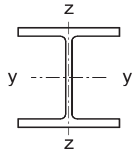
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
305x305x158		$M_{c,y,Rd}$	925	925	925	925	925	925	925	925	925	925	925
$N_{pl,Rd}$ = 6930	n/a	$M_{c,z,Rd}$	424	424	424	424	424	424	424	424	424	424	424
	1.00	$M_{N,y,Rd}$	925	925	834	730	626	521	417	313	209	104	0
		$M_{N,z,Rd}$	424	424	424	420	403	371	325	265	191	103	0
305x305x137		$M_{c,y,Rd}$	792	792	792	792	792	792	792	792	792	792	792
$N_{pl,Rd}$ = 6000	n/a	$M_{c,z,Rd}$	363	363	363	363	363	363	363	363	363	363	363
	1.00	$M_{N,y,Rd}$	792	792	716	626	537	447	358	268	179	89.5	0
		$M_{N,z,Rd}$	363	363	363	360	345	318	279	228	164	88.1	0
305x305x118		$M_{c,y,Rd}$	675	675	675	675	675	675	675	675	675	675	675
$N_{pl,Rd}$ = 5180	n/a	$M_{c,z,Rd}$	309	309	309	309	309	309	309	309	309	309	309
	1.00	$M_{N,y,Rd}$	675	675	612	535	459	382	306	229	153	76.5	0
		$M_{N,z,Rd}$	309	309	309	307	294	272	238	194	140	75.3	0
305x305x97		$M_{c,y,Rd}$	513	513	513	513	513	513	513	513	513	513	513
$N_{pl,Rd}$ = 4370	1.00	$M_{c,z,Rd}$	170	170	170	170	170	170	170	170	170	170	170
	0.00	$M_{N,y,Rd}$	-	-	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	-	-	-	-	-	-	-	-	-	-	-
254x254x167		$M_{c,y,Rd}$	836	836	836	836	836	836	836	836	836	836	836
$N_{pl,Rd}$ = 7350	n/a	$M_{c,z,Rd}$	392	392	392	392	392	392	392	392	392	392	392
	1.00	$M_{N,y,Rd}$	836	836	748	654	561	467	374	280	187	93.5	0
		$M_{N,z,Rd}$	392	392	392	387	370	340	297	242	174	93.1	0
254x254x132		$M_{c,y,Rd}$	645	645	645	645	645	645	645	645	645	645	645
$N_{pl,Rd}$ = 5800	n/a	$M_{c,z,Rd}$	303	303	303	303	303	303	303	303	303	303	303
	1.00	$M_{N,y,Rd}$	645	645	577	505	433	361	289	217	144	72.2	0
		$M_{N,z,Rd}$	303	303	303	299	286	263	230	187	134	72.1	0
254x254x107		$M_{c,y,Rd}$	512	512	512	512	512	512	512	512	512	512	512
$N_{pl,Rd}$ = 4690	n/a	$M_{c,z,Rd}$	240	240	240	240	240	240	240	240	240	240	240
	1.00	$M_{N,y,Rd}$	512	512	460	403	345	288	230	173	115	57.5	0
		$M_{N,z,Rd}$	240	240	240	238	228	209	183	149	107	57.7	0

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N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

BS EN 1993-1-1:2005
BS 4-1:2005

AXIAL FORCE & BENDING

S355 / Advance® 355

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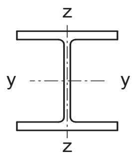
Advance® UKC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
305x305x158	1.00	$N_{b,y,Rd}$	6930	6930	6930	6860	6740	6620	6500	6240	5950	5630	5260	4870	4460
$N_{pl,Rd}$ = 6930		$N_{b,z,Rd}$	6930	6780	6490	6190	5880	5560	5220	4520	3830	3200	2680	2250	1910
$f_y W_{el,y}$ = 817	**1.00**	$M_{b,Rd}$	925	925	925	925	918	897	877	838	801	764	729	694	662
$f_y W_{el,z}$ = 279															
305x305x137	1.00	$N_{b,y,Rd}$	6000	6000	6000	5930	5830	5720	5610	5380	5130	4840	4520	4170	3810
$N_{pl,Rd}$ = 6000		$N_{b,z,Rd}$	6000	5860	5610	5350	5080	4800	4500	3880	3280	2740	2290	1920	1630
$f_y W_{el,y}$ = 706	**1.00**	$M_{b,Rd}$	792	792	792	792	783	764	746	709	673	637	603	570	539
$f_y W_{el,z}$ = 239															
305x305x118	1.00	$N_{b,y,Rd}$	5180	5180	5180	5110	5020	4930	4830	4630	4410	4160	3880	3570	3260
$N_{pl,Rd}$ = 5180		$N_{b,z,Rd}$	5180	5050	4830	4600	4370	4120	3860	3330	2800	2340	1950	1640	1390
$f_y W_{el,y}$ = 607	**1.00**	$M_{b,Rd}$	675	675	675	675	665	648	630	596	562	528	495	464	435
$f_y W_{el,z}$ = 203															
305x305x97	1.00	$N_{b,y,Rd}$	4370	4370	4370	4300	4220	4140	4060	3880	3690	3460	3210	2950	2670
$N_{pl,Rd}$ = 4370		$N_{b,z,Rd}$	4370	4240	4050	3860	3650	3440	3220	2750	2300	1910	1590	1330	1120
$f_y W_{el,y}$ = 513	1.00	$M_{b,Rd}$	513	513	513	513	506	492	479	451	423	395	367	342	318
$f_y W_{el,z}$ = 170															
254x254x167	1.00	$N_{b,y,Rd}$	7350	7350	7300	7160	7020	6860	6710	6360	5960	5510	5010	4500	4000
$N_{pl,Rd}$ = 7350		$N_{b,z,Rd}$	7350	7030	6680	6300	5910	5490	5060	4200	3420	2780	2270	1880	1580
$f_y W_{el,y}$ = 716	**1.00**	$M_{b,Rd}$	836	836	836	836	826	809	794	765	738	712	687	663	639
$f_y W_{el,z}$ = 257															
254x254x132	1.00	$N_{b,y,Rd}$	5800	5800	5750	5630	5520	5390	5260	4980	4650	4270	3870	3460	3060
$N_{pl,Rd}$ = 5800		$N_{b,z,Rd}$	5800	5530	5240	4940	4630	4290	3940	3250	2640	2130	1740	1440	1210
$f_y W_{el,y}$ = 563	**1.00**	$M_{b,Rd}$	645	645	645	645	630	615	601	574	549	525	501	479	457
$f_y W_{el,z}$ = 199															
254x254x107	1.00	$N_{b,y,Rd}$	4690	4690	4640	4550	4450	4350	4240	3990	3720	3400	3060	2720	2400
$N_{pl,Rd}$ = 4690		$N_{b,z,Rd}$	4690	4470	4230	3980	3720	3440	3160	2590	2090	1690	1380	1140	955
$f_y W_{el,y}$ = 453	**1.00**	$M_{b,Rd}$	512	512	512	509	495	482	469	444	419	396	374	353	334
$f_y W_{el,z}$ = 158															

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

n = N_{Ed} / $N_{pl,Rd}$

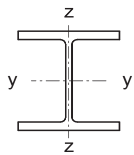
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
254x254x89		$M_{c,y,Rd}$	422	422	422	422	422	422	422	422	422	422	422
$N_{pl,Rd}$ = 3900	n/a	$M_{c,z,Rd}$	198	198	198	198	198	198	198	198	198	198	198
	1.00	$M_{N,y,Rd}$	422	422	379	331	284	237	189	142	94.6	47.3	0
		$M_{N,z,Rd}$	198	198	198	196	187	172	151	123	88.3	47.4	0
254x254x73		$M_{c,y,Rd}$	352	352	352	352	352	352	352	352	352	352	352
$N_{pl,Rd}$ = 3310	n/a	$M_{c,z,Rd}$	165	165	165	165	165	165	165	165	165	165	165
	1.00	$M_{N,y,Rd}$	352	352	317	278	238	198	159	119	79.3	39.6	0
		$M_{N,z,Rd}$	165	165	165	164	157	144	126	103	74.1	39.8	0
203x203x127 +		$M_{c,y,Rd}$	523	523	523	523	523	523	523	523	523	523	523
$N_{pl,Rd}$ = 5590	n/a	$M_{c,z,Rd}$	243	243	243	243	243	243	243	243	243	243	243
	1.00	$M_{N,y,Rd}$	523	523	467	408	350	292	233	175	117	58.3	0
		$M_{N,z,Rd}$	243	243	243	240	228	210	183	149	107	57.3	0
203x203x113 +		$M_{c,y,Rd}$	459	459	459	459	459	459	459	459	459	459	459
$N_{pl,Rd}$ = 5000	n/a	$M_{c,z,Rd}$	213	213	213	213	213	213	213	213	213	213	213
	1.00	$M_{N,y,Rd}$	459	459	411	359	308	257	205	154	103	51.3	0
		$M_{N,z,Rd}$	213	213	213	211	201	185	162	132	94.6	50.7	0
203x203x100 +		$M_{c,y,Rd}$	396	396	396	396	396	396	396	396	396	396	396
$N_{pl,Rd}$ = 4380	n/a	$M_{c,z,Rd}$	184	184	184	184	184	184	184	184	184	184	184
	1.00	$M_{N,y,Rd}$	396	396	355	311	266	222	178	133	88.8	44.4	0
		$M_{N,z,Rd}$	184	184	184	182	174	160	140	114	81.9	44.0	0
203x203x86		$M_{c,y,Rd}$	337	337	337	337	337	337	337	337	337	337	337
$N_{pl,Rd}$ = 3800	n/a	$M_{c,z,Rd}$	157	157	157	157	157	157	157	157	157	157	157
	1.00	$M_{N,y,Rd}$	337	337	303	265	227	189	152	114	75.8	37.9	0
		$M_{N,z,Rd}$	157	157	157	156	149	137	120	97.8	70.4	37.8	0
203x203x71		$M_{c,y,Rd}$	276	276	276	276	276	276	276	276	276	276	276
$N_{pl,Rd}$ = 3120	n/a	$M_{c,z,Rd}$	129	129	129	129	129	129	129	129	129	129	129
	1.00	$M_{N,y,Rd}$	276	276	246	216	185	154	123	92.4	61.6	30.8	0
		$M_{N,z,Rd}$	129	129	129	127	121	112	97.5	79.3	57.0	30.6	0

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+ These sections are in addition to the range of BS 4 sections

N_{Ed} = Design value of the axial force.

