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NSC

Annual Review

Cover Image
The Met Office, Exeter
Main client: The Met Office
Architect: Stride Treglown
Main contractor: Willmott Dixon
Structural engineer: WSP Parsons Brinckerhoff
Steelwork contractor: William Haley Engineering
Steel tonnage: 230t

© Willmott Dixon/Michael Whitestone

NSC Annual Review

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Year ends on a high note as steel's market share rises

Sarah McCann-Bartlett, Director General of the British Constructional Steelwork Association, introduces the 2016 Annual Review of NSC.

Welcome to our annual review of some of the highlights from New Steel Construction during 2016. Once again, steel dominated the UK's non-residential construction sector across a wide range of building types and locations. As you can read here, steel continues to prove its worth on projects large and small the length and breadth of the UK and Ireland, and across all sectors.

It is no surprise then that we ended 2016 on a high note with news from independent market researchers that steel had increased its share of the key multi-storey building and shed markets during the year. The increased market share for offices is particularly striking, up almost four percentage points from an already high level.

Steel increased its share of the multi-storey market overall and even rose in single storey sheds where the market share is always comfortably over 90%. Whether it is sheds or iconic structures, an increasing number of developers seem to be capturing the many advantages of building in steel, including cost, speed, quality, flexibility and sustainability.

There is great variety in the projects featured in NSC each month but one thing that the projects have in common is that their steelwork was fabricated by members of the BCSA.

Choosing a BCSA member remains the best assurance of ensuring a quality steelwork contractor for your project. They are served by the most sophisticated supply chain in the world's constructional steelwork industry, as we have been highlighting in a series of supply chain focussed articles on Steel for Life sponsors in NSC.

We look forward to developing that supply chain focus in 2017, and to seeing the BCSA's members' deserved reputation as a world leading force in constructional steelwork further enhanced on another wide range of excellent projects.

Innovation gong for offloading frame

Leach Structural Steelwork's offloading frame won the Innovation category at the North West Construction Safety Group awards.

Allowing an operative to safely load and unload steel while working on the back of a truck, the frame was designed and built at the company's own premises.

The frame comprises a walkway section measuring approximately 7.5m-long, with a support for two inertia reels.

Weighing 550kg, the frame locates into sockets on the trailer, usually provided by the bottom bearers, which are welded to the spine beams of the unit.

The frame is delivered to site on the first delivery and it is then hoisted from the trailer using permanent lifting points.

Once it is set level on the ground and brought to vertical using lifting points, the frame is then hoisted and inserted into the sockets on the trailer. It can be attached to either side of the trailer, generally opposite the storage area to maximise crane access.

Steel drives Sky car park delivery

Steel construction's speed of delivery has come to the fore as an 830-space multi-storey car park for media company Sky had its frame erected and flooring installed in just eight weeks.

Sky's headquarters in Osterley, west London has undergone a major expansion with new offices and a new multi-storey car park both being constructed.

Bourne Parking was the main contractor and steelwork contractor for the car park.

"Normally the build programme would be much longer but the client wanted the car park as quickly as possible, so with four cranes working simultaneously for the steel erection we were able to achieve this fast programme," explains Bourne Parking Senior Project Manager Greg Brown.

The car park measures 90m-long × 50m-wide and consists of seven levels, including ground floor and an open rooftop level.

The structure is a steel braced frame that supports precast flooring planks, with steelwork erected around a 7.5m × 16m grid pattern.

Prior to Bourne starting on-site, the plot for the car park had already been cleared with an old office block demolished under a separate contract.

Once the piling and the installation of ground beams had been completed, as well as the construction of two precast cores, the steel erection programme was able to begin.

£300M steel-framed expansion of Sheffield's Meadowhall

British Land, joint owner of the large Meadowhall shopping centre in Sheffield, has revealed plans for a new steel-framed leisure hall at the site.

The plans represent the single biggest investment in Meadowhall since it opened more than 25 years ago. At over £300M, the proposals are also one of the largest investments in the Sheffield City Region for a decade and will create over 1,000 jobs.

Comprising 30,600m^2 of space, the proposed leisure hall will add a range of dining and entertainment experiences not currently available at the centre.

These will include new restaurants, a state-of-the-art cinema, a new café court, gym, and other leisure space that could be used to offer everything from ten-pin bowling to indoor golf.

Housed under a large glazed roof, the steel-framed leisure hall will integrate with the existing centre to create a new multi-levelled, landscaped mall with high quality internal and external spaces for promotional and community uses. It has also been designed to accommodate large outdoor events including live music.

British Land hopes to start on-site during 2018 and open the leisure hall to visitors in late 2020 or early 2021.

Steel-framed BIM store for Asda

Steelwork has been completed on Asda's first Level 2 BIM (Building Information Modelling) project in Clacton-on-Sea, Essex.

Working on behalf of main contractor ISG, Walter Watson is erecting the steelwork for the 3,200m² supermarket that is being constructed on the site of a former multi-occupancy retail development.

The steel-framed building will include a customer café, deli counter, an in-store bakery and staff areas with shower and changing facilities. The site also includes an automated petrol filling station and a large car park with four electric vehicle charge points.

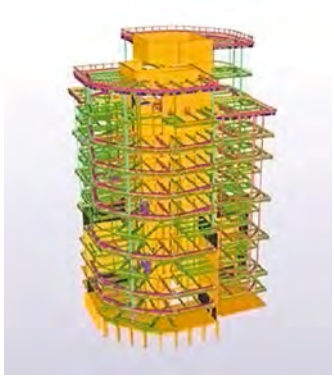
The build programme has been fully designed in BIM with all consultants working in collaboration software system Autodesk Revit, resulting in the production of seven fully-annotated 3D models.

ISG's Western Regional Managing Director Rob Martin commented: "The Clacton-on-Sea project represents the culmination of a journey by Asda into advanced collaborative working practices, where ISG has played a key role as a trusted project partner and influencer.

"In a sector where operational costs and asset management are critical, BIM not only creates efficiency benefits during the build phase but also throughout the service life of the store and we are thrilled to be working with Asda on such a milestone project."

Steel projects come to the fore at Tekla Awards

Trimble has announced the winners of the UK Tekla Awards 2016, which will now be entered into the Tekla Global BIM Awards.



The awards focus on projects of all shapes and sizes, which have used Trimble's Tekla software as part of the process for designing and modelling structures, or where the use of Tekla software has aided collaboration.

Severfield won the Commercial Projects Award for the South Bank Tower development in London (pictured), while William Hare won the Sports and Recreation Projects category for its work on the Olympic Stadium roof.

A Public Vote category was also won by Severfield for the Ordsall Chord bridgeworks.

Trimble Solutions (UK) Managing Director Richard Fletcher said: "It's no surprise that once again our competition has yielded some brilliant projects. In fact, the entries that were submitted to this year's awards were so strong that determining the winners of the seven categories was a tough decision to make.

"The awards are an ideal way for our customers to raise their company profile and attract potential new clients, as well as impress existing clients. They showcase and reward the hard work and innovation that goes into using software to solve engineering challenges, working collaboratively and delivering better outcomes for all involved."

Historic gas holders return to Kings Cross

Three Victorian cast iron gas holders have been refurbished and are now being re-erected as part of a residential development at Kings Cross, London.

Bourne Steel has been contracted by main contractor Carillion to erect the gas holders as independently-standing feature structures around three circular residential blocks that will contain 144 apartments.

The erection process is challenging and care has to be taken to not damage the cast iron columns and beams, as they are fragile.

The gas holders also have to be re-built in a certain sequence as they are not tied back to any existing or new structure. In total there are 41 columns, each approximately 14m-tall, to be erected, along with connecting lattice beams and guide rails.

NEWS IN BRIEF

Software developer **StruMIS** has launched V10 (version 10) of its steel fabrication software, which is said to offer an array of updated enhancements for the medium and larger-sized steelwork fabrication contractors. StruMIS V10 is also said to include many new features to operate steel fabrication sites more efficiently including an integrated 3D BIMReview tool.

British Constructional Steelwork Association steelwork contractors are now able to demonstrate compliance with Level 2 Building Information Modelling (BIM) with the launch of the Steel Construction BIM Charter.

Belfast's **Waterfront**, the province's only purpose-built conference centre has now doubled its existing conference, exhibition and entertainment space to 7,000m² following the opening of a £29.5M steel-framed extension. Walter Watson fabricated, supplied and erected 1,200t of structural steelwork for the project.

Aberdeen Football Club Chairman Stewart Milne has revealed plans for a new stadium and training facility at Kingsford, on the city's outskirts. Announcing the proposals, Mr Milne commented: "Kingsford offers an opportunity to locate both the stadium and the training facilities within a single site and it is in an ideal location for supporters travelling from all areas in and around Aberdeen.

The highly regarded structural engineer **Roger Pope**, who has been a specialist technical consultant to the BCSA and Tata Steel for many years, was made a Fellow of the BCSA at this year's National Dinner. His career began in 1964 with an industrial scholarship to attend Oxford University from the Steel Company of Wales, later part of British Steel Corporation.

Lincoln transport hub approved

A new bus station and 1,000-space multi-storey car park is to be built in Lincoln after the Government released funding.

The £29M transport hub scheme is designed to improve city centre journeys for people living in, working in or visiting the city.

Main contractor Willmott Dixon has confirmed that structural steelwork will play a significant role in the project as the bus station will be steel-framed and the car park will have a composite design with steel supporting precast planks.

The scheme will also include a new bridge, which is curved in plan and designed as a steel Vierendeel truss.

The scheme is expected to create up to 200 jobs in the city, and could deliver an economic boost worth £9M a year.

The Department for Transport is providing £11M towards the project, with the City of Lincoln Council providing £16M and the Greater Lincolnshire Local Enterprise Partnership contributing £2M.

The city's MP Karl McCartney said: "I am delighted that the Government continues to back Lincoln with its support for funding vital transport projects and the Transport Hub is no exception.

"The construction of the Transport Hub is another important step forward in making Lincoln the most vibrant, successful and modern City in the whole of the East Midlands. Lincoln is rapidly becoming the place to live, work, visit and study."

£5M processing equipment investment made by steel stockholder

AJN Steelstock has made a multi-million pound investment at its new 17-acre depot in Somerset, which includes £5M of steel processing machinery supplied by FICEP.

The new site's production total is said to be growing rapidly month by month, with the goal to achieve 500t per day within five years by increasing shift patterns from one to three in order to fully exploit the potential of the FICEP steel processing machinery.

The eight new FICEP machines in operation at AJN include an Endeavour – a multi-spindle drilling line, the Gemini – the gantry drilling, milling and thermal cutting system for plates, several Katana – high speed bandsaws, a Rapid – high speed drilling line for angles and flats, and a shot blasting machine.

The order with FICEP also included another Endeavour machine that was purchased for AJN's Kentford facility.

AJN has conducted a detailed time study analysis that determined a 48-minute job on its old machinery now takes under five minutes on the Endeavour and is four times faster when drilling only, while productivity is said to have been further enhanced by the Gemini.

AJN Finance Director Courtney Bell said: "When we decided to expand into a new site, FICEP were the ones who offered us the best solutions after a considerable review of existing and new suppliers.

"The Endeavour proved to be the right solution for drilling and sawing. On top of this, the Rapid 25 we purchased allowed us to secure a large amount of new business."

Student accommodation opts for Metframe

Student accommodation provider Unite's latest development in Coventry has made use of voestalpine Metsec's light gauge steel Metframe system to meet the project's specific design and performance requirements.

Unite operates over 125 sites across 25 key university cities and towns in the UK. The latest development on Far Gosford Street, known as Gosford Gate, will be home to 286 students and is a key part of a long-term regeneration programme in the Coventry area.

Led by main contractor Bowmer & Kirkland, the process of constructing a facility to host a large number of students within a restricted urban area was said to require the full design and engineering capabilities of Metsec.

In addition to the logistical issues of working in a congested location, the complex design required a number of bespoke elements, to ensure that the framing solution accommodated the number of curves on the building.

Metframe is a lightweight panelised solution, said to be ideal for medium-rise buildings. The panels are manufactured offsite and faceted around the curves on the building.

The contractor said this precision engineering helped to avoid waste on-site, limit the cost to the customer as well as help to reduce the project's overall environmental impact.

Ryan Simmonds at Metsec commented: "When designing the framework, we had to consider both pitched and flat areas of the roof. Areas of the framework also needed to be faceted to accommodate the building's curved corners. The use of BIM was crucial to ensure we could visualise the interfaces and ensure our teams would not face any issues on-site when it came to installation.

"From the design and planning phase, we worked collaboratively with the architect, integrating our BIM model into theirs, allowing them to coordinate their own model and other following trades."

UKAS delivers steel sector scheme

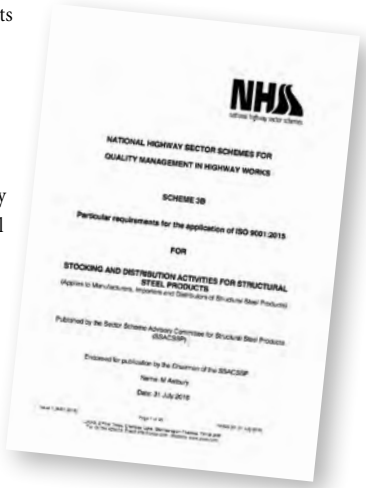
The United Kingdom Accreditation Service (UKAS) has published National Highways Sector Scheme 3B – Stocking and Distribution activities for Structural Steel Products (NHSS3B).

