Steel Spotlight

King’s Cross steps up to the podium

A 4,000 sq m podium structure has been erected at King’s Cross in London to allow safe access to five buildings being constructed simultaneously.

ST PANCRAS, LONDON
RUBY KITCHING

Steelwork contractor Fisher Engineering
Main contractor Bam Construct
Structural engineer Bam Design

Client Argent
Architect Allies and Morrison

It’s all systems go on the 23-ha mixed-use development site at King’s Cross, London which is being delivered by the King’s Cross Central Limited Partnership.

In the southern part of the site, nestled between St Pancras International to the west and King’s Cross station to the east, is Zone B where main contractors Bam Construct, Kier and Vinci are collectively working on five different buildings at the same time.

To facilitate this, consultant Bam Design and Bam Construct have designed and built a 4,000 sq m podium structure to allow safe access to all sites. The steelwork contractor is Fisher Engineering.

The triangular shaped steel-framed podium covers the plan area of the future Pancras Square, the centre of which will eventually have seven buildings. Covering an area of 3,500 sq m, the podium contract is valued at £80m. Bam Construction began work on site in April 2012 installing 416 piles for contractor Bam Nuttall had cleared the former gas works and installed a perimeter of contiguous piled wall for the basement. While each building will have its own basement, the B0 podium structure provides a shared basement for all buildings for deliveries after construction.

During the construction phase, the podium creates a robust construction surface at level 1 and at basement level. Currently, several activities are taking place in Zone B from muck shifting to core construction.

B0 is mostly a double-height space to accommodate plant during construction and articulated kerrys after completion. The basement area will include plant rooms in the centre of the plot. Around 600 tonnes of steel was erected in just eight weeks to create the podium, including plate girders which were up to 1.5 m deep. The longest spanning members measured 38.6 m.

Steel savings

Initially the podium structure had been designed using in situ concrete, but Bam Design decided that it would take too long to build, so proposed a steel-framed solution with precast concrete slabs. Steel members could also span further with a shallower depth, which was essential to achieve the required headroom.

“There was a six-week saving in using steel instead of concrete, which made for a much more comfortable environment to deliver the rest of the project,” says Bam Kelly Bam Design.

He adds that another town centre may have been requested on the site had the podium been built using concrete, adding to costs.

He says concrete construction would have required a lot of temporary propping that would have restricted access and slowed the programme down. “With so much concrete construction going on in the area, there could have been supply issues too,” says Bam Design director David Carter.

Although steel was selected mainly to achieve project milestones, it was also used because it would provide a sufficiently stable and level platform for Pancas Square’s water features. The public square will have infinity pools, which require a very stable base to create the required serene effect. In some cases, deeper beam sections were chosen to meet the more stringent performance criteria set by the pools. Services are also hung from the podium’s beams.

In redesigning the podium as a steel-framed structure, Bam Design was also able to rationalise and simplify the scheme, particularly to take into account the site’s 7 m fall in height and incorporate architectural and service details from Bam Design’s 3D Revit computer model.

The Revit model helped with interfacing the needs of the different projects, recalls Mc Kelly, particularly the provisions required for the podium’s beams. Several models will be on site much later than the rest of the project. Fisher Engineering was able to use this model to co-ordinate their fabrication model with the design model.

Preferred solution

The concrete solution was stepped in two directions, which would have made providing temporary access very difficult. The steel solution now has fewer, more regular steps to accommodate the change in height across the site and has been easier to construct,” comments Bam Design structural associate Mike Hayes.

Rationalising the scheme also involved deciding which columns could be taken out and replaced by deeper beam sections to span further. This was possible in some cases, but was restricted by cost and the limits imposed by the required basement headroom.

Podium sections are generally 356 columns and are about 8 m to 9 m tall. They span directly onto basements which sit on piles, cast over groups of piles. Beams are generally either 762 or 1,016 mm deep, with 200 mm precast planks making up the podium slab.

The planks were designed to be self-spanning so required no backpropping. A 100 mm thick structural topping on top of the slab, waterproof layer and asphalt topping make up the finished surface, prior to landscaping.

In 2014 Camden Council and BNP Paribas Real Estate will move into two of the new office buildings at Pancras Square (Building B1 and B3 respectively). Buildings B2 and B4 are being built by the King’s Cross Central Limited Partnership.

Excavation for Building B1 is currently under way, requiring 50 lorries per day and a 762 mm diameter concrete pipe to carry the spoil from the area. The lorries traverse the site at basement level where a conveyor belt will carry the slabs to the site. The slab is being prepared for the structural topping and the final waterproofing layers.

By February 2013, the podium will be complete and excavation work on the private sector buildings is due to begin. By 2016, the podium will be occupied by offices and a hotel.

“Over the years the podium will provide a new lease of life as Pancras Square,” says Hayes.

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Steel site answers need for support

Up-to-date, reliable information, downloadable detailed guidance from industry experts and an intelligent search function: welcome to www.steelconstruction.info, a veritable ‘Wikipedia’

STEELCONSTRUCTION.INFO RUBY KITCHING

The internet is usually the first port of call for most construction professionals when it comes to sourcing information. But it can often be a confusing and laborious exercise trying to pin down the most current and reliable data for specifying, costing, designing, manufacturing and building. This is why the British Constructional Steelwork Association (BCSA), Tata Steel, and the Steel Construction Institute have pulled together everything related to constructional steel on one Wikipedia-style website, www.steelconstruction.info. Current information on topics such as embedded carbon, lifecycle costs and fire engineering are also included on the website. “The new website has been designed to appeal to all construction professionals using a simple and comprehensive format,” says BCSA project manager for the site Chris Dolling.