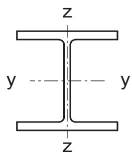
$n = N_{Ed} / N_{pl,Rd}$

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

UNIVERSAL COLUMNS
Advance® UKC

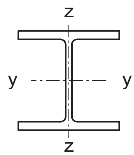


Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
254x254x89	1.00	$N_{b,y,Rd}$	3900	3900	3860	3780	3690	3610	3510	3310	3070	2810	2520	2240	1970
$N_{pl,Rd}$ = 3900		$N_{b,z,Rd}$	3900	3710	3510	3300	3080	2850	2610	2140	1720	1390	1130	938	785
$f_y W_{el,y}$ = 378	**1.00**	$M_{b,Rd}$	422	422	422	417	405	393	381	357	334	312	291	272	254
$f_y W_{el,z}$ = 131															
254x254x73	1.00	$N_{b,y,Rd}$	3310	3310	3260	3190	3120	3040	2960	2780	2580	2340	2090	1850	1620
$N_{pl,Rd}$ = 3310		$N_{b,z,Rd}$	3300	3130	2960	2780	2580	2380	2170	1770	1410	1140	925	762	637
$f_y W_{el,y}$ = 319	**1.00**	$M_{b,Rd}$	352	352	352	345	334	322	311	288	265	243	223	205	189
$f_y W_{el,z}$ = 109															
203x203x127 +	1.00	$N_{b,y,Rd}$	5590	5590	5460	5320	5180	5030	4870	4500	4070	3600	3130	2700	2320
$N_{pl,Rd}$ = 5590		$N_{b,z,Rd}$	5490	5160	4810	4430	4040	3630	3220	2500	1940	1520	1220	998	829
$f_y W_{el,y}$ = 441	**1.00**	$M_{b,Rd}$	523	523	523	519	508	497	488	469	452	435	419	403	388
$f_y W_{el,z}$ = 159															
203x203x113 +	1.00	$N_{b,y,Rd}$	5000	5000	4880	4760	4630	4490	4340	4000	3600	3170	2750	2360	2030
$N_{pl,Rd}$ = 5000		$N_{b,z,Rd}$	4910	4610	4290	3950	3590	3220	2860	2210	1710	1340	1080	879	730
$f_y W_{el,y}$ = 391	**1.00**	$M_{b,Rd}$	459	459	459	452	441	431	422	404	388	371	356	341	326
$f_y W_{el,z}$ = 139															
203x203x100 +	1.00	$N_{b,y,Rd}$	4380	4370	4270	4160	4040	3920	3780	3470	3120	2740	2360	2020	1740
$N_{pl,Rd}$ = 4380		$N_{b,z,Rd}$	4290	4030	3750	3450	3130	2800	2480	1910	1470	1160	926	755	627
$f_y W_{el,y}$ = 341	**1.00**	$M_{b,Rd}$	396	396	396	387	377	368	359	342	326	311	296	282	268
$f_y W_{el,z}$ = 121															
203x203x86	1.00	$N_{b,y,Rd}$	3800	3780	3690	3590	3490	3380	3260	2980	2670	2330	2000	1710	1460
$N_{pl,Rd}$ = 3800		$N_{b,z,Rd}$	3710	3480	3230	2970	2690	2400	2120	1630	1260	986	789	644	534
$f_y W_{el,y}$ = 293	**1.00**	$M_{b,Rd}$	337	337	337	327	318	309	300	284	269	254	240	226	214
$f_y W_{el,z}$ = 103															
203x203x71	1.00	$N_{b,y,Rd}$	3120	3110	3030	2950	2860	2770	2670	2440	2170	1890	1620	1390	1180
$N_{pl,Rd}$ = 3120		$N_{b,z,Rd}$	3050	2860	2650	2430	2200	1960	1730	1330	1020	801	640	522	433
$f_y W_{el,y}$ = 244	**1.00**	$M_{b,Rd}$	276	276	274	265	256	248	240	224	209	195	182	171	160
$f_y W_{el,z}$ = 84.8															

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
n = N_{Ed} / $N_{pl,Rd}$
Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.
For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.
FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL COLUMNS
Advance® UKC

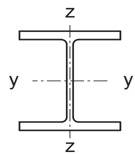


Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
203x203x60		$M_{c,y,Rd}$	233	233	233	233	233	233	233	233	233	233	233
$N_{pl,Rd}$ = 2710	n/a	$M_{c,z,Rd}$	108	108	108	108	108	108	108	108	108	108	108
	1.00	$M_{N,y,Rd}$	233	233	211	185	158	132	106	79.2	52.8	26.4	0
		$M_{N,z,Rd}$	108	108	108	108	103	95.4	83.7	68.3	49.3	26.5	0
203x203x52		$M_{c,y,Rd}$	201	201	201	201	201	201	201	201	201	201	201
$N_{pl,Rd}$ = 2350	n/a	$M_{c,z,Rd}$	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8
	1.00	$M_{N,y,Rd}$	201	201	182	159	137	114	91.0	68.3	45.5	22.8	0
		$M_{N,z,Rd}$	93.8	93.8	93.8	93.0	89.2	82.2	72.1	58.8	42.4	22.8	0
203x203x46		$M_{c,y,Rd}$	177	177	177	177	177	177	177	177	177	177	177
$N_{pl,Rd}$ = 2080	n/a	$M_{c,z,Rd}$	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9
	1.00	$M_{N,y,Rd}$	177	177	160	140	120	100	80.1	60.1	40.1	20.0	0
		$M_{N,z,Rd}$	81.9	81.9	81.9	81.4	78.2	72.2	63.4	51.8	37.3	20.1	0
152x152x51 +		$M_{c,y,Rd}$	155	155	155	155	155	155	155	155	155	155	155
$N_{pl,Rd}$ = 2310	n/a	$M_{c,z,Rd}$	70.6	70.6	70.6	70.6	70.6	70.6	70.6	70.6	70.6	70.6	70.6
	1.00	$M_{N,y,Rd}$	155	155	142	124	106	88.4	70.8	53.1	35.4	17.7	0
		$M_{N,z,Rd}$	70.6	70.6	70.6	70.2	67.6	62.5	54.9	44.9	32.4	17.4	0
152x152x44 +		$M_{c,y,Rd}$	132	132	132	132	132	132	132	132	132	132	132
$N_{pl,Rd}$ = 1990	n/a	$M_{c,z,Rd}$	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
	1.00	$M_{N,y,Rd}$	132	132	120	105	90.3	75.2	60.2	45.1	30.1	15.0	0
		$M_{N,z,Rd}$	60.0	60.0	60.0	59.7	57.4	53.1	46.7	38.2	27.5	14.8	0
152x152x37		$M_{c,y,Rd}$	110	110	110	110	110	110	110	110	110	110	110
$N_{pl,Rd}$ = 1670	n/a	$M_{c,z,Rd}$	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5
	1.00	$M_{N,y,Rd}$	110	110	100.0	87.5	75.0	62.5	50.0	37.5	25.0	12.5	0
		$M_{N,z,Rd}$	49.5	49.5	49.5	49.3	47.5	43.9	38.6	31.6	22.8	12.3	0
152x152x30		$M_{c,y,Rd}$	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
$N_{pl,Rd}$ = 1360	n/a	$M_{c,z,Rd}$	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
	1.00	$M_{N,y,Rd}$	87.9	87.9	80.4	70.3	60.3	50.2	40.2	30.1	20.1	10.0	0
		$M_{N,z,Rd}$	39.6	39.6	39.6	39.4	38.0	35.2	31.0	25.3	18.3	9.85	0
152x152x23		$M_{c,y,Rd}$	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2
$N_{pl,Rd}$ = 1040	1.00	$M_{c,z,Rd}$	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7
	0.00	$M_{N,y,Rd}$	-	-	-	-	-	-	-	-	-	-	-
		$M_{N,z,Rd}$	-	-	-	-	-	-	-	-	-	-	-

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.
+ These sections are in addition to the range of BS 4 sections
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
- Not applicable for Class 3 and Class 4 sections.
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
FOR EXPLANATION OF TABLES SEE NOTE 10.