NHSS3B will apply to steel manufacturers, steel traders and steel stockholders that stock and distribute structural steel products and supply them for Highways England projects.

In relation to BS EN ISO 9001:2015, NHSS3B describes the quality management system for the stocking and distribution of structural steel products. It also includes the legal obligations placed on importers and distributors of structural steel products by the Construction Products Regulation as the vast majority of these products are covered by harmonised standards.

The sector scheme will be included in Highways England's 1800 Series specification and will become a mandatory requirement for companies supplying steel products to Highways England projects from 15 September 2018. Before this date the scheme is voluntary.

Copies of NHSS3B can be downloaded from the UKAS website at: *www.ukas.com/technical-services/publications/publications-relating-to-certification-body-accreditation-3/*


NHS

NATIONAL HIGHWAY SECTOR SCHEMES FOR QUALITY MANAGEMENT IN HIGHWAY WORKS

SCHEME 3B

Particular requirements for the application of ISO 9001:2015

FOR

STOCKING AND DISTRIBUTION ACTIVITIES FOR STRUCTURAL STEEL PRODUCTS

Flagship Welsh school opens to pupils

Holywell School in Flintshire, one of the first projects in Wales' 21st Century Schools Programme has opened.

The flagship £30M steel-framed super school provides a combined facility for 600 high school students and 315 infant and junior school pupils.

Requiring 700t of structural steelwork, erected by EvadX, the new building replaces the old High School, which is situated next door, and two local primary schools.

Main contractor Galliford Try began work on the project in January 2015 and it has now begun phase two of the scheme that consists of demolishing the old school buildings to create new sports pitches. The new Holywell School has an elaborate design combining a three-storey secondary school with a single storey primary school both housed within two elliptical-shaped zones.

Apart from the sports hall, drama hall and dining areas, the entire school is curved both on plan and elevation.

The steel frame forms a stretched figure of eight shape with the primary school formed around an open elliptical-shaped courtyard in the top loop, and a three-storey atrium infilling the lower loop surrounded by the secondary school classrooms.

Nene Valley tourist site rises up with steelwork

Structural steelwork is under way on the Rushden Lakes leisure, retail and tourism development in the Nene Valley, Northamptonshire.

Covering an area of 244 acres, the £55M development will include three main steel-framed retail buildings, requiring nearly 2,000t of steel and currently being erected by Caunton Engineering.

In consultation with the Wildlife Trust and Natural England, project architect HPW has designed the buildings to include extensive renewable energy systems.

The three blocks consist of a House of Fraser store, another block accommodating Marks and Spencer and Primark, and one further retail structure.

Working on behalf of main contractor Winvic Construction, Caunton will also be supplying and erecting the steel for three further smaller buildings to house restaurants overlooking the site's lake.

The first retail units on the site are scheduled to open in early 2017.

NEWS IN BRIEF

Plans have been submitted for a second large office block in the **New Bailey** regeneration area of Salford. Two New Bailey will be 11-storeys high and built with red steel and glass, according to the plans submitted to Salford City Council. Designed by architects AHMM, the building will offer 17,500m² of office space, nearly double the size of its completed sister building, the eight-storey One New Bailey.

Cellular beam specialist **Kloeckner Metals UK | Westok** has upgraded its Cellbeam software package with the launch of Version 10.2. The software is typically used by steel construction engineers and designers to analyse and design Westok Cellbeam and Ultra Shallow Floor Beams (USFBs) for single and multi-storey construction projects. Cellbeam and all of Kloeckner Westok's software is free to download from *www.kloecknerwestok.com*

British Land has been given the green light by the City of London for its 32-storey tower at 2-3 Finsbury Avenue, which is part of the 1980s built Broadgate redevelopment. Designed by Arup, the new tower will replace the building that housed Swiss bank UBS' London headquarters until they moved into the recently-completed 5 Broadgate next door.

The British Constructional Steelwork Association **Metal Decking Group** has developed four short guidance documents for those involved in the planning and preparation of metal decking installation. The guidance documents are: Loading and Positioning of Packs; System Edge Protection Installation; Propping Guide, and Concrete Pouring.

Jaguar Land Rover has appointed BAM Construction to deliver a new multi-storey car park on Kingsbury Road in Castle Bromwich, Birmingham. The 59,000m² structure will provide 2,764 spaces for staff and production vehicle parking and will replace an existing surface car park.

Steel awards highlight industry's innovation

The Structural Steel Design Awards (SSDA) scheme was instituted in 1969 to recognise the high standards of structural and architectural design attainable in the use of steel.

AWARDS

Thames Tower Redevelopment, Reading

London Olympic Roof Conversion

South Stand Expansion, Etihad Stadium

Harlech Castle Footbridge

The Memorial Spire, International Bomber Command Centre, Lincoln

COMMENDATIONS

Land Rover BAR America's Cup HQ Building, Portsmouth

The Diamond Engineering Building, The University of Sheffield

Lagan Weir Pedestrian and Cycle Bridge, Belfast

6 Bevis Marks Roof Garden, London

MERITS

Leeds Station Southern Entrance

Energy from Waste Facility, Ardley

NATIONAL FINALISTS

Energy from Waste Facility, Peterborough

New Watford Market

University of Cambridge Primary School

Sports Hall & Sixth Form Centre, Channing School, London

South Bank Tower, London

Whyke Horizon Footbridge, Chichester

Strabane Pedestrian and Cycle Bridge, Co. Tyrone

Information Age Gallery, The Science Museum, London

Kiosk and Shelter, Bournemouth Pier Approach

Chairman of the Judges, David Lazenby

BCSA President, Wendy Coney

Five projects were Award winners at this year's Structural Steel Design Awards (SSDA) held on 5th October at the Museum of London.

The five winning projects at the 48th annual SSDA were the London Olympic Roof Conversion; Harlech Castle Footbridge; Thames Tower Redevelopment, Reading; South Stand Expansion, Etihad Stadium; and The Memorial Spire, International Bomber Command Centre, Lincoln.

From the shortlist of 20 projects, all of this year's entries scored highly in efficiency, cost-effectiveness, aesthetics, sustainability and innovation.

Chairman of the Judges, David Lazenby CBE said: "It is reassuring that we have seen an increase in the number of submissions for the Awards scheme this year, and the quality and appeal of the projects is as high as ever.

"The spread of the projects, both geographically and in type, demonstrates how steelwork is used successfully in almost any type of work. Bearing in mind the great ingenuity applied by designers and practitioners there are scarcely any limits to the nature of the submissions."

British Constructional Steelwork Association [BCSA] President Wendy Coney said: "While it is well known that single storey sheds are almost all built in steel, tonight's shortlist demonstrates that steel is also the structural material of choice for schools, offices, sports stadia, power generation facilities, footbridges, and a wide range of other structures.

"Much has changed since our 2015 Awards ceremony. It has been a tumultuous year for UK steelmakers. But the supply of structural steel was unaffected and confidence in steel as the framing material of choice has been maintained.

BCSA steelwork contractor members continued to source their steel from high-quality domestic and imported sources, supported by a strong distribution and stockholding sector. This enabled us to meet demand for the full range of projects and clients."

Attendees gather before the ceremony at the Museum of London

Thames Tower Redevelopment, Reading

This project's original scheme concept was to demolish the existing concrete-framed Thames Tower in Reading town centre and replace it with a new 25-storey high tower, which would have necessitated the requirement for new supporting foundations.

However, after an innovative design proposal provided by Peter Brett Associates, the core of the existing structure was maintained and developed using a series of strengthening works throughout the height of the concrete frame, along with the provision of four new additional steel-framed office floors to increase the nett usable internal areas.

dn-a Director, Stuart McLarty comments: "Thames Tower originally had stumpy proportions, which contradicted its name as a tower. Adding four additional floors, squaring the corners and removing the concrete spandrels to allow for towering windows created a more elegant, proportionate building."

Peter Brett Associates Project Engineer Roderick Wilson adds: "Steel is ideal for this kind of project as it is quick to erect and lightweight in comparison to other materials.

"By strengthening some of the concrete columns we have added new floors to the top of the building and crucially we have been able to reduce costs by re-using all existing foundations."

As well as the four additional steel-framed floors, steel construction has also played a role in maximising and extending the existing floors of the tower.

Summing up the judges say, this is a thorough and rigorous project, which has been carried out with ingenuity and skill. With, both painstaking analysis and inventive thought, a substantial but unloved city-centre concrete building has been enlarged upwards and horizontally by the creative use of steelwork.

FACT FILE
Thames Tower Redevelopment, Reading
Architect: dn-a
Structural engineer: Peter Brett Associates LLP
Steelwork contractor: Shipley Structures Ltd
Main contractor: Bowmer & Kirkland Ltd
Client: Landid Property Holdings Ltd

London Olympic Roof Conversion

When West Ham United Football Club kicked off the current season at their new home in Stratford, it signalled the culmination of nearly three years of work to transform the former London 2012 Olympic Stadium

Components have been added, replaced, reused, and enhanced, creating a world-class venue of permanence, while the stadium now boasts a new cantilever roof, which at 45,000m^2 and an 84m maximum span, is nearly six times the weight of its predecessor and is the largest spanning tensile roof in the world.

The roof was specifically designed to improve acoustics and heighten the spectator experience, focusing sound and projecting it towards the pitch, all while reducing noise for the surrounding residential areas.

"Due to the very long spans and weight restrictions, steel was the only viable construction solution," says BuroHappold Engineering Partner Matthew Birchall.

One of the main stipulations for the future use of the stadium was that it would retain its running track. To prevent this from adversely affecting the atmosphere at football matches, an automated system of retractable seating was included in the new design, with all four sides of the lower bowl able to move over the running track when in football mode. To meet UEFA rules, the roof extends fully over the retractable seating.

The new structure included 8km of steel cables weighing 930t, 112 steel rafters, 2,308 purlins, 422 struts, 9,900 roof panels and 14 light paddles each weighing 43t, with the whole structure weighing in at around 4,700t, nearly six times the weight of its predecessor

The challenges have been met superbly and the project is a triumph for the team and for structural steelwork, say the judges.

FACT FILE
London Olympic Roof Conversion
Architect: Populous
Structural engineer: BuroHappold Engineering
Steelwork contractor: William Hare
Main contractor: Balfour Beatty Major Projects
Client: London Legacy Development Corporation

South Stand Expansion, Etihad Stadium

FACT FILE
South Stand Expansion, Etihad Stadium
Architect: Populous
Steelwork engineer: BuroHappold Engineering
Steelwork contractor: Severfield
Main contractor: Laing O'Rourke
Client: Manchester City Football Club

Described as an architecturally sympathetic extension of an existing catenary ringed structure, the project to extend Manchester City's Etihad Stadium South Stand increased the capacity of the stadium during the 2014/15 football season, adding 6,000 new seats in the stand through a third tier and a further 1,500 additional seats around the pitch.

Steelwork contractor Severfield supplied, fabricated, and installed 4,000t of structural steelwork for the job.

"We also dismantled the existing roof, carried out all temporary works and designed connections," explains Severfield Project Manager Paul Hulme.

The design was technically complex as the existing roof involved a cable net structure with a tension ring, from which steel roof rafters hung. The structural integrity of the existing tension ring relies on it running around the whole circumference of the roof; therefore any modification to the roof could not affect this, even in areas where roof rafters were removed.

Protection of the existing cable was vital as there was no repair procedure in place and damage would have resulted in the need for a replacement and a potential two-year closure of the stadium.

Extensive design optimisation exercises were undertaken, particularly for the steel roof and the stability cores. A whole series of geometric studies evaluated the effects of different stay and mast angles, concluding on a final solution to satisfy both minimum material requirements and cost.

"Steel was the natural choice for the roof given its high strength-to-weight ratio. Steel enables large long span structures to be formed with no internal columns thus providing unobstructed sightlines for viewers," says BuroHappold Engineering Project Director Fergus McCormick.

Summing up the judges say, the work tested all facets of steelwork construction to their limits, including design, fabrication and construction. A stunning testimony to all concerned and to the capabilities of steelwork.

Harlech Castle Footbridge

FACT FILE
Harlech Castle Footbridge
Concept designer: Mott MacDonald
Structural engineer: David Dexter Associates
Steelwork contractor: S H Structures Ltd
Main contractor: RL Davies & Son Ltd
Client: Cadw

Harlech Castle is said to be one of the finest surviving 13th Century castles in the UK and consequently it is a Grade I Listed Building, a Scheduled Ancient Monument and also part of a World Heritage Site.

The many visitors who arrive at the site every year would testify that in the past access to the castle was strenuous as it was via a series of timber steps with no provision for the disabled.

A new footbridge has changed all of that, by dramatically improving access and linking a new visitor centre to the castle.

Project client, Cadw always had a clear vision for the footbridge and due to the sensitive nature of the historic site the aesthetics were an important consideration.

© Cadw 2016

Client consultants Mott MacDonald explored various concepts to satisfy the constraints of functionality, alignment, heritage and visual impacts before finally opting for the S-shaped low profile Vierendeel truss design.

Both horizontal and vertical alignments were constrained by the need to connect straight through the castle's gatehouse while maintaining a suitable gradient acceptable to those with impaired mobility.

"Steel as a construction material offered a variety of structural solutions that satisfied the constraints of alignment, functionality, heritage and visual impact," says Mott MacDonald Senior Engineer – Bridges & Civil Structures Katalin Andrasi.

According to S H Structures Sales and Marketing Manager Tim Burton, perhaps the biggest challenge was the limited footprint of the site and the restricted access through Harlech. These challenges were overcome with the careful selection of the multi-wheel steer mobile crane and rear wheel steer transport trailers.

In a very sensitive setting this elegant bridge provides level access to the historic castle, whilst minimising its visual impact. The detailing and fabrication of the curved deck are exemplary, sum up the judges.

The Memorial Spire, International Bomber Command Centre, Lincoln

Lincoln has been chosen as the site for the International Bomber Command Centre (IBCC) as the county earned the title of Bomber County, as it was the home of 27 operational bases during the Second World War.

At the heart of the IBBC is the Memorial Spire. Sitting majestically above the City of Lincoln, the weathering steel structure will act as a beacon marking the courage and bravery of those who served.

Designed by Place Architecture the architectural references are taken from the airframe and wings of an Avro Lancaster Bomber.

The structure represents two wing fragments tapering towards the sky separated by perforated plates similar to those used in the aircraft's frame construction.

Further references can be found in the Spire's dimensions; standing 31.9m high this represents the same span of a Lancaster's wing and at 5m wide at its base is the same width of the aircraft's wing.

"By using weathering steel we fulfilled the brief, but we also created a multi-layered sculpture that references flight, aircraft manufacture and is also a nod to nearby Lincoln Cathedral," says Place Architecture Project Architect Stephen Palmer.

"Weathering steel also allowed us to design a sculpture with an organic feel and one that has a changing hue, which is ideal for its countryside setting."

The external profiled plates had to be curved to form the wing-like form. Press-breaking the individual plates to the desired shape using files extracted from the 3D model achieved this.

The formed plates were built up in purpose-made jigs prior to being welded together to form the complete spire sections that would go to site as two loads.

Once on-site, the spire sections, with a total weight of 55t were safely installed onto their holding down bolts, which were part of the foundations installed by local contractor Lindum Group.

The judges say, this excellent project is a fitting testament to the memory of the World War II bomber crews that flew from Lincolnshire and other parts of the UK.

FACT FILE
The Memorial Spire International Bomber Command Centre, Lincoln
Architect: Place Architecture
Structural engineer: s h e d
Steelwork contractor: S H Structures Ltd
Main contractor: Lindum Group Ltd
Client: The Lincolnshire Bomber Command Memorial Trust

Cantilevers maximise the project's floorspace

FACT FILE
London Wall Place, London
Main client: Brookfield, Oxford Properties
Architect: Make
Main contractor: Multiplex
Structural engineer: WSP Parsons Brinckerhoff
Steelwork contractor: William Hare
Steel tonnage: 8,500t

Cantilevering wall

Steel transfer structures supporting cantilevers and terraces abound on this prestigious City of London commercial development.

London Wall Place will be a new destination in the City of London, offering an acre of landscaped public realm set between two landmark office buildings with more than 46,000m² of Grade A office space. The realm features remains from the Roman City Wall and a Saxon church, surrounded by gardens, water features and suspended walkways.

Overall the project covers an area of more than 15,000m², on a plot previously occupied by numerous buildings including the 1960s built 20-storey high St Alphage House.

Work started on-site in 2013 with main contractor Multiplex demolishing all of the existing buildings, while protecting the historic structures, and then enlarging the site's existing basement to create a two-level deep zone.

A portion of the high-level pedestrian walkways, known as the Barbican and City Highwalks, originally crossed the site and were removed as part of the demolition programme.

These will be reinstated with a series of new weathering steel bridge-like walkways as part of the overall scheme (see box).

Both buildings, to be called 1 and 2 London Wall Place are steel-framed structures rising to 12 and 16 storeys respectively. Structurally independent they will however be linked by one of the weathering steel walkways that will eventually span the centrally positioned pubic realm.

The steelwork starts at ground floor level atop the concrete ground floor slab. Both buildings comprise a steel frame with composite concrete floors stabilised by concrete cores that incorporate the stairs and lift shafts.

"A number of alternate structural systems were considered during the design phase," says Multiplex Project Director Phil Clarke. "But it had to be a steel solution to meet the structural demands of the cantilevers."

Providing more than 27,000m² of floorspace, the 12-storey 1 London Wall Place is the largest, in terms of volume, of the two structures.

The final shape of the external envelope has been driven by the rights to light afforded to the adjacent Barbican and St Paul's Cathedral viewing corridor. Consequently the structure sets back at a number of areas to create terraces at the upper levels in order to reflect the planning requirements.

"To maximise floor space this building cantilevers out over adjacent roads on two of its main elevations," explains WSP Parson Brinckerhoff Senior Technical Director Stephen Jackson.

1 London Wall Place cantilevers by up to 8m along the London Wall elevation and by up to 3.5m along Fore Street.

Deep fabricated beams up to 1.95m in depth have been incorporated into the level 2 transfer structure to achieve the longest cantilevers. Other local transfers are also incorporated within the building at every floor to achieve changes in column grid as the envelope sets back floors and terraces.

Overall this structure's floor framing typically consists of primary beams spanning 9m with secondary beams, spaced at 3m centres, spanning up to 16.5m and in some locations up to 18m.

Steelwork contractor William Hare has installed numerous fabricated sections to act as transfer structures as standard rolled sections do not provide the required capacity.

"The heaviest fabricated beam we have installed is 70t and like many of these large beams it had to be lifted into place by a 160t-capacity crawler crane we had on-site for the early part of the steel programme," says William Hare Operations Director Curzon Graham.

Having such as large crawler crane on-site was a challenge in itself. Because the basement extends below most of the site's footprint and the slab would not ordinarily be able to support such a large crane, more than 300 temporary props were used to support the slab while the crane was on-site.

On the adjacent 16-storey 2 London Wall Place, the floor framing, from level two upwards, typically consists of primary beams spanning 7.5m and secondary beams provided at 3.75m centres with spans of up to 13.5m and in some locations up to 15m.

This structure also features cantilevers, which have again been introduced to maximise the floor area, although on this building the cantilevers are approximately 11m beyond the nearest internal column.

Along the south east corner of 2 London Wall Place the building cantilevers out over the main thoroughfare of London Wall, creating one of the project's main features and something of a structural steel highlight.

A series of single-storey high trusses have been installed to form these long cantilevers and to help limit the potential for high deflections.

The chord members of the truss are 640mm deep fabricated sections that form part of the main floor framing. The diagonal bracing elements are universal column sections enhanced with plates welded across the flanges to provide the necessary strength and stiffness.

Supporting 15 floors of the building, the truss members and their supporting columns are heavy and large. They were brought to site in two or three sections to make them transportable by trailer. Once on-site they were bolted together and then lifted into place by a 500t capacity mobile crane again sited on the ground floor slab with extensive back propping through the deep basement.

London Wall Place is due to complete this year (2017).

High-level walkways

A unique feature of the London Wall Place project will be the reinstated walkway structures, or Highwalks, that will cross the site to re-establish links to other parts of the City's high-level walkways.

Seven walkway structures fabricated from weathering steel are being installed as part of William Hare's steel package.

Three of the structures are reinstated bridges, one crossing London Wall and the other two spanning Fore Street, while a fourth will create a new high-level pedestrian bridge across Wood Street.

The other structures crisscross the site below and around the new buildings linking all of the bridges together.

How the multiple cantilevers will look on 1 London Wall Place

Steel's speed of construction is helping the project stay on track

New town make-over

FACT FILE
The Lexicon, Bracknell, Berkshire
Main client: Legal & General/Schroders
Architect: BDP/ Chapman Taylor
Main contractor: Mace
Structural engineer: Arup
Steelwork contractor: Severfield
Steel tonnage: 4,200t

Steel construction is playing a leading role in a £250M retail scheme that will transform Bracknell town centre. Martin Cooper reports.

One of the new towns built after the Second World War to ease inner city congestion and provide war weary families with modern housing, Bracknell is now getting a much-needed makeover.

Construction work is now under way on Phase 2 of a new retail quarter in the town centre designed by BDP and Chapman Taylor for Bracknell Regeneration Partnership, a joint venture between Legal & General and Schroders along with Bracknell Forest Council. Working on behalf of main contractor Mace, Severfield is undertaking all of the structural steelwork for phase two, as well as installing metal decking.

Known as The Lexicon, the scheme is a shopping and leisure destination, which promises a vibrant mix of brands and experiences and a high quality mix of shops and venues connected in a pedestrian-friendly environment.

Phase one of the scheme consisted of the construction of a steel-framed Waitrose supermarket that was completed in 2011. Acting as one of the anchors for the overall scheme, this structure was fabricated, supplied and erected by Billington Structures.

Phase two, which kicked off on-site in 2015 covers an area of 60,000m^2 and comprises two department stores, retail units, restaurants and cafes, a 12-screen cinema, multi-storey car park and 92 apartments.

Prior to Mace starting on-site, the demolition of the site's 1960s and 70s built shopping district had been completed. Early works included a huge earthmoving operation to level the sloping topography. Piling was then undertaken and this work has continued alongside the steel programme, although in areas were it had been completed, Severfield were able to begin erecting the new structures.

Mace Project Director Andrew James says six of the new structures within the scheme are steel-framed buildings and the material was chosen for its long-span qualities and speed of construction.

Another important consideration is steel's flexibility and adaptability, which allows for different shop configurations to be installed if and when the client changes or retail requirements alter.

A further building within Phase two is also steel-framed and this is a nine-storey structure dating back to the 1980s. Originally designed as an office block on top of a two-level retail podium, the structure is being renovated to accommodate residential units on the upper seven levels.

The original podium has been demolished and approximately 300t of new steelwork will be bolted to the existing tower to form a much larger two-level podium that will accommodate an H&M store as well as numerous food outlets.

The six new steel structures being erected by Severfield consists of two anchor department stores (Marks & Spencer and Fenwick), and four other retail blocks, one of which incorporates the cinema complex.

Visualisation of a Lexicon mall

The two 7,400m² department stores are situated either side of the concrete-framed mult-storey car park, and because they link directly into the facility their designs have dictated the latter's.

The M&S store is based around a 9.6m × 9.6m steel grid pattern that consists of a basement plant level and loading dock with two trading floors above.

Each trading floor has a 6m floor-to-ceiling height that allows them to tie into alternate car park floors, as the latter structure is based around a 3m floor-to-ceiling height.

M&S was the first building to be erected, as this part of the site's footprint was the first to have its groundworks completed.

"This area had a very steep slope that had to be infilled," says Mr James. "Plus getting the anchor stores erected first was important as they have the longest fit-out programmes."

Just before M&S was fully erected another Severfield erection gang had begun on the adjacent Fenwick store.

"Using a number of 80t-capacity mobile cranes and up to five gangs of erectors we have staggered the steel programme so at least two buildings are being progressed at any one time," explains Severfield Project Manager Robin Hamill.

The Fenwick store is based around a slightly larger 11.4m steel grid pattern incorporating three trading levels with an additional 1,400m² future expansion zone.

With three trading floors to fit into a building with a similar height to the M&S store, and with the need to tie into the adjacent car park, the building has floor-to-ceiling heights of 5m.

To help reduce the floor depth the services are integrated within 750mm deep fabricated plate girders with 1,200mm wide × 450mm deep notches in the ends and 300mm diameter holes in the web.

The different floor-to-ceiling heights and number of floors within the anchor stores was client driven," explains Arup Project Engineer Ewan Smith. "It did mean some redesign work was necessary on the car park to align the floors.

"In order to keep the department stores' overall heights similar the Fenwick store has integrated services within cellular beams, while height wasn't an issue for the M&S structure so it has fewer floors and large services voids between floors."

The project's largest structure is known as building five, which measures 100m × 90m. It accommodates two levels of retail units, based on a typical 7.8m × 13.5m grid with the cinema located above on the third level.

Some flexibility has been achieved within the retail floors as an extra mezzanine floor has been accommodated within the area to be taken by a Next store.

"The large retail grid works well with the cinema above," adds Mr Smith. "The auditoriums have to be column-free spaces and so their column locations have dictated the pattern below in the retail levels."

Completing the steel package are two more steel braced frame retail structures known as buildings four and eight. The former will accommodate double-height units with a mezzanine capability based around a 7.8m × 10.2m grid, while eight is similar in design except it has a larger 7.8m × 13.5m grid pattern.

The final steel-framed retail block (building eight) is situated on a plot separated from the main scheme by the existing pedestrianised High Street. This part of The Lexicon is known as Charles Square and it will also include an adjacent concrete structure.

"Logistics is a key issue as the site is very congested with numerous trades and surrounded by busy roads, the existing town centre retail area, a police station, council offices, a library and residential properties," says Mr James.