UNIVERSAL COLUMNS
Advance® UKC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of n = N_{Ed} / $N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
203x203x60	1.00	$N_{b,y,Rd}$	2710	2690	2620	2550	2470	2380	2290	2080	1830	1580	1340	1140	968
$N_{pl,Rd}$ = 2710		$N_{b,z,Rd}$	2640	2470	2280	2080	1870	1660	1450	1100	844	659	526	428	355
$f_y W_{el,y}$ = 207	**1.00**	$M_{b,Rd}$	233	233	230	221	213	205	196	181	166	152	140	129	120
$f_y W_{el,z}$ = 71.2															
203x203x52	1.00	$N_{b,y,Rd}$	2350	2340	2270	2210	2140	2070	1980	1800	1580	1360	1160	980	833
$N_{pl,Rd}$ = 2350		$N_{b,z,Rd}$	2290	2140	1980	1800	1620	1430	1260	952	728	568	453	369	306
$f_y W_{el,y}$ = 181	**1.00**	$M_{b,Rd}$	201	201	198	190	182	174	167	151	137	125	114	104	95.8
$f_y W_{el,z}$ = 61.8															
203x203x46	1.00	$N_{b,y,Rd}$	2080	2070	2010	1950	1890	1820	1750	1580	1390	1190	1010	855	726
$N_{pl,Rd}$ = 2080		$N_{b,z,Rd}$	2030	1890	1740	1590	1430	1260	1100	832	635	495	395	321	266
$f_y W_{el,y}$ = 160	**1.00**	$M_{b,Rd}$	177	177	173	166	158	151	144	129	115	104	93.5	85.1	77.9
$f_y W_{el,z}$ = 54.0															
152x152x51 +	1.00	$N_{b,y,Rd}$	2310	2250	2170	2080	1990	1880	1760	1490	1220	986	803	661	551
$N_{pl,Rd}$ = 2310		$N_{b,z,Rd}$	2160	1960	1730	1490	1260	1050	879	625	461	352	277	224	184
$f_y W_{el,y}$ = 135	**1.00**	$M_{b,Rd}$	155	155	149	143	138	133	128	119	110	102	94.4	87.8	81.9
$f_y W_{el,z}$ = 46.2															
152x152x44 +	1.00	$N_{b,y,Rd}$	1990	1930	1860	1790	1700	1600	1500	1260	1030	831	675	555	463
$N_{pl,Rd}$ = 1990		$N_{b,z,Rd}$	1860	1680	1480	1280	1070	894	745	529	390	297	234	189	155
$f_y W_{el,y}$ = 116	**1.00**	$M_{b,Rd}$	132	131	125	120	115	110	105	96.2	88.0	80.6	74.1	68.4	63.4
$f_y W_{el,z}$ = 39.1															
152x152x37	1.00	$N_{b,y,Rd}$	1670	1620	1560	1490	1420	1340	1250	1050	849	684	555	456	380
$N_{pl,Rd}$ = 1670		$N_{b,z,Rd}$	1550	1400	1240	1060	889	738	614	435	320	244	192	155	127
$f_y W_{el,y}$ = 97.0	**1.00**	$M_{b,Rd}$	110	108	103	98.0	93.1	88.4	83.8	75.2	67.7	61.2	55.7	51.0	47.0
$f_y W_{el,z}$ = 32.5															
152x152x30	1.00	$N_{b,y,Rd}$	1360	1320	1270	1210	1150	1080	1010	839	679	545	442	362	302
$N_{pl,Rd}$ = 1360		$N_{b,z,Rd}$	1260	1140	999	854	714	592	492	347	256	195	153	123	102
$f_y W_{el,y}$ = 78.8	**1.00**	$M_{b,Rd}$	87.9	86.2	81.6	77.0	72.4	67.9	63.6	55.7	49.1	43.7	39.3	35.6	32.5
$f_y W_{el,z}$ = 26.0															
152x152x23	1.00	$N_{b,y,Rd}$	1040	999	960	916	867	812	751	618	495	395	319	261	217
$N_{pl,Rd}$ = 1040		$N_{b,z,Rd}$	955	856	746	632	524	431	356	250	183	140	110	88.3	72.6
$f_y W_{el,y}$ = 58.2	1.00	$M_{b,Rd}$	58.2	57.2	54.0	50.7	47.3	43.9	40.7	34.8	30.1	26.4	23.4	20.9	18.6
$f_y W_{el,z}$ = 18.7															

Advance® and UKC are trademarks of Tata Steel. A fuller description of the relationship between Universal Columns (UC) and the Advance® range of sections manufactured by Tata Steel is given in note 12.

+ These sections are in addition to the range of BS 4 sections

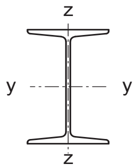
n = N_{Ed} / $N_{pl,Rd}$

Under combined axial compression and bending the resistances are only valid up to the given N_{Ed} / $N_{pl,Rd}$ limit.

For higher values of n = N_{Ed} / $N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

JOISTS



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
254x203x82		$M_{c,y,Rd}$	372	372	372	372	372	372	372	372	372	372	372
$N_{pl,Rd}$ = 3620	n/a	$M_{c,z,Rd}$	128	128	128	128	128	128	128	128	128	128	128
	1.00	$M_{N,y,Rd}$	372	372	336	294	252	210	168	126	84.0	42.0	0
		$M_{N,z,Rd}$	128	128	128	127	122	112	98.4	80.3	57.8	31.1	0
254x114x37		$M_{c,y,Rd}$	163	163	163	163	163	163	163	163	163	163	163
$N_{pl,Rd}$ = 1680	n/a	$M_{c,z,Rd}$	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1
	1.00	$M_{N,y,Rd}$	163	163	161	141	121	101	80.5	60.4	40.3	20.1	0
		$M_{N,z,Rd}$	28.1	28.1	28.1	28.1	28.1	27.0	24.6	20.6	15.2	8.34	0
203x152x52		$M_{c,y,Rd}$	187	187	187	187	187	187	187	187	187	187	187
$N_{pl,Rd}$ = 2300	n/a	$M_{c,z,Rd}$	60.7	60.7	60.7	60.7	60.7	60.7	60.7	60.7	60.7	60.7	60.7
	1.00	$M_{N,y,Rd}$	187	187	170	149	128	106	85.1	63.8	42.5	21.3	0
		$M_{N,z,Rd}$	60.7	60.7	60.7	60.4	58.2	53.8	47.3	38.7	27.9	15.0	0
152x127x37		$M_{c,y,Rd}$	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
$N_{pl,Rd}$ = 1690	n/a	$M_{c,z,Rd}$	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4
	1.00	$M_{N,y,Rd}$	99.0	99.0	92.9	81.3	69.7	58.1	46.4	34.8	23.2	11.6	0
		$M_{N,z,Rd}$	35.4	35.4	35.4	35.4	34.6	32.4	28.8	23.7	17.2	9.33	0
127x114x29		$M_{c,y,Rd}$	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.3
$N_{pl,Rd}$ = 1330	n/a	$M_{c,z,Rd}$	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1
	1.00	$M_{N,y,Rd}$	64.3	64.3	60.4	52.8	45.3	37.7	30.2	22.6	15.1	7.55	0
		$M_{N,z,Rd}$	25.1	25.1	25.1	25.1	24.6	23.0	20.5	16.9	12.3	6.64	0
127x114x27		$M_{c,y,Rd}$	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1
$N_{pl,Rd}$ = 1210	n/a	$M_{c,z,Rd}$	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2
	1.00	$M_{N,y,Rd}$	61.1	61.1	55.4	48.5	41.6	34.7	27.7	20.8	13.9	6.93	0
		$M_{N,z,Rd}$	24.2	24.2	24.2	24.1	23.1	21.3	18.7	15.3	11.0	5.94	0
127x76x16		$M_{c,y,Rd}$	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9
$N_{pl,Rd}$ = 749	n/a	$M_{c,z,Rd}$	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37
	1.00	$M_{N,y,Rd}$	36.9	36.9	34.9	30.5	26.2	21.8	17.4	13.1	8.72	4.36	0
		$M_{N,z,Rd}$	9.37	9.37	9.37	9.37	9.20	8.64	7.69	6.36	4.63	2.51	0

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

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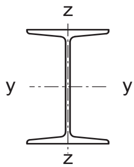

Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
254x203x82	1.00	$N_{b,y,Rd}$	3620	3620	3590	3540	3490	3430	3370	3220	3030	2790	2500	2200	1910
$N_{pl,Rd}$ = 3620		$N_{b,z,Rd}$	3520	3330	3120	2860	2560	2240	1930	1410	1050	805	634	511	420
$f_y W_{el,y}$ = 327	**1.00**	$M_{b,Rd}$	372	372	364	352	340	328	317	296	276	257	240	224	210
$f_y W_{el,z}$ = 77.3															
254x114x37	1.00	$N_{b,y,Rd}$	1680	1680	1660	1640	1610	1580	1550	1480	1380	1250	1110	964	830
$N_{pl,Rd}$ = 1680		$N_{b,z,Rd}$	1450	1190	903	663	495	379	299	198	141	105	81.2	64.7	52.7
$f_y W_{el,y}$ = 142	**1.00**	$M_{b,Rd}$	157	139	122	107	94.6	84.5	76.1	63.5	54.5	47.7	42.5	38.3	34.4
$f_y W_{el,z}$ = 16.7															
203x152x52	1.00	$N_{b,y,Rd}$	2300	2280	2240	2200	2150	2100	2040	1880	1670	1430	1190	997	837
$N_{pl,Rd}$ = 2300		$N_{b,z,Rd}$	2160	1980	1750	1490	1220	992	808	556	402	303	236	189	155
$f_y W_{el,y}$ = 163	**1.00**	$M_{b,Rd}$	187	183	175	168	160	153	147	134	123	112	103	95.3	88.4
$f_y W_{el,z}$ = 36.9															
152x127x37	1.00	$N_{b,y,Rd}$	1680	1620	1550	1470	1380	1280	1170	946	746	590	473	386	320
$N_{pl,Rd}$ = 1690		$N_{b,z,Rd}$	1450	1230	982	764	594	468	375	255	184	138	108	86.5	70.8
$f_y W_{el,y}$ = 84.8	**1.00**	$M_{b,Rd}$	99.0	95.0	90.5	86.4	82.4	78.6	74.9	68.1	61.9	56.5	51.8	47.7	44.2
$f_y W_{el,z}$ = 21.2															
127x114x29	1.00	$N_{b,y,Rd}$	1300	1240	1170	1080	989	882	774	581	438	338	267	216	178
$N_{pl,Rd}$ = 1330		$N_{b,z,Rd}$	1110	902	694	523	398	310	247	167	119	89.7	69.8	55.8	45.7
$f_y W_{el,y}$ = 54.7	**1.00**	$M_{b,Rd}$	64.3	61.0	58.1	55.3	52.7	50.2	47.8	43.3	39.3	35.8	32.8	30.2	27.9
$f_y W_{el,z}$ = 15.0															
127x114x27	1.00	$N_{b,y,Rd}$	1190	1140	1070	1000	919	825	728	552	419	324	256	207	171
$N_{pl,Rd}$ = 1210		$N_{b,z,Rd}$	1030	845	659	502	385	301	240	162	116	87.5	68.1	54.5	44.6
$f_y W_{el,y}$ = 52.9	**1.00**	$M_{b,Rd}$	61.1	57.7	54.8	52.0	49.4	46.8	44.4	39.9	36.0	32.7	29.8	27.4	25.2
$f_y W_{el,z}$ = 14.7															
127x76x16	1.00	$N_{b,y,Rd}$	741	718	692	658	615	560	496	371	277	211	165	133	109
$N_{pl,Rd}$ = 749		$N_{b,z,Rd}$	556	377	246	168	121	91.0	70.9	46.4	32.7	24.3	18.7	14.9	12.1
$f_y W_{el,y}$ = 32.0	**1.00**	$M_{b,Rd}$	34.2	31.0	28.0	25.3	22.8	20.7	18.9	16.1	13.9	11.9	10.4	9.23	8.30
$f_y W_{el,z}$ = 5.68															

$n = N_{Ed} / N_{pl,Rd}$

Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

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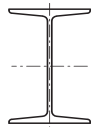

Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
114x114x27		$M_{c,y,Rd}$	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6
$N_{pl,Rd}$ = 1220	n/a	$M_{c,z,Rd}$	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4
	1.00	$M_{N,y,Rd}$	53.6	53.6	50.2	43.9	37.6	31.4	25.1	18.8	12.5	6.27	0
		$M_{N,z,Rd}$	23.4	23.4	23.4	23.4	22.8	21.3	18.9	15.6	11.3	6.12	0
102x102x23		$M_{c,y,Rd}$	40.1	40.1	40.1	40.1	40.1	40.1	40.1	40.1	40.1	40.1	40.1
$N_{pl,Rd}$ = 1040	n/a	$M_{c,z,Rd}$	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
	1.00	$M_{N,y,Rd}$	40.1	40.1	37.4	32.8	28.1	23.4	18.7	14.0	9.36	4.68	0
		$M_{N,z,Rd}$	18.0	18.0	18.0	18.0	17.5	16.3	14.5	11.9	8.65	4.68	0
102x44x7		$M_{c,y,Rd}$	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
$N_{pl,Rd}$ = 337	n/a	$M_{c,z,Rd}$	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14
	1.00	$M_{N,y,Rd}$	12.6	12.6	12.6	11.2	9.60	8.00	6.40	4.80	3.20	1.60	0
		$M_{N,z,Rd}$	2.14	2.14	2.14	2.14	2.14	2.11	1.95	1.66	1.24	0.684	0
89x89x19		$M_{c,y,Rd}$	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
$N_{pl,Rd}$ = 884	n/a	$M_{c,z,Rd}$	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
	1.00	$M_{N,y,Rd}$	29.4	29.4	27.5	24.1	20.6	17.2	13.8	10.3	6.88	3.44	0
		$M_{N,z,Rd}$	13.5	13.5	13.5	13.5	13.2	12.3	10.9	9.02	6.55	3.55	0
76x76x15		$M_{c,y,Rd}$	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
$N_{pl,Rd}$ = 678	n/a	$M_{c,z,Rd}$	9.16	9.16	9.16	9.16	9.16	9.16	9.16	9.16	9.16	9.16	9.16
	1.00	$M_{N,y,Rd}$	19.2	19.2	18.1	15.8	13.6	11.3	9.04	6.78	4.52	2.26	0
		$M_{N,z,Rd}$	9.16	9.16	9.16	9.16	8.96	8.39	7.45	6.14	4.47	2.42	0
76x76x13		$M_{c,y,Rd}$	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3
$N_{pl,Rd}$ = 575	n/a	$M_{c,z,Rd}$	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
	1.00	$M_{N,y,Rd}$	17.3	17.3	15.5	13.5	11.6	9.66	7.73	5.79	3.86	1.93	0
		$M_{N,z,Rd}$	7.95	7.95	7.95	7.85	7.49	6.88	6.01	4.89	3.52	1.89	0

N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

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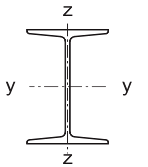


Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
114x114x27	1.00	$N_{b,y,Rd}$	1190	1120	1050	954	849	738	632	459	341	260	205	165	136
$N_{pl,Rd}$ = 1220		$N_{b,z,Rd}$	1020	834	643	485	370	288	230	155	111	83.3	64.9	51.9	42.4
$f_y W_{el,y}$ = 45.8	**1.00**	$M_{b,Rd}$	53.6	51.3	49.0	46.9	44.9	43.0	41.2	37.7	34.5	31.6	29.1	26.9	24.9
$f_y W_{el,z}$ = 13.9															
102x102x23	1.00	$N_{b,y,Rd}$	995	928	847	751	644	541	451	318	232	176	138	111	90.7
$N_{pl,Rd}$ = 1040		$N_{b,z,Rd}$	834	651	480	352	264	204	162	108	77.2	57.8	44.9	35.9	29.3
$f_y W_{el,y}$ = 33.9	**1.00**	$M_{b,Rd}$	40.0	38.0	36.3	34.7	33.2	31.7	30.3	27.6	25.2	23.1	21.2	19.5	18.1
$f_y W_{el,z}$ = 10.8															
102x44x7	1.00	$N_{b,y,Rd}$	328	313	293	265	229	191	158	109	78.1	58.6	45.5	36.4	29.7
$N_{pl,Rd}$ = 337		$N_{b,z,Rd}$	123	61.3	36.1	23.6	16.7	12.4	9.56	6.19	4.33	3.20	2.46	1.95	1.58
$f_y W_{el,y}$ = 10.7	**1.00**	$M_{b,Rd}$	8.68	6.80	5.55	4.68	4.05	3.56	3.19	2.58	2.14	1.83	1.60	1.42	1.28
$f_y W_{el,z}$ = 1.25															
89x89x19	1.00	$N_{b,y,Rd}$	828	757	669	566	463	375	305	210	151	114	88.8	71.1	58.2
$N_{pl,Rd}$ = 884		$N_{b,z,Rd}$	669	492	345	246	182	139	110	72.9	51.9	38.8	30.1	24.0	19.6
$f_y W_{el,y}$ = 24.5	**1.00**	$M_{b,Rd}$	29.1	27.7	26.4	25.3	24.2	23.1	22.1	20.1	18.4	16.8	15.4	14.2	13.2
$f_y W_{el,z}$ = 8.09															
76x76x15	1.00	$N_{b,y,Rd}$	618	548	460	367	287	225	180	122	87.0	65.2	50.6	40.4	33.0
$N_{pl,Rd}$ = 678		$N_{b,z,Rd}$	476	327	220	153	112	85.2	66.9	44.2	31.3	23.4	18.1	14.4	11.8
$f_y W_{el,y}$ = 16.0	**1.00**	$M_{b,Rd}$	18.8	17.9	17.0	16.2	15.4	14.7	14.0	12.6	11.4	10.4	9.51	8.74	8.08
$f_y W_{el,z}$ = 5.40															
76x76x13	1.00	$N_{b,y,Rd}$	528	473	403	326	257	204	163	111	79.3	59.5	46.3	37.0	30.2
$N_{pl,Rd}$ = 575		$N_{b,z,Rd}$	406	279	188	131	96.1	73.0	57.3	37.9	26.9	20.0	15.5	12.4	10.1
$f_y W_{el,y}$ = 14.7	**1.00**	$M_{b,Rd}$	16.7	15.7	14.8	14.0	13.2	12.4	11.7	10.4	9.24	8.32	7.55	6.90	6.32
$f_y W_{el,z}$ = 4.83															