"When it comes to working at Charles Square, logistics will be even more challenging as one of the buildings is landlocked by the existing pedestrianised streets which remain open to the public throughout the development. This effectively cuts the project into three.

There is no direct road access to one of the buildings and so deliveries of materials, such as steelwork, will have to be made through an existing structure that has been part-demolished and will form part of building eight in the completed scheme. We use an online just-in-time delivery system to aid this work."

The project will utilise a variety of cladding materials including brick, timber, aluminium, coloured glazing, and gold/silver coloured copper cladding.

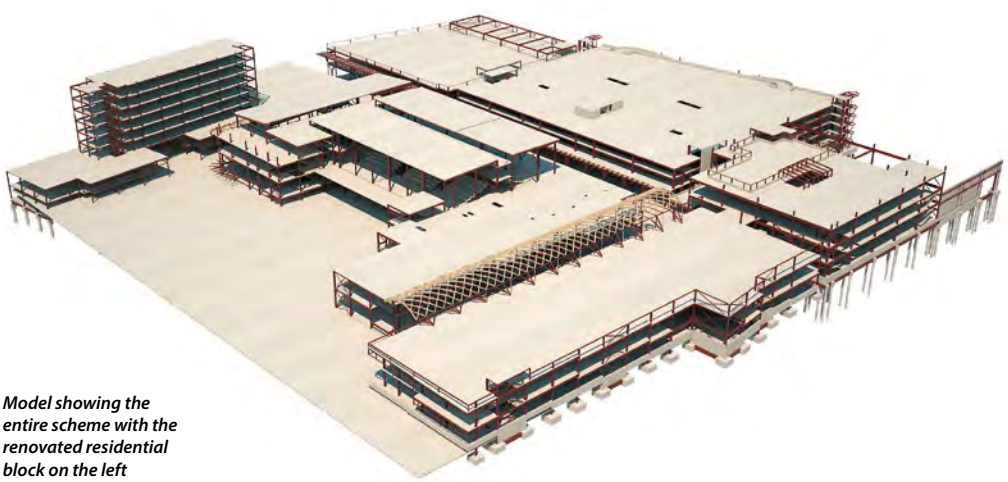
The Fenwick store in particular will standout as it will be clad in 5mm-thick perforated anodized aluminium rainscreen cladding, which will be backlit. This system is bespoke and has been developed specifically for this scheme.

The pedestrianised streets within the scheme will be spanned by canopies formed with steel and glulam beams covered with ETFE.

Another key concept for the scheme is the public realm design, which forms part of the 'greening of Bracknell' to transform the character of the existing town.

A large open space, which could be used as an outdoor auditorium, is being constructed between the M&S store and Waitrose.

The Lexicon is due to open this Spring (2017).



Model showing the entire scheme with the renovated residential block on the left

Dining facilities are housed in the atrium

A lesson in steel efficiency

A revised, streamlined and value engineered design has helped a new steel-framed school take shape rapidly.

A new secondary school is being delivered by BAM Construction in the Fife coastal town of Anstruther as part of the ongoing hub Scotland initiative.

Replacing the existing school, the new steel-framed structure will also provide a home for the council's local office, a library, a base for police officers, and consequently the project is officially known as The Waid Community Campus incorporating Waid Academy.

The overall campus includes an existing primary school, and a community sports centre, while the 800-place Waid Academy's new sports facilities, including an all-weather rugby pitch, will be open to the public at certain times.

Typically, the ground floor of the building houses the community facilities with the school occupying the first and second floors, with one of the exceptions being the dining area which is located within the centrally-located atrium.

Work on-site started last year but, prior to the project team beginning, the initial design had been value engineered in order to bring the scheme within budget. Without this streamlining design work taking place the project may not have started at all.

"As well as different cladding systems, the main alteration was to change the roof to a mono-pitched design from one that originally had a multi-pitched roof profile," explains BAM's Construction Director Martin Cooper.

The new economical pitched roof is said to reflect the project's rural setting and is a nod to the many agricultural buildings in the surrounding countryside.

With its more economical steel-framed design settled upon, the job was able to kick off with BAM initially installing a new access road.

"An existing road alongside the construction site is used by people taking their children to the primary school and by users of the sports centre," says Mr Cooper.

"It was our decision to construct a new road, and now we have our own dedicated route for deliveries, including the steelwork, which is much safer for all concerned."

Once the road was completed, a series of piled foundations and a concrete ring beam were installed in advance of the steel erection programme commencing.

Steelwork contractor BHC fabricated, supplied and erected 520t of steel for the project. This equated to approximately 1,400 individual pieces, requiring 2,850 connections and a grand total of 16,822 bolts.

During its 15-week erection programme, BHC used two 80t-capacity mobile cranes, in conjunction with various sized MEWPs, to erect the entire steel frame and install metal decking and precast planks.

The building's envelope nears completion

The speed of the erection process and the knock-on effects this has for the whole construction programme was the main reason for choosing steel as the framing solution, according to BDP's Project Architect Stuart Duncan.

The building is roughly square-shaped on plan with each elevation measuring approximately 65m-long. For the erection programme, the building was divided into three zones, with each one completed to its full height before BHC moved onto the next zone.

BHC's second mobile crane would then follow on behind the steel erection gang and install the flooring systems for each completed zone.

The three zones encompass the structure's two outer wings, and a central zone includes the building's large atrium and drama hall.

AECOM Project Engineer Craig Kempsell says: "We proposed a combination of flooring construction, comprising insitu concrete on metal decking and precast concrete slabs with insitu structural concrete topping.

"The precast concrete planks are supported on a grillage of steel ultra shallow floor beams, providing a reduced structural zone and promoting an efficient overall floor zone with exposed soffits within the classrooms."

Between the teaching wings the use of insitu concrete on metal decking provides a bridge between the two stiff precast floor plates. The use of conventional downstand universal beams provided additional efficiency and this was possible due to the introduction of suspended ceilings in these areas with a reduced floor-to-ceiling height.

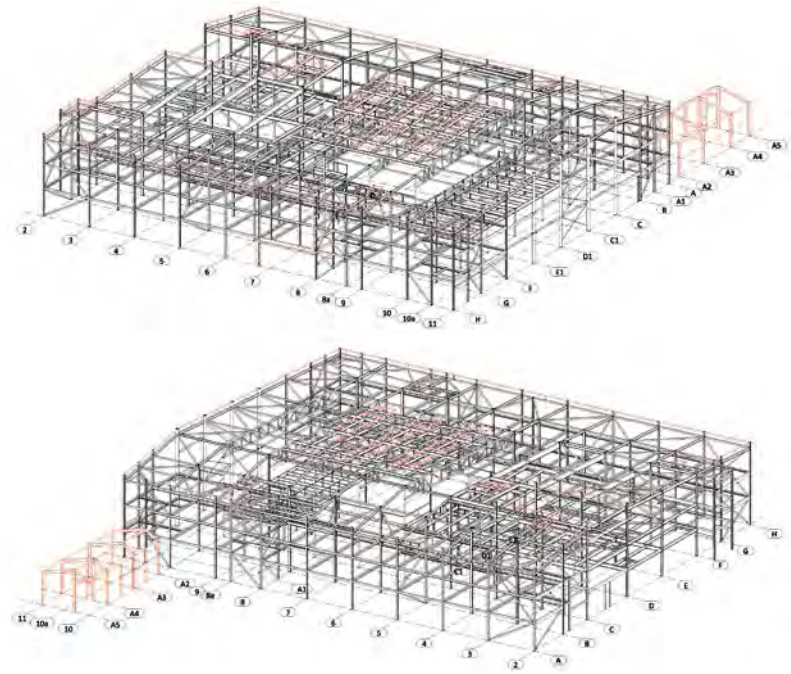
The steel frames' columns are spaced at 7.5m intervals to form the teaching area. These were brought to site in 12m lengths corresponding to the overall height of the structure and providing effective robustness for the category 2B structure.

Next to the centrally-positioned atrium is a double-height drama hall and this space was particularly challenging to design and build. The proposed installation of retractable tiered seating and the intended occupation of the space required a detailed assessment of the dynamic response of the floor plate, due to the potential effects of rhythmic synchronized movement.

Steelwork within the floor acts compositely with the slab, with strategically positioned columns providing local enhancements to achieve adequate floor plate stiffness.

Occupying two thirds of the structure's central zone is the full height atrium. This part of the building is formed by five 30m-long × 1.8m-deep steelwork trusses, which had to be spliced at mid-span to facilitate transport to site in two pieces for subsequent assembly on-site prior to being lifted into position.

Mobile cranes erected the frame in 15 weeks



A series of internal exposed CHS columns surround the atrium space with large 406mm diameter columns positioned within the adjoining elevation. These were required to provide adequate stiffness to the lateral supports of the glazed façade. As the columns were unrestrained over their full length the increased section size was essential, providing both function and form.

Overall the steel frame is stabilised by the two precast floors in the two teaching wings, which provide stiff plate diaphragm action, transferring lateral and notional forces to vertical steel bracing located within the perimeter and internal partition walls.

Due to curtain wall, window and service penetration positioning locating the bracing was challenging. A number of bracing techniques were utilised. Typically SHS/RHS bracing was adopted within the secondary steel zone in order to conceal it behind finishes.

Because Anstruther is a coastal town, the steelwork was primed with an enhanced protective paint specification to protect the structure against atmospheric corrosion while it was exposed during the erection and ongoing construction process.

Waid Academy is scheduled to be open in time for the 2017 autumn term.

FACT FILE

Waid Community Campus incorporating Waid Academy, Anstruther, Fife

Main client: hub East Central Scotland, Fife Council

Architect: BDP

Main contractor: BAM Construction

Structural engineer: AECOM

Steelwork contractor: BHC

Steel tonnage: 520t

Steel ticks all the boxes

Steel has many benefits that deliver value to designers, contractors, developers and building users. Most arise automatically once the decision to build in steel is made, and at no extra cost.

Safety

- ✓ Accurate fabrication work takes place offsite under controlled and regulated factory conditions
- ✓ Fabricated steel is only brought to site when needed avoiding potentially dangerous clutter
- ✓ Fewer people are needed on-site, reducing the risk of accidents
- ✓ On-site pre-assembly reduces the number of lifting operations and the need to work at height
- ✓ Steel frames are full strength as soon as they are completed so stairs can be fitted, providing safe access for other trades straightaway
- ✓ Steel decking for composite slabs provides a safe platform after installation and protection to lower storeys

Speed

- ✓ Steel construction is fast with skilled erection teams who have a safety focus
- ✓ Steel gives the earliest start on-site and earliest possible pay back on investments
- ✓ Time related savings can amount to between 3% and 5% of the overall project value
- ✓ Fast and safe erection of steelwork makes way for other critical path operations
- ✓ Accurate offsite fabrication eliminates time-wasting quality issues and reworking on-site
- ✓ Offsite trial erections of complex structures can ensure that everything goes right on the day

Quality

- ✓ Quality assurance runs throughout the steel construction supply chain
- ✓ Steel construction provides the surest guarantee of a high-quality finished building
- ✓ Steel sections are tested, certified, and CE Marked before delivery with inspection certificates
- ✓ Fabrication processes are quality assured and fully CE Marked
- ✓ 3D modelling and numerically controlled fabrication systems deliver precision-engineered components to tight tolerances
- ✓ All BCSA steelwork contractors are regularly checked for their technical capabilities and financial standing

Efficiency

- ✓ Efficient steel designs take advantage of the high strength-to-weight ratio of steel
- ✓ Superior use of space and longer flexible internal column-free spaces can be achieved
- ✓ Lean manufacture within an integrated supply chain gives a more predictable construction programme
- ✓ Just-in-time deliveries can be sequenced and synchronised with the construction programme
- ✓ Steel is fabricated offsite to tight tolerances and brought to site for erection with virtually no waste
- ✓ With 3D modelling as standard practice steelwork contractors have long been delivering the efficiencies of BIM

Cost

- ✓ Steel is the most cost-effective framing material for buildings and structures of all types
- ✓ Steel is cheaper than it was 15 years ago in inflation adjusted terms, and has fallen in price since 1980
- ✓ Cost saving benefits from productivity advances achieved throughout the steel supply chain are shared with customers
- ✓ A competitive sector with a large number of steelwork contractors ensures that customers get value for money
- ✓ Cost savings in steel buildings start at the foundations, where the loads imposed by a steel frame are up to 50% less than those of a concrete alternative
- ✓ In October, an independent study showed that on a typical city centre office building, the frame and upper floors cost of the cellular steel composite beam and slab option was 15% lower than the concrete alternative

Sustainability

- ✓ Steel is the world's most recycled material
- ✓ 99% of structural steel used in the UK is either re-used or recycled, waste is minimal to non-existent
- ✓ Steel is multicycled, meaning that it can be used again and again without any loss of quality
- ✓ Steel buildings are adaptable and flexible offering future-proofed solutions
- ✓ Almost all steel-framed buildings can provide optimal thermal mass
- ✓ Signatory companies to the BCSA's Sustainability Charter agree to their sustainability credentials being assessed and monitored

Acoustics and Vibration

- ✓ Steel-framed buildings easily satisfy the acoustic performance requirements for residential buildings
- ✓ Infill steel-framed external walls provide both acoustic and thermal insulation
- ✓ Conventional steel construction systems meet the required vibration performance criteria without any special measures being adopted
- ✓ Extra stiffening can be applied for extremely vibration sensitive applications like hospital operating theatre floors
- ✓ Even with these additions steel remains the most cost-effective and lightweight solution
- ✓ Long-span applications, for which steel is the only option, have been found to offer excellent vibration damping

Fire Protection

- ✓ More is understood about the behaviour of steel in fire than any other construction material
- ✓ The UK has a competitive and very effective fire protection industry
- ✓ A continuous programme of research means that cost-effective fire protection measures are always being improved
- ✓ Advanced design and analysis techniques avoid over-specification of fire protection requirements
- ✓ The analysis of composite steel deck floors in fire can eliminate fire protection on many secondary beams
- ✓ Offsite application of thin film intumescent coatings shortens construction programmes

Computer designed frames

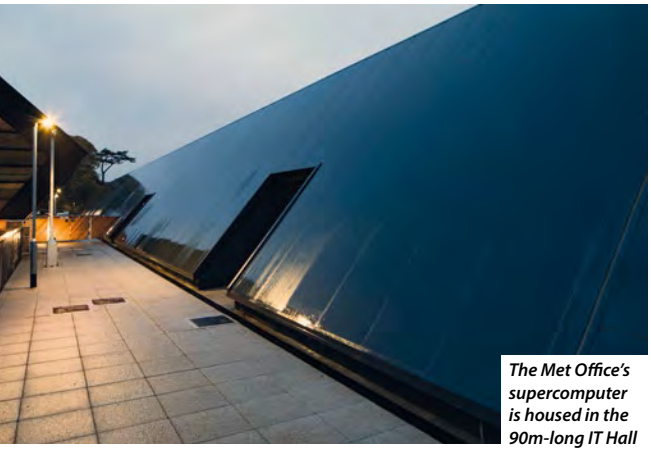
Office accommodation is provided by the Collaboration Space

FACT FILE
The Met Office, Exeter
Main client: The Met Office
Architect: Stride Treglown
Main contractor: Willmott Dixon
Structural engineer: WSP Parsons Brinckerhoff
Steelwork contractor: William Haley Engineering
Steel tonnage: 230t

Two steel-framed structures house and service the Met Office's new supercomputer, a device that will bolster the UK's position as a world leader in weather and climate prediction. Martin Cooper reports.

Construction work has been completed at the Exeter Science Park for a new Met Office facility to house one of the most powerful supercomputers in the world.

As well as helping the Met Office to improve its weather predictions, the computer will also be a catalyst for regional growth in the South West, supporting collaboration and partnerships between science, business and academia.



The Met Office's supercomputer is housed in the 90m-long IT Hall

Located a short distance from the Met Office's current headquarters, the computer is housed in a purpose-built structure [IT Hall], while adjacent to this, a distinctive sloping two-storey office structure, known as the Collaboration Space, has also been built.

The IT Hall is a single-storey steel portal-framed structure measuring approximately 90m-long and 25m-wide, but importantly offering a central 15m-wide column-free span for the computer hall.

The Collaboration Space is a far more complex steel structure leaning in two directions, which has required enhanced stability systems to resist the forces generated by the complex and eccentric geometry.

Both of these buildings have gone through a process of design development as WSP Parsons Brinckerhoff Associate Director Ian Branch explains: "Throughout the design process a variety of materials were considered for both buildings. The choice of steel was made primarily to suit the challenging programme requirements.

"The use of Revit 3D modelling greatly benefitted the development of difficult details for the complex geometry. This was then easily transferred to the steelwork contractor for them to incorporate into their model."

Once the design was finalized, work started on-site last year. The project sits on a greenfield site on the edge of Exeter Science Park, a recent development on the outskirts of the city that has further expansion plans.

Early works included the installation of pad and strip foundations in readiness for steelwork contractor William Haley Engineering to begin the steel erection programme.

Steelwork erection started with the IT Hall, the simpler of the two frames. This structure had to be the first to be erected as it houses the supercomputer and consequently needs to be ready first. Powering and serving the computer are a high volume of complex services all of which needed to be coordinated via 3D modelling in Revit.

Using a single 50t-capacity mobile crane William Haley erected the IT Hall in approximately three weeks. The propped portal frame has sloping sides formed with

raking columns, with two internal column lines providing the large open central space for the computer hall, while the two outer 5m wide spans accommodate ancillary spaces.

As it will house the supercomputer, the IT Hall may be considered to be the more important of the two structures. However the hexagon-shaped Collaboration Space was the most challenging to design and erect.

The structure's accommodation space is based around a two-storey internal box based around a 7.2m × 4.8m grid pattern. The two main elevations, with the front sloping inwards and the back doing the reverse, are built from this steel box.

The internal box was erected first and was initially stabilised by temporary bracing. An in situ concrete lift shaft, combined with moment frames and braced bays within the sloping walls, provided the stability in the final condition.

CHS columns set an angle of 60 degrees form the two sloping elevations.

"Tubular steelwork was chosen for this part of the structure for aesthetic reasons as it will be left fully exposed behind glazing," explains WSP Parsons Brinckerhoff Senior Engineer Catherine Mungall.

As well as the two main sloping façades, the structure has two folded ends formed by two rows of raking CHS columns. To form the fold, the bottom members slope outwards and the top sections slope inwards with a central bolted connection holding the shape in place. The columns were all designed as moment frames.

As well as the two large glazed façades, the remainder of the Collaboration Space is wrapped in a zinc cladding.

"To avoid any clashes and deal with the unusual geometry and complex cladding details on this structure we laser- surveyed the building to produce a 3D model," explains Willmott Dixon's Leigh Dickson.

"This way of producing a model is very quick and allowed the team to get on with the cladding installation quickly."

Both of the buildings were handed over to The Met Office late last year (2016) and the supercomputer is now being installed in three phases with the final phase due to be completed this Spring.

Supercomputer

The supercomputer will be 13 times more powerful than the current system used by the Met Office and will have 120,000 times more memory than a top-end smartphone. It will be able to perform more than 16,000 trillion calculations per second, and at 140t, it will weigh the equivalent of 11 double-decker buses.

The supercomputer's sophisticated forecasts are anticipated to deliver £2bn of socio-economic benefits to the UK by enabling better advance preparation and contingency plans to protect homes and businesses.

Met Office Chief Executive Rob Varley says: "We are very excited about this new investment in UK science. It will lead to a step change in weather forecasting and climate prediction, and give us the capability to strengthen our collaborations with partners in the South West, UK and around the world."

One of the sloping elevations of the Collaboration Space

The fully galvanized flue stack erected and awaiting cladding

Energy beacon

The Greenwich Peninsula Low Carbon Energy Centre is an important sustainable and affordable energy landmark for one of London's major urban development areas.

Standing 49m-tall and positioned adjacent to the southern entrance of London's Blackwall Tunnel, a flue stack with a difference has been built as part of the Greenwich Peninsula Low Carbon Energy Centre project.

Designed in collaboration with C.F. Møller Architects, the flue is said to be the most ambitious public commission to date for renowned artist Conrad Shawcross.

Uniting sophisticated engineering and complex optical research the monumental structure – which is also 20m-wide and 3m-deep – is constructed from five interconnected steel ladder frames that will be clad with perforated aluminium panels.

These triangular panels fold across the surface of the tower forming intricate geometric patterns that visually break up the flat planes to create an uneven sculpted surface.

According to Mr Shawcross, a key aspect of the design is the creation of the Moiré Effect, which is created by overlaying the perforations on each panel at different angles to each other, resulting in a dynamic and beguiling surface, which appears to change continually.

During the evening the tower will be lit from within, continually redefining the shape of the structure and its surroundings.

C.F. Møller Architects Associate Sam Whatman says: "The original design concept for the tower was to align the flues in a row in order to create a tower with an unusually slim profile, a fin or 'blade' on the skyline. This concept brought many structural challenges, not least the high wind loading on the long face of the structure.

"The tensile strength of steel coupled with its ductility made steel the obvious choice as it allowed us to create a strong but slim and highly perforated structure."

In addition to the structural properties of the material, the industrial aesthetic of steel lent itself to the historical context of Greenwich Peninsula.

"The cross bracing inherent to the structure echoes the lattice work of the neighbouring gas holder dating from 1886. Further benefits include the ability to accurately fabricate the frame in sections offsite followed by a quick installation on-site," adds Mr Whatman.

The flue stack will act as a beacon or landmark to the huge regeneration scheme that is taking place on the North Greenwich Peninsula. This previously industrial area of south London that is now famous for the O_2 Arena (formerly the Millennium Dome) will eventually accommodate more than 10,000 new homes and over 300,000m² of office space.

The flue and the connected energy centre are being built to guarantee a supply of efficient and sustainable power to the development.

The steel-framed energy building measures 90m-long by 25m-wide and 12m-high, and it will house technically advanced boilers and combined heat and power plant that will distribute heat energy to each plot across the development.

Steelwork for the project is being fabricated, supplied and erected by Billington Structures, with 345t needed for the flue stack and 130t for the frame of the energy centre building.

Both the flue stack and the energy centre building are steel braced frames, however, both are structurally independent.

"Initially the design envisaged the flue tower being formed with fabricated girders, but in order to make the structure as light and as narrow as possible regular UC sections were the final choice," explains Price & Myers Project Engineer Amanda Constantinesco.

Although the flue is braced it still requires a series of 1m-long holding down bolts for extra stability. These bolts are set within large circular base plates which guaranteed that once the ladders were up they were immediately stable without the need for any temporary bracing or propping.

There are five ladders in total and each one arrived on-site in three pieces, which after being lifted into place and bolted up formed one 49m-high section.

The 3m-wide ladders are spaced at 4.5m centres and are connected by series of diagonal cross members. Large nodes on the ladders accept these cross members with some nodes accepting up to eight members.

The flue stack overlooks the southern entrance of the Blackwall Tunnel

Because the flue stack's cladding is perforated, the steelwork will be exposed to the elements. For this reason all of the steelwork has been galvanized to guarantee a rust-resistant finish and less maintenance.

The length of the ladder sections was carefully planned so that they fitted the hot-dip galvanizing facilities with only millimetres to spare. The width of the sections meant that each one had to be dipped once, lifted, turned and dipped again from the other side in a very precise operation to ensure full coverage.

Billington Structures' erection sequence saw the company erect each end of the energy centre building first. This left a central area clear to allow them to position a 200t mobile crane to erect the ladder frames. Once the flue was erected Billington then erected the final middle portion of the energy building.

The visitor centre has a large glazed main façade

The majority of energy centre is a large braced box offering open column-free spans of 20m into which all of the boilers are being installed. At 90m-long the building has been future-proofed as it has plenty of room for additional boilers to be installed when the North Greenwich development expands further.

Likewise, the flue stack will initially accommodate four flues, but this can be increased to a maximum of ten when the need arises.

Guided by a desire to demystify the process of energy generation, the machine rooms and flexible ancillary office accommodation are supplemented with a visitor centre at one end of the building that will offer an interactive educational experience for prearranged groups of visitors.

A 20m-long truss supports the roof at this end of the building and creates the column-free double-height space for the visitor centre. This end of the building also features a large glazed façade that will allow natural light to illuminate the centre.

The Greenwich Peninsula Low Carbon Energy Centre is due to be operational soon.

FACT FILE

Greenwich Peninsula Low Carbon Energy Centre, London

Main client: Royal Borough of Greenwich
Architect: C.F. Møller Architects
Main contractor: Kier Construction
Structural engineer: Price & Myers
Steelwork contractor: Billington Structures
Steel tonnage: 475t

Building 101 nears completion, while the transfer deck is in place for building 100

A tale of two cities

The steel-framed Embankment commercial development represents the first part of a large regeneration scheme altering the area separating Manchester and Salford.

The reception area of Building 101 features a large column-free space

Set within a retained Grade II listed sandstone façade wall, and consisting of a nine and a 10-storey office block sat atop a three-level car park podium, the Embankment scheme forms an initial phase of a much larger regeneration project that aims to breathe new life into the area where the cities of Manchester and Salford meet.

On the banks of the River Irwell, overlooking Manchester Cathedral, the project is situated on a plot once occupied by Exchange Station that closed down in 1969.

Opened in 1884, the bulk of this station was within the boundaries of Salford, although Europe's longest platform – built in 1929 – did provide a direct link to nearby Manchester Victoria Station.

Although the original buildings and platforms are long gone, the sandstone façade of the masonry podium that once supported the station has been retained and this forms the exterior for a three-storey car park on top of which, at podium level, the two office blocks will both sit.

The steel-framed car park infills most of the retained façade, except the rounded corner areas, creating 442 spaces.

The main pedestrian access route from street level to the car parking levels is via the new podium hub, utilising two large arch openings in the listed façade wall. Access to the upper levels is via a lift or a feature helical stair, which rises up to a fully glazed atrium structure atop the podium.

The car park has been built around a variable grid pattern to meet parking requirements and the constraints of the existing retained façade, with stability-giving cross bracing positioned within internal bays and perimeter elevations.