$n = N_{Ed} / N_{pl,Rd}$

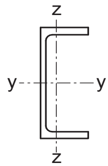
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

PARALLEL FLANGE CHANNEL
Advance® UKPFC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
430x100x64	1.00	$M_{c,y,Rd}$	422	422	422	422	422	352	352	352	352	352	352
$N_{pl,Rd}$ = 2830	**0.443**	$M_{c,z,Rd}$	60.7	60.7	60.7	60.7	60.7	33.8	33.8	33.8	33.8	33.8	33.8
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
380x100x54	1.00	$M_{c,y,Rd}$	322	322	322	322	273	273	273	273	273	273	273
$N_{pl,Rd}$ = 2370	**0.392**	$M_{c,z,Rd}$	55.5	55.5	55.5	55.5	30.8	30.8	30.8	30.8	30.8	30.8	30.8
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
300x100x46	n/a	$M_{c,y,Rd}$	221	221	221	221	221	221	221	221	221	221	221
$N_{pl,Rd}$ = 2000	**1.00**	$M_{c,z,Rd}$	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
300x90x41	n/a	$M_{c,y,Rd}$	202	202	202	202	202	202	202	202	202	202	202
$N_{pl,Rd}$ = 1870	**1.00**	$M_{c,z,Rd}$	40.5	40.5	40.5	40.5	40.5	40.5	40.5	40.5	40.5	40.5	40.5
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
260x90x35	n/a	$M_{c,y,Rd}$	151	151	151	151	151	151	151	151	151	151	151
$N_{pl,Rd}$ = 1580	**1.00**	$M_{c,z,Rd}$	36.2	36.2	36.2	36.2	36.2	36.2	36.2	36.2	36.2	36.2	36.2
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
260x75x28	n/a	$M_{c,y,Rd}$	116	116	116	116	116	116	116	116	116	116	116
$N_{pl,Rd}$ = 1250	**1.00**	$M_{c,z,Rd}$	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
230x90x32	n/a	$M_{c,y,Rd}$	126	126	126	126	126	126	126	126	126	126	126
$N_{pl,Rd}$ = 1460	**1.00**	$M_{c,z,Rd}$	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
230x75x26	n/a	$M_{c,y,Rd}$	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7
$N_{pl,Rd}$ = 1160	**1.00**	$M_{c,z,Rd}$	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											

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N_{Ed} = Design value of the axial force.

$n = N_{Ed} / N_{pl,Rd}$

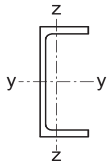
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.

Reduced moment resistance $M_{N,y,Rd}$ and $M_{N,z,Rd}$ are not calculated for channels.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

PARALLEL FLANGE CHANNEL
Advance® UKPFC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$													
		L (m)	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
430x100x64	1.00	$N_{b,y,Rd}$	2830	2780	2660	2550	2430	2300	2170	2030	1890	1750	1610	1480	1360
$N_{pl,Rd}$ = 2830		$N_{b,z,Rd}$	1750	1100	704	481	348	263	205	164	135	113	95.3	81.7	70.9
$f_y W_{el,y}$ = 352	1.00	$M_{b,Rd}$	275	213	171	143	122	108	96.0	86.8	79.4	73.1	67.9	63.3	59.4
$f_y W_{el,z}$ = 33.8	**0.443**	$M_{b,Rd}$	310	233	183	151	129	113	100	90.2	82.2	75.6	70.1	65.3	61.2
380x100x54	1.00	$N_{b,y,Rd}$	2370	2300	2190	2080	1970	1850	1720	1590	1460	1340	1220	1110	1010
$N_{pl,Rd}$ = 2370		$N_{b,z,Rd}$	1500	957	619	424	307	232	181	146	119	99.6	84.4	72.4	62.8
$f_y W_{el,y}$ = 273	1.00	$M_{b,Rd}$	215	167	135	113	97.0	85.3	76.3	69.1	63.2	58.3	54.1	50.5	47.4
$f_y W_{el,z}$ = 30.8	**0.392**	$M_{b,Rd}$	239	181	144	119	102	89.0	79.3	71.6	65.3	60.1	55.7	52.0	48.7
300x100x46	1.00	$N_{b,y,Rd}$	1980	1870	1760	1640	1510	1380	1240	1110	986	875	777	692	618
$N_{pl,Rd}$ = 2000		$N_{b,z,Rd}$	1290	834	542	373	270	204	160	128	105	87.8	74.4	63.9	55.4
$f_y W_{el,y}$ = 189	**1.00**	$M_{b,Rd}$	169	132	108	91.1	79.0	69.9	62.8	57.0	52.3	48.3	45.0	42.0	39.5
$f_y W_{el,z}$ = 28.2															
300x90x41	1.00	$N_{b,y,Rd}$	1850	1740	1630	1510	1390	1260	1130	1000	887	785	695	617	550
$N_{pl,Rd}$ = 1870		$N_{b,z,Rd}$	1070	641	404	274	197	149	116	92.7	75.9	63.3	53.6	45.9	39.8
$f_y W_{el,y}$ = 171	**1.00**	$M_{b,Rd}$	142	108	86.4	72.2	62.2	54.7	49.0	44.4	40.6	37.4	34.7	32.4	30.4
$f_y W_{el,z}$ = 22.4															
260x90x35	1.00	$N_{b,y,Rd}$	1530	1430	1320	1200	1080	956	836	727	633	552	483	426	377
$N_{pl,Rd}$ = 1580		$N_{b,z,Rd}$	918	555	351	238	172	129	101	80.8	66.2	55.2	46.7	40.1	34.7
$f_y W_{el,y}$ = 129	**1.00**	$M_{b,Rd}$	107	82.3	66.4	55.8	48.2	42.6	38.1	34.6	31.7	29.2	27.2	25.4	23.8
$f_y W_{el,z}$ = 20.0															
260x75x28	1.00	$N_{b,y,Rd}$	1210	1130	1040	943	843	742	647	561	487	424	370	326	288
$N_{pl,Rd}$ = 1250		$N_{b,z,Rd}$	579	319	195	131	93.3	69.9	54.3	43.4	35.4	29.5	24.9	21.4	18.5
$f_y W_{el,y}$ = 98.7	**1.00**	$M_{b,Rd}$	71.0	51.7	40.5	33.5	28.6	25.1	22.3	20.1	18.4	16.9	15.7	14.6	13.7
$f_y W_{el,z}$ = 12.2															
230x90x32	1.00	$N_{b,y,Rd}$	1390	1290	1170	1050	921	796	682	584	502	434	377	330	291
$N_{pl,Rd}$ = 1460		$N_{b,z,Rd}$	859	523	332	226	163	123	95.6	76.6	62.8	52.4	44.3	38.0	33.0
$f_y W_{el,y}$ = 109	**1.00**	$M_{b,Rd}$	91.7	71.7	58.8	49.9	43.5	38.6	34.7	31.6	29.0	26.8	25.0	23.3	21.9
$f_y W_{el,z}$ = 19.5															
230x75x26	1.00	$N_{b,y,Rd}$	1110	1020	932	831	728	627	537	459	394	340	296	259	228
$N_{pl,Rd}$ = 1160		$N_{b,z,Rd}$	554	308	189	126	90.4	67.8	52.7	42.1	34.4	28.7	24.2	20.8	18.0
$f_y W_{el,y}$ = 84.8	**1.00**	$M_{b,Rd}$	62.7	47.0	37.6	31.4	27.1	23.9	21.4	19.3	17.7	16.3	15.1	14.1	13.3
$f_y W_{el,z}$ = 12.4															

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$n = N_{Ed} / N_{pl,Rd}$

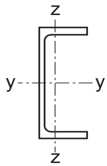
Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

PARALLEL FLANGE CHANNEL
Advance® UKPFC



Cross-section resistance check

Section Designation and Axial Force Resistance $N_{pl,Rd}$ (kN)	n Limit Class 3 **Class 2**	Moment Resistance $M_{c,y,Rd}$, $M_{c,z,Rd}$ (kNm) and Reduced Moment Resistance $M_{N,y,Rd}$, $M_{N,z,Rd}$ (kNm) for Ratios of Design Axial Force to Design Axial Plastic Resistance $n = N_{Ed} / N_{pl,Rd}$											
		n	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
200x90x30	n/a	$M_{c,y,Rd}$	103	103	103	103	103	103	103	103	103	103	103
$N_{pl,Rd}$ = 1350	**1.00**	$M_{c,z,Rd}$	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
200x75x23	n/a	$M_{c,y,Rd}$	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6
$N_{pl,Rd}$ = 1060	**1.00**	$M_{c,z,Rd}$	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
180x90x26	n/a	$M_{c,y,Rd}$	82.4	82.4	82.4	82.4	82.4	82.4	82.4	82.4	82.4	82.4	82.4
$N_{pl,Rd}$ = 1180	**1.00**	$M_{c,z,Rd}$	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
180x75x20	n/a	$M_{c,y,Rd}$	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5
$N_{pl,Rd}$ = 919	**1.00**	$M_{c,z,Rd}$	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
150x90x24	n/a	$M_{c,y,Rd}$	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5
$N_{pl,Rd}$ = 1080	**1.00**	$M_{c,z,Rd}$	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
150x75x18	n/a	$M_{c,y,Rd}$	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
$N_{pl,Rd}$ = 809	**1.00**	$M_{c,z,Rd}$	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
125x65x15	n/a	$M_{c,y,Rd}$	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9
$N_{pl,Rd}$ = 667	**1.00**	$M_{c,z,Rd}$	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											
100x50x10	n/a	$M_{c,y,Rd}$	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4
$N_{pl,Rd}$ = 462	**1.00**	$M_{c,z,Rd}$	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21
		$M_{N,y,Rd}$											
		$M_{N,z,Rd}$											

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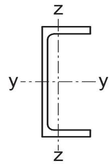
N_{Ed} = Design value of the axial force.
$n = N_{Ed} / N_{pl,Rd}$
The values in this table are conservative for tension as the more onerous compression section classification limits have been used.
Reduced moment resistance $M_{N,y,Rd}$ and $M_{N,z,Rd}$ are not calculated for channels.
FOR EXPLANATION OF TABLES SEE NOTE 10.