As far as the steelwork is concerned, the car park and the first office structure (Building 101) are complete, with the second office structure (Building 100) due to begin early this year (2017).

For the duration of the construction, the façade has been propped and the steel-framed car park has been built back from the wall. The last two or three metres of the podium slab is supported by the wall, and tied into it with resin fixings.

The roof of the car park or podium deck provided the design team with the project's biggest challenge as Ramboll Design Engineer Allan Wilson explains: "Both of the office buildings will have a similar design that includes main columns set at 7.5m centres, which doesn't match the car park grid below. This, combined with the larger column density in the core areas, led us to adopt transfer structures at this level to maximise parking spaces."

The client requirement to maximise the number of car parking spaces did not permit the building cores to continue down through the podium structure. Therefore, steel-framed cores were adopted to minimise the loads onto the transfer structures, as they are significantly lighter than concrete cores.

Encompassing an area around each of the building's cores, which equates to approximately one third of their footprints, the two transfer slabs employ an innovative design, with a 1500 thick RC slab built off a 130mm thick composite slab acting as permanent formwork.

The remainder of the podium slab is 170mm thick. In order to resolve complex punching shear issues, 914UB cruciform sections were cast within the depth of the transfer slabs.

"Many buildings of this size would have used a concrete core, but a steel core is quicker to erect," says Elland Steel Structures Commercial Director Jeremy Shorrocks. "In order to get the required stiffness the steel core is heavily braced and consists of a condensed configuration of beams and columns all supported by the transfer slab."

Steelwork for both transfer slabs was installed as part of the initial car park construction programme in preparation for the steel erection programme for Building 100 starting this year (2017).

Building 101 is a ten-storey commercial block offering clear spans of up to 15.3m spans. Westok cellular beams, 680mm-deep with 475mm diameter holes, have been used throughout for service integration.

A depiction of the new public realm and the two offices

The centrally-positioned braced steel core, that accommodates six lifts, provides the structure with its stability.

Offering some aesthetic appeal around the exterior, all of the perimeter columns are CHS sections that are set within a 900mm cantilever and will be left exposed in the building's completed form. These sections are 406.4mm diameter columns at the lower levels, decreasing to 323.9mm diameter columns for the upper two storeys.

Building columns outside of the building core were generally co-ordinated with the car park layout, but where this was not possible, transfer beams were employed to take the loads into the podium columns.

There are 25 transfer beams in total with the largest measuring 1,400mm-deep and weighing close to 8t.

Building 100 will have a similar design to its neighbour, however it will have a larger floor area on plan, but one less storey (nine-storeys), so the net lettable area is approximately the same as Building 101.

This second building will include a column-less cantilever corner (6.5m projection) and will also incorporate curves to follow the shape of the listed retained façade wall. A further 1,500t of structural steelwork will be fabricated, supplied and erected for this phase.

For the erection programme Elland Steel Structures began its work by firstly installing the car park steelwork directly below each of the transfer slabs.

In preparation for the next phase of the construction programme, all of the transfer beams for Building 100 were also installed in readiness.

While the transfer slab was being cast Elland completed the remainder of the car park steel erection.

"We then erected Building 101, using a sequence that required three levels of core to be erected, followed by three levels of main building steelwork wrapping around the core structure in a clockwise manner," adds Mr Shorrocks.

"These floors were metal-decked while the next three levels of core were going up. This then gave us a surface on which to work off for the next stage of the sequence."

The Embankment scheme will be connected to Manchester city centre via the old station's link bridge that spans the River Irwell. As part of the project the bridge is being renovated including the wrought ironwork railings.

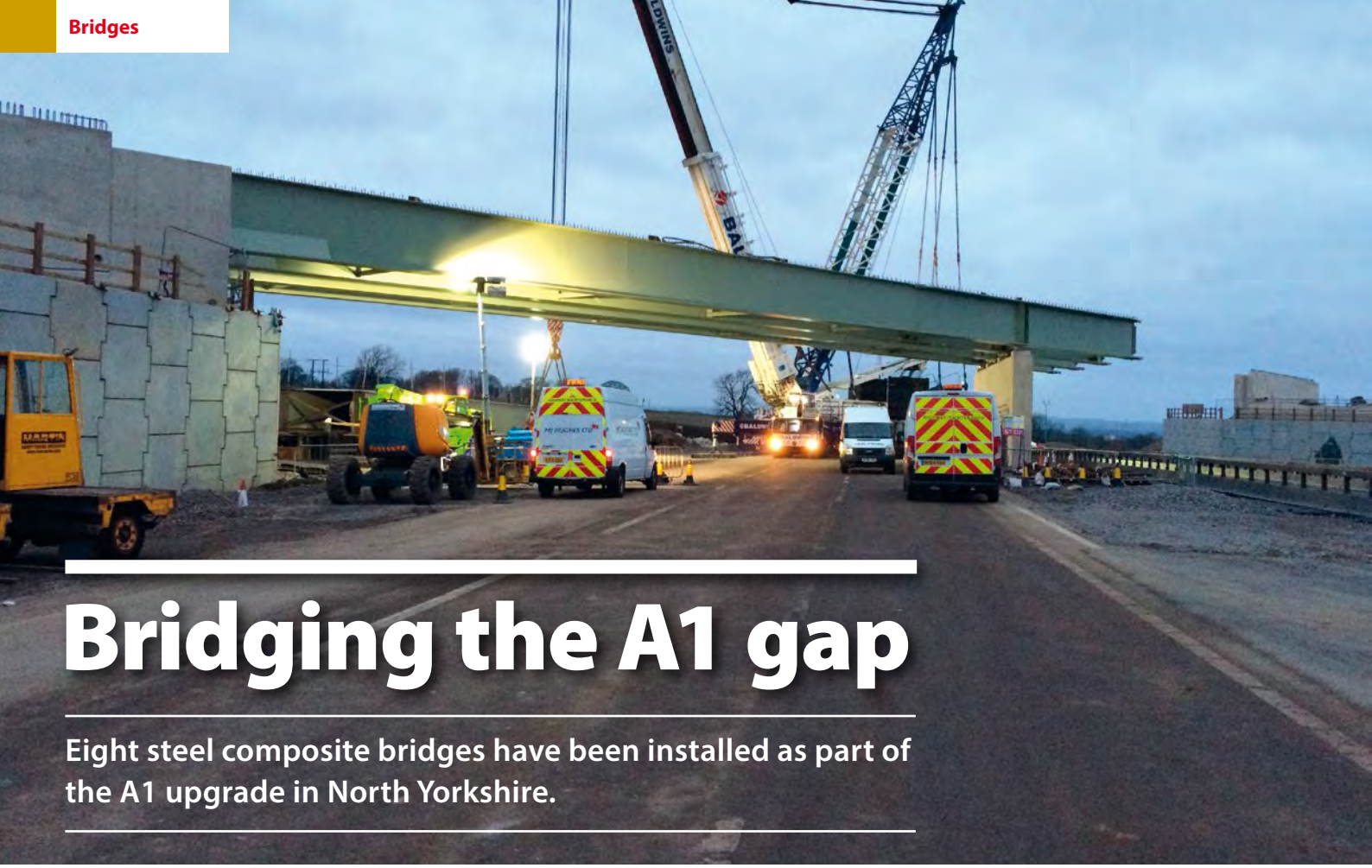
A new public square, adjacent to the scheme, has also been constructed and many of the retained façade's arches will include shops and restaurants complimenting the realm.

A commitment to sustainability by the client requires the buildings to achieve a BREEAM 'Excellent' rating, as well as achieving an efficient thermal performance, which improves on current Part L requirements.

FACT FILE
The Embankment, Salford
Main client: Ask Real Estate, Tristan Capital, Carillion JV
Architect: Flanagan Lawrence
Main contractor: Carillion
Structural engineer: Ramboll
Steelwork contractor: Elland Steel Structures
Steel tonnage: 2,700t

Above: A 1960s view of Exchange Station showing the now demolished buildings and the retained façade

Below: L S Lowry's painting of the station in its heyday



Bridging the A1 gap

Eight steel composite bridges have been installed as part of the A1 upgrade in North Yorkshire.

FACT FILE
Bridges on A1 Leeming to Barton upgrade
Main client: Highways England
Main contractor: Carillion/Morgan Sindall JV
Structural engineer: Aecom
Steelwork contractor: Cleveland Bridge
Steel tonnage: 1,431t

As the only section of non-motorway on the strategic M1/A1(M) route between London and Newcastle the busy 12-mile section between Leeming and Barton in North Yorkshire is being upgraded from a dual carriageway into a three-lane motorway.

Once completed the scheme will unlock growth and boost the economy by creating a continuous motorway-standard route that will also improve journey times and increase safety.

This stretch of road carries approximately 69,000 vehicles every day and according to Highways England, it is not entirely fit for purpose for today's traffic volume.

It suffers from poor alignment with numerous side roads and minor lanes entering and exiting, which has contributed to the accident severity ratio being significantly higher than other similar roads.

A major part of this project is the construction of new bridges that either span the widened road, or carry the new highway over streets and rivers.

Eight of these new bridges are steel composite structures and they have been fabricated, supplied and erected by Cleveland Bridge for the Carillion/Morgan Sindall JV.

The project's structural engineer is Aecom, and its Principal Engineer Peter Robinson explains the choice of materials for the bridge's design.

"We had to look at a number of criteria when choosing which materials to use for each bridge. Steel was used for the longer span structures because it is lighter than other materials and so more cost-effective, while another important factor was installation and getting materials to site. Steel beams and components are generally fabricated offsite and then quickly assembled and erected on-site, which causes minimal disruption."

All of the steel bridges were modelled in 3D using the Autodesk Revit programme. This was then inserted into a BIM model, which proved to be critical for providing on-site toolbox talks and to help the various trades carry out clash detections.

The longest steel bridge on the scheme at 86.5m and the one with the biggest steel tonnage at 398t is the Kneeton Lane Overbridge, which is located just north of Scotch Corner.

This structure consists of two spans supported on reinforced earth abutments that have been squared up to allow for a semi-integral form of construction.

The central pier however is skewed to follow the alignment of the A1(M) below, this results in asymmetrical spans.

"The bridge was checked for lateral torsional buckling in the temporary condition using the analysis package Lusas. Because of the skewed pier, significant twisting occurred which led to the use of plan bracing to provide the required stability," says Mr Robinson.

To install this structure Cleveland Bridge delivered six braced pairs of girders, each measuring 2.5m deep, to site and assembled

Kneeton Lane Overbridge

Left and below: Kneeton Lane Overbridge being installed

Agricola Underbridge is widened with new steel girders

them into units, each measuring 15m-wide by 23.75m-long. This assembly work was carried out using 500t-capacity mobile cranes and done on the temporarily closed northbound carriageway of the A1.

"We then painted the bolted connections and the main contractor was given access to fit the permanent formwork to the assembled girders. This reduced the need for additional road closures to install the formwork when the girders were in position," says Cleveland Bridge Construction Manager Ian Brierley.

The 500t crane was then replaced with a 1,000t-capacity crane, which lifted the four sections into place during two consecutive overnight road closures, with the heaviest lift weighing 170t.

A similar procedure for a near identical bridge was carried out at the southern end of the scheme near the village of Leeming. Known as the Low Street Overbridge, this structure over the A1 is slightly lighter requiring 378t of structural steelwork.

A slightly different approach was needed for the Agricola Bridge that carries the A1 across the River Swale, just south of Brompton.

Agricola is an existing three-span steel composite semi-integral structure, which has been widened to accommodate the new three-lane highway plus its hard shoulder.

After the abutments and centrally-positioned pier had been extended on either side, the southbound and northbound elements of the bridge each required 87t of steel that equated to four new 1m-deep girders each with an overall length of 57m.

Each side of the Agricola Bridge was installed in a single visit using a 200t-capacity mobile crane positioned on the existing and temporarily closed A1 bridge over the River Swale.

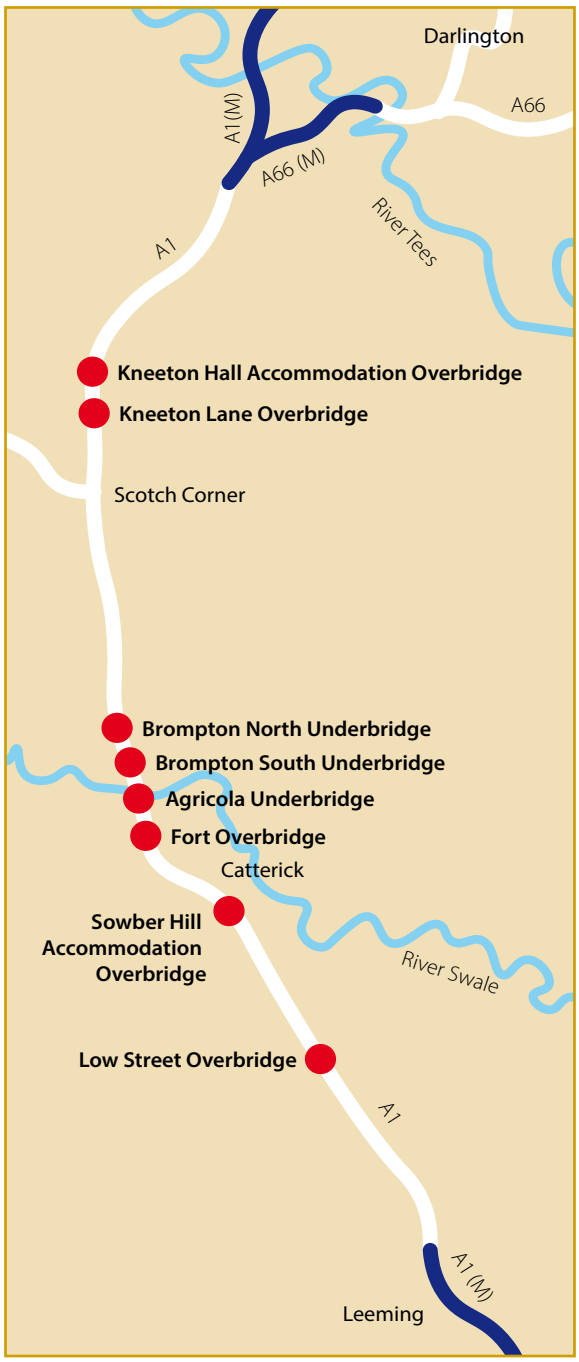
The final bridge structure to be installed was the Fort Overbridge, a two-span continuous steel composite bridge supported on conventional abutments with inspection galleries.

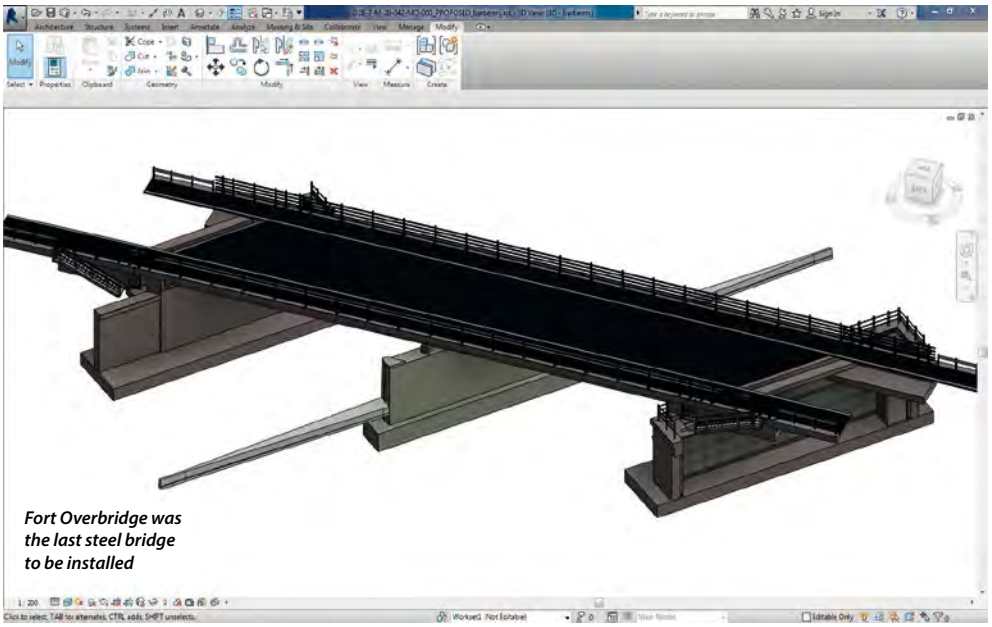
The structure replaces the existing Fort Overbridge, which had an insufficient spans for the widened road. As the structure is near the Roman site of Cataractonium some archaeological works were undertaken prior to the work starting on the new bridge.

According to Aecom the requirement to include a number of large services proved to be a challenge during the design of this bridge.

"Working closely with Cleveland Bridge and the various utility companies a solution was found to locate the services within steel ducts beneath the deck slab supported on the cross bracing. The bridge steelwork was installed with the steel ducts already in place reducing the number of lifting operations on-site," explains Mr Robinson.

Summing up the steel bridgeworks, Mr Brierley says: "All of our bridge beam installations have been required to take place during a temporary closure of the A1 or its service roads. This required careful planning of the works to allow the programme to be achieved and avoid delaying the reopening of the A1 and the associated disruption to national traffic."





Fort Overbridge was the last steel bridge to be installed

Amazon flows into central England

The centre has more than 50 loading bays

The centrepiece of a new distribution park is a huge warehouse for the world's largest online retailer.

Large open spans were an important consideration for Amazon

Distribution centres don't come much larger than the colossal shed being built for online retailer Amazon, which is currently nearing completion at the Mountpark Bardon site near Coalville, Leicestershire.

Known as unit one, and the first of three new centres to be built on the site, the structure measures 504m in length and has a width of 184m, offering just over one million square feet of floor space.

Main contractor Winvic started on this greenfield site, which is separated from Mountpark's existing distribution park by a main road, back in 2015.

Groundworks, drainage and some hard-standing surrounding the building's footprint was mostly completed prior to Caunton Engineering's steel erection programme starting.

Working on a design and build contract, Caunton completed its erection programme in just nine weeks, despite some inclement weather during May and June.

The structure is a large portal frame consisting of six spans. The two outer spans are 35m-wide, while the inner four spans measure 28.5m wide.

Second unit under way

On an adjoining site, but with a similar project team containing main contractor Winvic and steelwork contractor Caunton Engineering, unit two of the development is under way.

This portal-framed structure has a similar design to its larger neighbour, although it is only half the size of the Amazon warehouse offering 29,200m² of warehouse and office space.

The speculative build structure measures 250m-long and consists of four 28m-wide spans, with perimeter columns spaced at 8m centres and valley columns again arranged in a hit-and-miss configuration. A total of 850t of structural steelwork was needed to complete this unit.

Valley columns are 356 U/C sections, perimeter columns are 610 U/Cs, while gable end members are 457s.

Perimeter columns are large 914 UB sections, set at 8.5m centres. Internally the columns are all bespoke columns fabricated from plate.

Arranged in a hit-and-miss configuration throughout the structure, thereby creating more column-free space within the building, the columns measure 650mm deep × 400mm wide, with 400mm × 25mm flanges.

"The perimeter columns are larger sections than we'd usually use as they were initially designed to support a mezzanine level, which was subsequently removed from the design," says Caunton Engineering Senior Structural Engineer Gavin Christie.

Using bespoke plated sections was deemed the best way of optimising inertia throughout the portal frame.

"The internal valley columns need to be stocky as they are unrestrained over their 16m height," adds Mr Christie.

For the erection programme Caunton used four 50t-capacity mobile cranes in conjunction with a variety of MEWPs.

"We worked in an arrow formation, erecting the two innermost spans first up to a certain amount of bays, and then erecting the outer spans along with the perimeter columns.

This process was repeated all thorough the length of the structure" explains Caunton Engineering Erection Manager Richard Patterson.

"In this way the central spans were stable once they were up and they then offered stability to the outer spans during erection."

All of the roof rafters were brought to site in two pieces, which were spliced on the ground to form either one 35m-long, or one 28m-long section and lifted into place as a single element.

However, as other trades were following on behind the steel erection, floor space was sometimes at a premium and on these occasions each half of a rafter was lifted into place individually and spliced together in the air.

Along one elevation the distribution centre has over 50 truck loading bays, while on the opposite side of the building there is an attached office block.

The single-storey structure is 220m-long and consists of two 11m-wide spans throughout its length. Topped with a gull-wing roof structure, a design where both sides of the roof pitch inwards, the office is surrounded by a 4m-high parapet that hides a plant deck.

The office structure gains its stability from the attached distribution centre main frame, as well as from strategically placed moment frames.

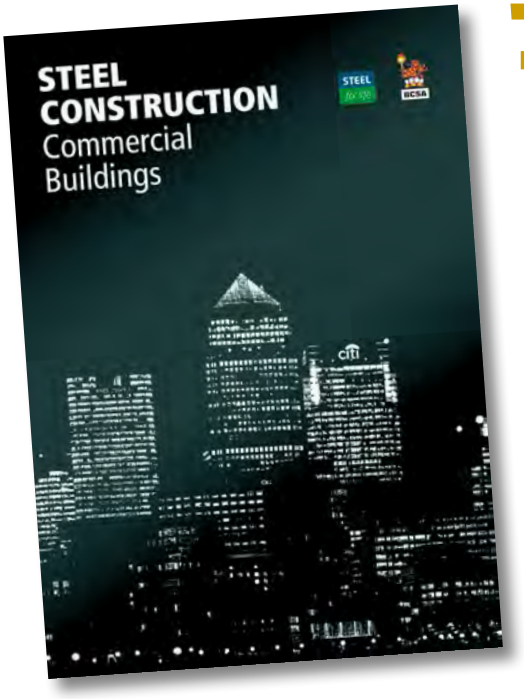
Speed is of the essence on all construction projects and this one is no exception. Having completed its steel package ahead of schedule, other trades were able to get a head start and so ensure the distribution centre met its completion date.

FACT FILE

Unit one, Mountpark Bardon Distribution Park, Leicestershire

Main client: Mountpark Logistics
Architect: Michael Sparks Associates
Main contractor: Winvic Construction
Structural engineer: BWB Consulting
Steelwork contractor: Caunton Engineering
Steel tonnage: 2,750t

The Bardon site takes shape with the Amazon warehouse



The leading commercial choice

***Steel Construction: Commercial Buildings* is the latest in a series of publications from the steel sector that keeps construction professionals abreast of developments that will help them design and construct steel-framed buildings.**

Steel dominates the multi-storey commercial buildings sector with a consistent market share of around 70%, and in a new publication entitled *Steel Construction: Commercial Buildings* a series of articles highlight and explain this impressive statistic.

Many of the most iconic structures in our urban landscape would not have been possible using any other framing material, and they stand as testament to structural steelwork's unique ability to help architects express their visions.

Within this publication case studies of real projects that are under construction illustrate many of the reasons why steel frames are consistently the preferred market choice for multi-storey buildings.

The case studies also show why steel's inherent advantages as a construction material consistently deliver savings on construction programmes.

For example, 6 Wellington Place in Leeds, one of the featured projects, had its original design value engineered in order to make it as efficient as possible.

According to the job's main contractor, the decision to use cellular beams throughout the building made the steel frame lighter and more cost-effective. Importantly, a lighter frame requires shallower foundations which ultimately meant the overall construction programme was quicker.

Structural steelwork often plays an integral role in city centre regeneration schemes as it is quick to erect and the ideal material for tight and confined sites with little or no room for storage or manoeuvring.

This is the case in Coventry where the Friargate development is using steelwork for

Projects such as 71 Queen Victoria Street, London relied on steel's numerous attributes

Cost-effective steel

The cost advantages of steel buildings are explained in the publication using up-to-date cost data from two model studies of the sort of buildings that are actually being constructed in the UK.

Due to its low self-weight relative to concrete alternatives, a steel solution will always allow significant savings to be made in foundations costs, while other cost benefits arise from steel's inherent buildability and construction programme advantages.

Steel's wider benefits include improved safety, as fabricating and erecting a steel frame is inherently safer than alternatives that involve multiple trades and congested sites.

Commercial buildings usually require column free open plan spaces

Long span flexibility

Creating long span, column-free flexible spaces that are typically desired by today's commercial tenants is one of the main reasons for using steel.

These clear spans in steel-framed commercial buildings are today commonly up to 15m, and in some cases much longer.

Forming these long spans efficiently will usually involve the use of cellular beams in order to integrate the building's services within the structural void of the main frame.

Other sectors have also cottoned onto the advantages of long-span construction and the flexibility that it brings.

The construction of many retail and education facilities will often utilise spans in excess of 12m, while car park operators see the value of steel creating column-free spaces which makes it easier for vehicles to be manoeuvred and more parking spaces made available.

its main commercial anchor building, with a second multi-storey block due to start soon.

The structural engineer for this project says early in the design phase a comparative study which looked at a number of framing options was undertaken, and the steel-framed solution met all of the architectural and services requirements in the most cost-effective manner.

The City of London and its environs has for a long time been a hive of construction activity with the majority of its multi-storey office developments built with steel.

Principal Place Commercial is a current ongoing example. This 15-storey development, designed by Foster + Partners, will offer 79,000m^2 of efficient high density Grade A space with typical floors of 4,100m^2.

According to the main contractor Multiplex, this project was always going to be a steel-framed building because of the material's long-span qualities and its ease of construction.

However, some late design changes, which are easier to make with a steel frame, have enhanced the project and made steel an even more cost-effective solution.

The publication can also be downloaded for free at: *www.steelconstruction.info*

The Cooperative Group Head Office, Manchester, was the first building in the UK to earn the highest BREEAM rating

Sustainability

Steel has been described as the ultimate sustainable material as it is recyclable and reusable, fabricated offsite in high quality manufacturing facilities, while on-site it is routinely erected by skilled specialists working from the safe environment of a MEWP.

All of these factors play a part in the fact that steel-framed commercial buildings regularly achieve the highest ratings after being assessed under BREEAM for how they perform on key environmental indicators.