AXIAL FORCE & BENDING

PARALLEL FLANGE CHANNEL
Advance® UKPFC



Member buckling check

Section Designation and Resistances (kN, kNm)	n Limit	Compression Resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$ (kN) and Buckling Resistance Moment $M_{b,Rd}$ (kNm) for Varying buckling lengths L (m) within the limiting value of $n = N_{Ed} / N_{pl,Rd}$												
		L (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
200x90x30	1.00	$N_{b,y,Rd}$	1350	1320	1260	1210	1150	1090	1020	889	756	635	533	449	381
$N_{pl,Rd}$ = 1350		$N_{b,z,Rd}$	1170	990	800	626	489	386	310	211	152	115	89.6	71.8	58.8
$f_y W_{el,y}$ = 89.5	**1.00**	$M_{b,Rd}$	102	88.1	77.3	68.7	61.9	56.3	51.6	44.4	39.0	34.8	31.5	28.7	26.4
$f_y W_{el,z}$ = 19.0															
200x75x23	1.00	$N_{b,y,Rd}$	1060	1040	995	950	904	856	805	698	593	497	417	351	298
$N_{pl,Rd}$ = 1060		$N_{b,z,Rd}$	866	689	517	383	289	224	178	119	85.3	64.0	49.7	39.8	32.5
$f_y W_{el,y}$ = 69.6	**1.00**	$M_{b,Rd}$	74.3	62.1	53.0	46.1	40.8	36.6	33.2	28.1	24.4	21.6	19.4	17.6	16.1
$f_y W_{el,z}$ = 12.0															
180x90x26	1.00	$N_{b,y,Rd}$	1180	1140	1090	1030	973	912	849	718	595	490	405	338	285
$N_{pl,Rd}$ = 1180		$N_{b,z,Rd}$	1020	869	703	551	430	340	273	186	134	101	79.0	63.3	51.8
$f_y W_{el,y}$ = 71.7	**1.00**	$M_{b,Rd}$	81.3	70.2	61.6	54.8	49.4	44.9	41.2	35.5	31.2	27.8	25.1	23.0	21.1
$f_y W_{el,z}$ = 16.8															
180x75x20	1.00	$N_{b,y,Rd}$	919	887	844	800	754	706	655	551	455	373	308	256	216
$N_{pl,Rd}$ = 919		$N_{b,z,Rd}$	749	594	445	330	249	193	153	103	73.3	55.0	42.7	34.2	27.9
$f_y W_{el,y}$ = 54.0	**1.00**	$M_{b,Rd}$	57.5	48.0	40.8	35.4	31.2	28.0	25.3	21.4	18.5	16.4	14.7	13.4	12.2
$f_y W_{el,z}$ = 10.2															
150x90x24	1.00	$N_{b,y,Rd}$	1070	1010	955	892	825	754	683	547	433	346	280	230	192
$N_{pl,Rd}$ = 1080		$N_{b,z,Rd}$	938	796	643	504	394	311	250	170	123	92.7	72.3	58.0	47.5
$f_y W_{el,y}$ = 55.0	**1.00**	$M_{b,Rd}$	63.1	55.2	49.1	44.2	40.3	37.0	34.3	29.8	26.4	23.8	21.6	19.8	18.3
$f_y W_{el,z}$ = 15.8															
150x75x18	1.00	$N_{b,y,Rd}$	804	760	715	668	617	564	510	408	323	257	208	171	143
$N_{pl,Rd}$ = 809		$N_{b,z,Rd}$	661	527	396	294	222	172	137	91.6	65.6	49.2	38.2	30.6	25.0
$f_y W_{el,y}$ = 40.8	**1.00**	$M_{b,Rd}$	43.5	36.8	31.8	27.9	24.9	22.5	20.6	17.5	15.3	13.6	12.3	11.2	10.3
$f_y W_{el,z}$ = 9.44															
125x65x15	1.00	$N_{b,y,Rd}$	648	603	556	506	453	399	348	262	200	155	124	101	83.4
$N_{pl,Rd}$ = 667		$N_{b,z,Rd}$	510	379	268	192	142	109	85.8	57.1	40.6	30.4	23.6	18.8	15.4
$f_y W_{el,y}$ = 27.4	**1.00**	$M_{b,Rd}$	28.5	24.1	21.0	18.6	16.7	15.1	13.9	11.9	10.4	9.27	8.37	7.63	7.01
$f_y W_{el,z}$ = 6.67															
100x50x10	1.00	$N_{b,y,Rd}$	432	391	347	300	254	213	178	127	93.5	71.5	56.3	45.4	37.4
$N_{pl,Rd}$ = 462		$N_{b,z,Rd}$	297	191	124	85.2	61.8	46.7	36.5	24.0	17.0	12.7	9.79	7.79	6.35
$f_y W_{el,y}$ = 14.7	**1.00**	$M_{b,Rd}$	14.3	12.0	10.3	9.11	8.14	7.37	6.73	5.75	5.02	4.46	4.02	3.66	3.36
$f_y W_{el,z}$ = 3.51															

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$n = N_{Ed} / N_{pl,Rd}$

Under combined axial compression and bending the resistances are only valid up to the given $N_{Ed} / N_{pl,Rd}$ limit.

For higher values of $n = N_{Ed} / N_{pl,Rd}$ the section would be overloaded due to N_{Ed} alone even when M_{Ed} is zero, because N_{Ed} would exceed the local buckling resistance of the section.

FOR EXPLANATION OF TABLES SEE NOTE 10.

BOLT RESISTANCES

S355

Non Preloaded bolts

Property Class 4.6 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	24.3	16.2	32.4	1.8
16	157	45.2	30.1	60.3	2.7
20	245	70.6	47.0	94.1	3.4
24	353	102	67.8	136	4.1
30	561	162	108	215	5.1

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	30.3	*36.3*	*42.4*	*48.4*	*54.5*	*60.5*	*72.6*	*90.8*	*121*	*151*	*182*
16	25	35	50	50	42.7	51.2	59.7	*68.3*	*76.8*	*85.4*	*102*	*128*	*171*	*213*	*256*
20	30	40	60	60	48.3	57.9	67.6	77.2	86.9	*96.5*	*116*	*145*	*193*	*241*	*290*
24	35	50	70	70	**59.8**	71.8	83.8	95.8	108	120	*144*	*180*	*239*	*299*	*359*
30	45	60	85	90	**72.4**	**86.9**	**101**	116	130	145	174	*217*	*290*	*362*	*434*

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d\, t/\gamma_{M2}$
FOR EXPLANATION OF TABLES SEE NOTE 11.

BS EN 1993-1-8:2005
BS EN ISO 4014
BS EN ISO 4017

BOLT RESISTANCES

S355

Non Preloaded bolts

Property Class 8.8 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	48.6	27.5	55.0	3.7
16	157	90.4	60.3	121	5.5
20	245	141	94.1	188	6.8
24	353	203	136	271	8.2
30	561	323	215	431	10.1

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	30.3	36.3	42.4	48.4	54.5	*60.5*	*72.6*	*90.8*	*121*	*151*	*182*
16	25	35	50	50	**42.7**	**51.2**	**59.7**	68.3	76.8	85.4	102	*128*	*171*	*213*	*256*
20	30	40	60	60	**48.3**	**57.9**	**67.6**	**77.2**	**86.9**	96.5	116	145	*193*	*241*	*290*
24	35	50	70	70	**59.8**	**71.8**	**83.8**	**95.8**	**108**	**120**	144	180	239	*299*	*359*
30	45	60	85	90	**72.4**	**86.9**	**101**	**116**	**130**	**145**	**174**	217	290	362	*434*

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	25	40	50	45	53.0	*63.7*	*74.3*	*84.9*	*95.5*	*106*	*127*	*159*	*212*	*265*	*318*
16	30	50	65	55	69.6	83.6	97.5	111	*125*	*139*	*167*	*209*	*279*	*348*	*418*
20	35	60	80	70	**85.5**	103	120	137	154	171	*205*	*256*	*342*	*427*	*513*
24	40	75	95	80	**108**	**130**	152	174	195	217	260	*325*	*434*	*542*	*651*
30	50	90	115	100	**128**	**154**	**179**	**205**	231	256	308	385	*513*	*641*	*769*

For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.

Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.

Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.

Bearing values assume standard clearance holes.

If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.

If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.

In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d t / \gamma_{M2}$

FOR EXPLANATION OF TABLES SEE NOTE 11.

BS EN 1993-1-8:2005
BS EN ISO 4014
BS EN ISO 4017

BOLT RESISTANCES

S355

Non Preloaded bolts

Property Class 10.9 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	60.7	28.7	57.3	4.6
16	157	113	62.8	126	6.9
20	245	176	98.0	196	8.5
24	353	254	141	282	10.2
30	561	404	224	449	12.6

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge											
d	e_2	e_1	p_1	p_2	Thickness in mm of ply, t.										
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	30.3	36.3	42.4	48.4	54.5	*60.5*	*72.6*	*90.8*	*121*	*151*	*182*
16	25	35	50	50	**42.7**	**51.2**	**59.7**	68.3	76.8	85.4	102	*128*	*171*	*213*	*256*
20	30	40	60	60	**48.3**	**57.9**	**67.6**	**77.2**	**86.9**	**96.5**	116	145	193	*241*	*290*
24	35	50	70	70	**59.8**	**71.8**	**83.8**	**95.8**	**108**	**120**	144	180	239	*299*	*359*
30	45	60	85	90	**72.4**	**86.9**	**101**	**116**	**130**	**145**	**174**	**217**	290	362	434

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge											
d	e_2	e_1	p_1	p_2	Thickness in mm of ply, t.										
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	25	40	50	45	53	*63.7*	*74.3*	*84.9*	*95.5*	*106*	*127*	*159*	*212*	*265*	*318*
16	30	50	65	55	69.6	83.6	97.5	111	125	*139*	*167*	*209*	*279*	*348*	*418*
20	35	60	80	70	**85.5**	103	120	137	154	171	*205*	*256*	*342*	*427*	*513*
24	40	75	95	80	**108**	**130**	152	174	195	217	260	*325*	*434*	*542*	*651*
30	50	90	115	100	**128**	**154**	**179**	**205**	231	256	308	385	*513*	*641*	*769*

For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d t / \gamma_{M2}$
FOR EXPLANATION OF TABLES SEE NOTE 11.

BS EN 1993-1-8:2005
BS EN ISO 4016
BS EN ISO 4018

BOLT RESISTANCES

S355

Non Preloaded bolts

Property Class 4.6 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	17.0	16.2	32.4	1.3
16	157	31.7	30.1	60.3	1.9
20	245	49.4	47.0	94.1	2.4
24	353	71.2	67.8	136	2.9
30	561	113	108	215	3.5

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge											
d	e_2	e_1	p_1	p_2	Thickness in mm of ply, t.										
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	**12.1**	18.2	24.2	30.3	*36.3*	*42.4*	*54.5*	*72.6*	*103*	*133*	*163*
16	25	35	50	50	**8.5**	**17.1**	**25.6**	34.1	42.7	51.2	*68.3*	*93.9*	*137*	*179*	*222*
20	30	40	60	60	**0**	**9.7**	**19.3**	**29.0**	**38.6**	48.3	67.6	*96.5*	*145*	*193*	*241*
24	35	50	70	70	**0**	**0**	**12.0**	**23.9**	**35.9**	**47.9**	71.8	108	*168*	*227*	*287*
30	45	60	85	90	**0**	**0**	**0**	**7.2**	**21.7**	**36.2**	**65.2**	109	181	*253*	*326*

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u\, d\, t / \gamma_{M2}$
FOR EXPLANATION OF TABLES SEE NOTE 11

BS EN 1993-1-8:2005
BS EN ISO 4014
BS EN ISO 4017

BOLT RESISTANCES

S355

Non Preloaded bolts

Property Class 8.8 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	34.0	27.5	55.0	2.6
16	157	63.3	60.3	121	3.8
20	245	98.8	94.1	188	4.8
24	353	142	136	271	5.7
30	561	226	215	431	7.1

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge											
d	e_2	e_1	p_1	p_2	Thickness in mm of ply, t.										
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	**12.1**	**18.2**	**24.2**	30.3	36.3	42.4	54.5	*72.6*	*103*	*133*	*163*
16	25	35	50	50	**8.5**	**17.1**	**25.6**	**34.1**	**42.7**	**51.2**	68.3	93.9	*137*	*179*	*222*
20	30	40	60	60	**0**	**9.7**	**19.3**	**29.0**	**38.6**	**48.3**	**67.6**	96.5	145	*193*	*241*
24	35	50	70	70	**0**	**0**	**12.0**	**23.9**	**35.9**	**47.9**	**71.8**	**108**	168	227	*287*
30	45	60	85	90	**0**	**0**	**0**	**7.2**	**21.7**	**36.2**	**65.2**	**109**	**181**	253	326

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge											
d	e_2	e_1	p_1	p_2	Thickness in mm of ply, t.										
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	25	40	50	45	**21.2**	31.8	42.4	53.0	*63.7*	*74.3*	*95.5*	*127*	*180*	*233*	*286*
16	30	50	65	55	**13.9**	**27.9**	**41.8**	**55.7**	69.6	83.6	111	*153*	*223*	*292*	*362*
20	35	60	80	70	**0**	**17.1**	**34.2**	**51.3**	**68.4**	**85.5**	120	171	*256*	*342*	*427*
24	40	75	95	80	**0**	**0**	**21.7**	**43.4**	**65.1**	**86.8**	**130**	195	*304*	*412*	*521*
30	50	90	115	100	**0**	**0**	**0**	**12.8**	**38.5**	**64.1**	**115**	**192**	320	*449*	*577*

For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d\, t/\gamma_{M2}$
FOR EXPLANATION OF TABLES SEE NOTE 11

BS EN 1993-1-8:2005
BS EN ISO 4014
BS EN ISO 4017

BOLT RESISTANCES

S355

Non Preloaded bolts

Property Class 10.9 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	42.5	28.7	57.3	3.2
16	157	79.1	62.8	126	4.8
20	245	123	98.0	196	6.0
24	353	178	141	282	7.2
30	561	283	224	449	8.9

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	20	25	35	40	**12.1**	**18.2**	**24.2**	30.3	36.3	42.4	54.5	*72.6*	*103*	*133*	*163*
16	25	35	50	50	**8.5**	**17.1**	**25.6**	**34.1**	**42.7**	**51.2**	68.3	93.9	*137*	*179*	*222*
20	30	40	60	60	**0**	**9.7**	**19.3**	**29.0**	**38.6**	**48.3**	**67.6**	**96.5**	145	193	*241*
24	35	50	70	70	**0**	**0**	**12.0**	**23.9**	**35.9**	**47.9**	**71.8**	**108**	168	227	*287*
30	45	60	85	90	**0**	**0**	**0**	**7.2**	**21.7**	**36.2**	**65.2**	**109**	**181**	253	326

Diameter of Bolt	Minimum				Bearing Resistance (kN)										
	Edge distance	End distance	Pitch	Gauge	Thickness in mm of ply, t.										
d	e_2	e_1	p_1	p_2											
mm	mm	mm	mm	mm	5	6	7	8	9	10	12	15	20	25	30
12	25	40	50	45	**21.2**	31.8	42.4	53.0	*63.7*	*74.3*	*95.5*	*127*	*180*	*233*	*286*
16	30	50	65	55	**13.9**	**27.9**	**41.8**	**55.7**	69.6	83.6	111	*153*	*223*	*292*	*362*
20	35	60	80	70	**0**	**17.1**	**34.2**	**51.3**	**68.4**	**85.5**	120	171	*256*	*342*	*427*
24	40	75	95	80	**0**	**0**	**21.7**	**43.4**	**65.1**	**86.8**	**130**	195	*304*	*412*	*521*
30	50	90	115	100	**0**	**0**	**0**	**12.8**	**38.5**	**64.1**	**115**	**192**	320	449	*577*

For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
Values of bearing resistance in **bold** are less than the single shear resistance of the bolt.
Values of bearing resistance in *italic* are greater than the double shear resistance of the bolt.
Bearing values assume standard clearance holes.
If oversize or short slotted holes are used, bearing values should be multiplied by 0.8.
If long slotted or kidney shaped holes are used, bearing values should be multiplied by 0.6.
In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to $1.5 f_u d t / \gamma_{M2}$
FOR EXPLANATION OF TABLES SEE NOTE 11

Preloaded bolts at serviceability limit state (Category B)

Property Class 8.8 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Shear Resistance		Slip resistance, $F_{s,Rd,ser}$							
		Single Shear	Double Shear	μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
d	A_s	$F_{v,Rd}$	2 x $F_{v,Rd}$	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
mm	mm^2	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
12	84.3	27.5	55.0	8.6	17.2	12.9	25.7	17.2	34.3	21.5	42.9
16	157	60.3	121	16.0	32.0	24.0	48.0	32.0	63.9	40.0	79.9
20	245	94.1	188	24.9	49.9	37.4	74.8	49.9	100	62.4	125
24	353	136	271	35.9	71.9	53.9	108	71.9	144	89.9	180
30	561	215	431	57.1	114	85.7	171	114	228	143	286

Bearing resistances may be taken from the tables for non-preloaded bolts
For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
The shear resistances are ULS values
The slip resistances are SLS values
Values have been calculated assuming k_s=1. See BS EN 1993-1-8, section 3.9 for other values of k_s.