A steel-framed building can often be reconfigured for a new use, and given a whole new look by changing its cladding. The long-span capabilities of steel construction provide clear spaces that can be easily changed, offering the prospect of extending the structure's life. However, if a building is demolished, the steel-frame is wholly recyclable, meaning it can be re-used or recycled to create new steel.

Frame cost planning made simple

Guidance from the steel construction sector makes potentially tricky exercises in cost planning straightforward with regularly updated cost data.

Independent market research has for over 30 years shown steel to be by a large margin the most popular framing material for most building types in the UK.

Some 70% of multi-storey buildings and over 90% of single storey industrial buildings use steel as the framing solution.

Steel consistently delivers significant cost advantages compared to alternative materials, with a wide range of other benefits affecting sustainability, flexibility in use and future-proofing, provided at no extra cost.

It is no surprise that the market votes so overwhelmingly in favour of steel framing given its many inherent advantages as a modern construction method. The benefits start from the bottom up – the lower self-weight of steel ensures a lighter structure that needs smaller and cheaper foundations.

There are programme and other benefits to be taken advantage of, many arising from steel being fabricated offsite. Most of these benefits feed through directly to the bottom line and the steel construction sector goes to great lengths to provide design and other guidance that ensures designers, contractors and developers can easily take full advantage of them.

One of the key areas that advice is provided for is properly costing the alternative framing solutions at the early project planning stages. This can be a tricky exercise whatever materials are being costed, but the steel sector produces regularly updated guidance on the cost planning process itself as well as updates on real world prices for structural steelwork.

The cost planning process guidance, from the BCSA, is based on regular research into key aspects of structural steelwork design and construction and can be downloaded free from *www.steelconstruction.info*

BCIS rates for different locations as of 16/09/2016 (UK Mean = 100)

Location	BCIS Index
Central London	124
Manchester	101
Birmingham	99
Liverpool	96
Glasgow	96
Newcastle	95
Nottingham	93
Leeds	92
Cardiff	92
Belfast	62

Following the procedures laid out in the guide gives clarity and confidence to cost planners as they are taken through the stages involved in pricing structural steelwork.

Key factors are highlighted, from initial design stages through option analysis and on to detailed design. The guide is focused on showing how a sometimes complex calculation can be made straightforward.

Achieving optimal solutions depends crucially on assembling the relevant information at each stage in the process,

Building 1 rates at Q3 2016 on GIFA basis (Central London BCIS Location)

	Steel composite	Steel + Precast Concrete Slabs	Reinforced Concrete Flat Slab	Post-tensioned Concrete Flat Slab
Substructure	£71/m²	£75/m²	£91/m²	£85/m²
Frame and Upper Floors	£177/m²	£196/m²	£173/m²	£205/m²
Total Building	£1982/m²	£2099/m²	£2183/m²	£2165/m²

Building 2 rates at Q3 2016 on GIFA basis (Central London BCIS Location)

	Steel Cellular Composite	Post-tensioned Concrete Band Beam and Flat Slab
Substructure	£80/m²	£86/m²
Frame and Upper Floors	£244/m²	£281/m²
Total Building	£2461/m²	£2565/m²

Realistic information supports costing

Sourcing realistic cost information very early in the construction planning process is essential to properly support decisions on what structural frame materials to use.

Changing these decisions later in the process leads to difficulties that could delay the construction programme, partly through their impact on the design of building elements like foundations, finishes and cladding. Wrong decisions up front can mean higher costs for the frame itself as well as other elements.

Frame material and configuration choice are key decisions that are made early in the planning process, usually based on initial outline information and comparative budget costings, and the guide leads planners through the correct decision making process to arrive at a properly informed choice.

Key tools at these early stages include cost models and benchmarks. Cost consultants need a thorough understanding of both the project and historic cost data used to enable standard cost ranges to be adopted that suit the specific project.

Key cost drivers that have to be considered include building function, sector, location and site constraints, current market conditions and the proposed procurement route.

The guide explains why it is important not to review frame costs in isolation when undertaking cost analyses of alternative structural options, but to also consider the impact that frame choice has on related building elements like substructure, cladding and M&E installations to make proper comparative cost calculations.

When a design has been developed, the initial budget will be tested against the emerging design of the actual building through a quantification of the key components. The key cost drivers considered during the earlier estimating stage, such as function and site constraints, will now be reflected in the designs used for cost planning.

Ensuring that the appropriate rate per tone of steel is selected at this stage involves consideration of additional factors including section sizes and availability, connections, fire protection and construction methodology.

Consideration of these key factors throughout the design stages, along with early supply chain consultation, helps make sure that realistic costing of the steel frame and associated elements is maintained and improved as the design develops.

Throughout 2016 the guide updated a study of two typical buildings – a business park office building and a city centre office building – to provide up-to-date comparisons for reference when considering the structural frame options.

These studies were made by independent teams from Gardiner & Theobald, Peter Brett Associates and Mace Group and the results demonstrate the cost-effectiveness of steel frame and floor solutions.

and the guide shows how to do properly, ensuring that the correct information is sourced.

The guide is updated quarterly which helps cost planners get over the problems that can arise in trying to access accurate cost information in fast changing markets. Up-to-date cost ranges for various typical frame and floor solutions are provided, along with detailed comparative costings for complete buildings.

Other free assistance provided recently by the steel sector to help cost planners and designers in assessing their options include guides on Embodied Carbon, Thermal Mass, Fire Protection and Floor Vibration.

All of these and other up-to-date information on issues like corrosion protection and on the fabrication and construction of steel-framed buildings can also be found at *www.steelconstruction.info*

Benchmark rates at Q3 2016 on GIFA basis

Type	BCIS Index 100
Frame	
Low rise, short spans, repetitive grid/sections, easy-access	£120-150/m²
High rise, long spans, easy-access, repetitive grid	£170-200/m²
High rise, long spans, complex access, irregular grid, complex elements	£205-235/m²
Floor	
Metal decking and lightweight concrete topping	£55-70/m²
Precast concrete floor and topping	£65-85/m²
Fire protection (60 min resistance)	£17-26/m²
Portal frames	
Low eaves (6-8m)	£62-82/m²
High eaves (10-13m)	£78-103/m²

Indices aid proper assessments

A range of factors such as the function and facilities of the building, location and site constraints, prevailing market conditions and the procurement route selected will affect initial cost estimates.

The cost guide explains how these factors can potentially impact on proper assessments of costs for structural steel frames. For example, how to properly use the most commonly employed guide to cost indices at different locations across the UK – the Building Cost Information Service (BCIS) from the Royal Institute of Chartered Surveyors – to analyse the impact of location and site constraints on cost estimates, is explained.

It is important that the rate for proposed locations is adjusted to ensure that different local market conditions are taken into account, as the guide highlights. As an example, using a Central London benchmarked rate (BCIS Index 124) for a new project in Cardiff (BCIS Index 92) would adversely affect the accuracy of the estimate.

A site itself has direct impacts on the design and cost of buildings, possibly affecting the floor plate configuration, the building's height and regularity of the structural grid. Regular, repeating grids are the most cost efficient, and selecting non-standard sections or a wide range of sections and connections, means more complexity, pushing up fabrication costs.

Specialised requirements of some building projects such as retaining historic façades, overcoming restraints imposed by close proximity to other buildings or having to deal with poor ground conditions might also demand complex structural solutions.

Solutions involving bespoke features like transfer structures and heavy fabricated beams will incur higher fabrication costs that can increase overall costs themselves, as well as adding to installation time and cost.

Vibration guidance

Steel remains the most cost-effective and lightweight solution to meet the required vibration performance criteria for most multi-storey buildings.

Buildings that are fast to construct, have large uninterrupted floor areas and are flexible in their intended final use are becoming more popular.

Today's design and construction techniques enable steel construction to satisfy these demands and deliver structures which are competitive in terms of overall cost.

When it comes to long-span applications, most commonly found in commercial projects, good dynamic performance is the norm, despite common preconceptions that steel composite floors are livelier than concrete ones.

The reason for this good performance is because the stiffer beams and large mass of the long-span floor plates, which participates in any motion, reduce the magnitude of the vibration response. The steel sector has extensive experience in designing steel structures to ensure compliance with even the strictest vibration performance criteria.

To help designers in the steel construction sector new vibration and design guidance is available as a free download at: *www.steelconstruction.info*

Entitled *Steel Construction: Floor Vibration* it summarises the issue of floor dynamics and what the designer should do to confirm there isn't a problem.

The guide provides an overview of the dynamic behaviour of floors, the acceptance criteria commonly adopted and, importantly, the techniques for actually calculating the floor response.

Traditionally, a very basic approach was taken to calculate a natural frequency of the floor based on deflection and to avoid any resonance with walking activity. Up-to-date assessment requires the calculation of a response factor, with different limits appropriate for different environments, such as offices, bedrooms and hospitals.

The calculation of the floor response is complex, because different dynamic modes contribute to the overall response. However, the good news for structural engineers is that there is a brand new design tool available (*www.steelconstruction.info*), which can be used to give an immediate and accurate assessment of floor response, for a wide range of structural arrangements.

Nearly 20,000 finite element analyses of different floor grids, different composite slab thicknesses and different bay arrangements have contributed to the data within the tool.

To use the tool, the designer selects between a variable action of 2.5 kN/m^2 and 5 kN/m^2, being typical imposed loads on floors, while 0.8 kN/m^2 is added to allow for partitions.

The designer also selects the arrangement of secondary and primary beams with typical spans, which depend on the arrangement of the beams. Secondary beams may be placed at mid-span or third points.

The pre-set damping ratio of 3% is recommended for furnished floors in normal use. When a decking profile is chosen, an appropriate range of slab depths are then available to be selected.

The primary and secondary beams are selected automatically from the UB range (grade S355) as the lightest sections, which satisfy strength and deflection requirements. The selection of the lightest sections is made to produce the most conservative dynamic response as stiffer beams will reduce the response.

A visual plot of the response is also provided for both the steady state and transient response. Hovering over the plot shows the response factor.

Although there are clearly infinite permutations of spans, layout, beam sizes, slabs, etc, if the proposed solution differs from the pre-set arrangements in the tool, the designer simply has to recognise that stiffer beams than assumed will reduce the response, as will using thicker slabs (with corresponding stiffer beams).

The new guide and the on-line design tool provide both the background and the practical implementation of what would otherwise be a complicated and time-consuming assessment. By using these, engineers will find it straightforward to demonstrate that a proposed floor solution will have a satisfactory response.

A steel frame was used to accommodate the varying degrees of vibration performance at the Manchester Cancer Research Centre

The steel encyclopaedia

The steel sector's website – www.steelconstruction.info – is the best destination for architects and engineers to access steel related information.

Launched in October 2012, *www.steelconstruction.info* brought together all the sector's technical and cost information, which was only previously available from a variety of different sources.

Described as the free encyclopaedia for the UK steel construction sector, it was designed to be easy to use, as comprehensive as possible, and the one-stop-shop for technical guidance on steel construction.

Chris Dolling, Manager, Technical Development at BCSA explains: "We set out to provide the best possible internet-based source for steel construction information and we feel this is exactly what we've achieved.

"The Google Analytics for the website show year-on-year growth in the number of users and in October we exceeded a quarter of a million visits per month for the first time."

Key to the success of the website is the regular updates to ensure the information provided remains current. In 2016 the cost table, cost comparison figures, and BIS location factors were updated throughout the cost articles every quarter to suit the latest data from Gardiner & Theobald, and over 70 main articles were reviewed and updated where needed as part of the formal maintenance regime that ensures every article is kept up-to-date.

The Structural Steel Design Awards article was updated to feature the initial short-listed projects and then the winners as soon as they were announced. Fully hyperlinked 'Case studies' for each winning project were created and added to the ever-growing bank of project data. Approximately 50 other case studies of projects under construction in 2016 were also added covering a broad range of building types and sectors.

The Construction news page was regularly updated to include all of the main steel features in the wider construction press, of which there were eight through the year. New publications on *Commercial Buildings* and *Floor Vibration* were added, along with best practice guides on the installation of metal decking, and a new web-based 'Floor response calculator' that allows designers to make an immediate assessment of the dynamic response for a given floor solution.

For those who are new to *www.steelconstruction.info* the site has well over 100 wikipedia style articles, written by the steel sector's own experts as well as external consultants, and covering best practice in the use of steel across the construction sector, as well as topics such as fire engineering, costs, sustainability and health & safety.

These core articles act as a roadmap to each topic using links to more detailed information available from the sector and other external sources. A number of online CPD presentations are also included, which enable the user to take a test and download a certificate for their records.

There is also a host of links where users can go directly to web-based steel design software and tools, while the news section allows access to a number of BCSA and Steel for Life supplements that have appeared in the construction and architectural press, such as Construction News and Building magazine.

The steel sector has an ongoing pipeline of research and development work, and continuously updates its guidance in line with changes in legislation, standards and industry practice.

Consequently, the website is also updated on a regular basis, and registered users (one can register on the site) get quarterly email alerts highlighting all of the site's new features, updates and additional information.

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NSC magazine is available free of charge in a paper format for the UK and Ireland as well as in a digital format for use on tablets, smartphones and desktop computers.

A regularly updated website also carries news of steel construction issues and projects, as well as the NSC digital library containing the current issue and archives.

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