Preloaded bolts in tension (Category E)

Property Class 8.8 hexagon head bolts

Diameter of bolt	Tensile Stress Area	Tension Resistance	Min. thickness for punching shear
d	A_s	$F_{t,Rd}$	t_{min}
mm	mm^2	kN	mm
12	84.3	48.6	3.2
16	157	90.4	4.7
20	245	141	6.2
24	353	203	7.0
30	561	323	9.1

The minimum thickness is such that the design punching shear resistance $B_{p,Rd}$ is equal to the design tension resistance $F_{t,Rd}$.
FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Preloaded bolts at serviceability limit state (Category B)

Property Class 10.9 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Shear Resistance		Slip resistance, $F_{s,Rd,ser}$							
		Single Shear	Double Shear	μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
				Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
d	A_s	$F_{v,Rd}$	2 x $F_{v,Rd}$								
mm	mm^2	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
16	157	62.8	126	20.0	40.0	30.0	59.9	40.0	79.9	50.0	99.9
20	245	98.0	196	31.2	62.4	46.8	93.5	62.4	125	78.0	156
24	353	141	282	44.9	89.9	67.4	135	89.9	180	112	225
30	561	224	449	71.4	143	107	214	143	286	179	357

Bearing resistances may be taken from the tables for non-preloaded bolts
For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
The shear resistances are ULS values
The slip resistances are SLS values
Values have been calculated assuming k_s=1. See BS EN 1993-1-8, section 3.9 for other values of k_s.

Preloaded bolts in tension (Category E)

Property Class 10.9 hexagon head bolts

Diameter of bolt	Tensile Stress Area	Tension Resistance	Min. thickness for punching shear
d	A_s	$F_{t,Rd}$	t_{min}
mm	mm^2	kN	mm
16	157	113	5.9
20	245	176	7.8
24	353	254	8.7
30	561	404	11.4

The minimum thickness is such that the design punching shear resistance $B_{p,Rd}$ is equal to the design tension resistance $F_{t,Rd}$.
FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Preloaded bolts at ultimate limit state (Category C)

Property Class 8.8 hexagon head bolts

Diameter of Bolt	Tensile Stress Area	Slip Resistance							
		μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
		Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
d	A_s								
mm	mm^2	kN	kN	kN	kN	kN	kN	kN	kN
12	84.3	7.55	15.1	11.3	22.7	15.1	30.2	18.9	37.8
16	157	14.1	28.1	21.1	42.2	28.1	56.3	35.2	70.3
20	245	22.0	43.9	32.9	65.9	43.9	87.8	54.9	110
24	353	31.6	63.3	47.4	94.9	63.3	127	79.1	158
30	561	50.3	101	75.4	151	101	201	126	251

Bearing resistances may be taken from the tables for non-preloaded bolts
Shear resistances may be taken from the tables for Category B joints
FOR EXPLANATION OF TABLES SEE NOTE 11

Preloaded bolts at ultimate limit state (Category C)

Property Class 10.9 hexagon head bolts

Diameter of Bolt d mm	Tensile Stress Area A_s mm^2	Slip Resistance							
		μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
		Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN
16	157	17.6	35.2	26.4	52.8	35.2	70.3	44.0	87.9
20	245	27.4	54.9	41.2	82.3	54.9	110	68.6	137
24	353	39.5	79.1	59.3	119	79.1	158	98.8	198
30	561	62.8	126	94.2	188	126	251	157	314

Bearing resistances may be taken from the tables for non-preloaded bolts
Shear resistances may be taken from the tables for Category B joints
FOR EXPLANATION OF TABLES SEE NOTE 11

Preloaded bolts at serviceability limit state (Category B)

Property Class 8.8 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Shear Resistance		Slip resistance, $F_{s,Rd,ser}$							
		Single Shear	Double Shear	μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
d	A_s	$F_{v,Rd}$	2 x $F_{v,Rd}$	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
mm	mm^2	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
12	84.3	27.5	55.0	8.6	17.2	12.9	25.7	17.2	34.3	21.5	42.9
16	157	60.3	121	16.0	32.0	24.0	48.0	32.0	63.9	40.0	79.9
20	245	94.1	188	24.9	49.9	37.4	74.8	49.9	100	62.4	125
24	353	136	271	35.9	71.9	53.9	108	71.9	144	89.9	180
30	561	215	431	57.1	114	85.7	171	114	228	143	286

Bearing resistances may be taken from the tables for non-preloaded countersunk bolts
For M12 bolts the design shear resistance $F_{v,Rd}$ has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (§3.6.1(5))
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
The shear resistances are ULS values
The slip resistances are SLS values
Values have been calculated assuming k_s=1. See BS EN 1993-1-8, section 3.9 for other values of k_s.

Preloaded bolts in tension (Category E)

Property Class 8.8 countersunk bolts

Diameter of bolt	Tensile Stress Area	Tension Resistance	Min. thickness for punching shear
d	A_s	$F_{t,Rd}$	t_{min}
mm	mm^2	kN	mm
12	84.3	34.0	2.3
16	157	63.3	3.3
20	245	98.8	4.4
24	353	142	4.9
30	561	226	6.4

The minimum thickness is such that the design punching shear resistance $B_{p,Rd}$ is equal to the design tension resistance $F_{t,Rd}$.
FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Preloaded bolts at serviceability limit state (Category B)

Property Class 10.9 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Shear Resistance		Slip resistance, $F_{s,Rd,ser}$							
		Single Shear	Double Shear	μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
				Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
d	A_s	$F_{v,Rd}$	2 x $F_{v,Rd}$								
mm	mm^2	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
16	157	62.8	126	20.0	40.0	30.0	59.9	40.0	79.9	50.0	99.9
20	245	98.0	196	31.2	62.4	46.8	93.5	62.4	125	78.0	156
24	353	141	282	44.9	89.9	67.4	135	89.9	180	112	225
30	561	224	449	71.4	143	107	214	143	286	179	357

Bearing resistances may be taken from the tables for non-preloaded countersunk bolts
See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners.
The shear resistances are ULS values
The slip resistances are SLS values
Values have been calculated assuming k_s=1. See BS EN 1993-1-8, section 3.9 for other values of k_s.

Preloaded bolts in tension (Category E)

Property Class 10.9 countersunk bolts

Diameter of bolt	Tensile Stress Area	Tension Resistance	Min. thickness for punching shear
d	A_s	$F_{t,Rd}$	t_{min}
mm	mm^2	kN	mm
16	157	79.1	4.1
20	245	124	5.4
24	353	178	6.1
30	561	283	8

The minimum thickness is such that the design punching shear resistance $B_{p,Rd}$ is equal to the design tension resistance $F_{t,Rd}$.
FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Preloaded bolts at ultimate limit state (Category C)

Property Class 8.8 countersunk bolts

Diameter of Bolt	Tensile Stress Area	Slip Resistance							
		μ = 0.2		μ = 0.3		μ = 0.4		μ = 0.5	
		Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear	Single Shear	Double Shear
d	A_s								
mm	mm^2	kN	kN	kN	kN	kN	kN	kN	kN
12	84.3	7.55	15.1	11.3	22.7	15.1	30.2	18.9	37.8
16	157	14.1	28.1	21.1	42.2	28.1	56.3	35.2	70.3
20	245	22.0	43.9	32.9	65.9	43.9	87.8	54.9	110
24	353	31.6	63.3	47.4	94.9	63.3	127	79.1	158
30	561	50.3	101	75.4	151	101	201	126	251

Bearing resistances may be taken from the tables for non-preloaded countersunk bolts
Shear resistances may be taken from the tables for Category B joints
FOR EXPLANATION OF TABLES SEE NOTE 11

BOLT RESISTANCES

Preloaded bolts at ultimate limit state (Category C)

Property Class 10.9 countersunk bolts

Diameter of Bolt d mm	Tensile Stress Area A_s mm^2	Slip Resistance							
		$\mu = 0.2$		$\mu = 0.3$		$\mu = 0.4$		$\mu = 0.5$	
		Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN	Single Shear kN	Double Shear kN
16	157	17.6	35.2	26.4	52.8	35.2	70.3	44.0	87.9
20	245	27.4	54.9	41.2	82.3	54.9	110	68.6	137
24	353	39.5	79.1	59.3	119	79.1	158	98.8	198
30	561	62.8	126	94.2	188	126	251	157	314

Bearing resistances may be taken from the tables for non-preloaded countersunk bolts
Shear resistances may be taken from the tables for Category B joints
FOR EXPLANATION OF TABLES SEE NOTE 11

Design weld resistances

Leg Length s mm	Throat Thickness a mm	Longitudinal resistance $F_{w,L,Rd}$ kN/mm	Transverse resistance $F_{w,T,Rd}$ kN/mm
3.0	2.1	0.51	0.62
4.0	2.8	0.68	0.83
5.0	3.5	0.84	1.03
6.0	4.2	1.01	1.24
8.0	5.6	1.35	1.65
10.0	7.0	1.69	2.07
12.0	8.4	2.03	2.48
15.0	10.5	2.53	3.10
18.0	12.6	3.04	3.72
20.0	14.0	3.38	4.14
22.0	15.4	3.71	4.55
25.0	17.5	4.22	5.17

FOR EXPLANATION OF TABLES SEE NOTE 11.2

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