Specific guidance

He adds that the website includes information specific to clients, designers and contractors across the broad spectrum of disciplines within construction. Among them are mechanical and electrical engineering, quantity surveying, architectural or structural design. Throughout the ‘Wikipedia’ site, the user follows a simple and comprehensive format, “as diverse as cost planning, lifecycle assessment, fire engineering and the key issues involved in the design of schools and hospitals. These articles, which are all freely downloadable in pdf format, act as a roadmap to further information. The website is easy to navigate; the home page lists sectors and topics and clicking on any item leads to a new page with more options for a deeper understanding.

Layers of detail

Because people of different interests, backgrounds and knowledge bases will be using the website, the information offered is layered. So on the first click of a subject, general information is displayed and subsequent clicks offer greater levels of detail,

WEBSITE FEATURES

1. Sectors - Articles on design and construction issues in particular sectors, including offices, industrial buildings, schools and bridges.
2. Topics - Articles on key topics such as cost, sustainability, thermal mass and fire with extensive links to more detailed articles and external resources.
3. Online CPD - Articles, watch video presentations, take a test and download the certificate.
4. Key resources - Links to popular information downloads.
5. Hot topics - Links to most recently viewed articles.
6. Quick Links - Tata Steel product information, BCSA members directory and SCI technical resources.

HOT TOPICS

Cost of structural steelwork - Our cost spreadsheet is frequently accessed. The tool is set for the Tata Steel technical hotline can now be accessed on the website through the cost content section developed by Lindsay & Freibaid and updated each quarter. For example, searching under the topic of cost, cost comparison studies can be accessed that lead to, say, either a city centre or out-of-town office type and a table that gives gross internal floor area cost per sqm for a composite structure or a post-tensioned structure. Initially the costs relate to a City of London building, but adjustment factors are given should this be a building in any other major city.

Lifecycle assessment is essential for all good building design and specification

This article looks at embedded carbon, end-of-life scenarios and where to source reliable data. By searching under this topic, LCA and embodied carbon data can be found in product information, case studies, circular economy challenges and the Building a Circular Economy Network.

Thermal mass - The importance of sufficient benefits from thermal mass can be gained from a composite (steel and concrete) building as for a concrete building. The website references the Target Zero report. Here, the science behind thermal mass is explained through diagrams and some of the practical issues are considered. These include the fact that because using thermal mass involves exposing the soffit, the aesthetic implications need to be considered.

The cost of preparing a concrete surface for exposure can be significant, meaning that everyday concrete finishes are often not of a high aesthetic standard. If metal deck is used, the metal deck will require some cleaning after the concrete pour. However, an aesthetic finish can be achieved by using an etch primer and then over painting. An alternative way to achieve the aesthetic finish may be to use a Duraslab deck instead, where the metal deck has a decorative coating applied before profiling (similar to cladding). This option ameliorates the aesthetic impression of metal.

Fire engineering

Miscoharchitects and testing into the way steel behaves in a fire has led to fire protection strategies to be developed, current guides are referenced. “For example, when searching under fire engineering, active fire protection can be selected. Here, a description is given for how sprinklers are designed to automatically suppress small fires on or shortly after ignition, to prevent fire from spreading to the fire service. A link will then take you to, say, Approved Document E(2) for England & Wales, which states that almost all buildings over 30m tall are required to have a life safety protection system installed. Through multiple links to detailed resources, many articles and external resources, the website is designed to be viewed online and subsequently followed by links to detailed articles that can be downloaded or viewed online. For example, by clicking on retail buildings, you could read up on fire engineering, then eventually leading to links on external documents that can be downloaded or viewed online. Chapters are embelished with photographs, diagrams and video links relating to case studies and the whole format has been designed to be viewed on smart phones, iPads and Blackberries as well as desktop computers.

Mr Dolling says: “Users can keep up to date on new content by selecting the ‘keep me informed’ check box on the registration screen to receive updates when content is added or by following Steelconstruction on Twitter or the steelconstruction.info group on LinkedIn.”

APP FINDS STEEL CONTRACTOR FOR YOUR NEEDS

Selecting a suitable steelwork contractor for type and size of project can be done using the new steelwork contractor App for smart phones. A new steelwork contractor can be found on the website to gain access to a searchable directory of the member companies of the BCSA.

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A key feature of the website is the range of online continuing professional development tests. Users can read the relevant articles, watch the training videos and take a test. A downloadable certificate offers proof of completion. Twelve topics will be available initially including ‘Steel the safe solution’, a presentation that provides information on the safe erection of steel buildings. Users can also request in-house lunchtime CPD seminars online.

Produced in association with TATA STEEL

Steel Construction Info

A range of health and safety advice is available on the new website

Steel Spotlight

25 | 29 November 2011 www.cnplus.co.uk
To the beat of the drum

The Brent Civic Centre in Engineers Way, London, is an apt location for the UK’s greenest public office building. It also boasts some of the most exquisite steelwork detailing in the country.

The building is located in the shadow of Wembley Stadium and adjacent to Wembley Arena, the building is a welcome addition to the area, providing a much-needed hub.

Architect Hopkins with structural engineer URS, main contractor Skanska and steelwork contractor Bourne Construction Engineering are involved with the steel and concrete building, which has been designed to be functional, welcoming and inspiring. The steelwork was completed in October.

An L-shaped office block, with its long leg to the back of the site, will neatly accommodate up to 2,500 staff, who are currently spread over 14 different buildings around the borough. A steel-framed, south-facing glass fronted atrium occupies the full height of the structure and connects the council offices to the civic building, a drum-shaped building which has a more open and inviting feel. The south-facing façade is fully glazed and dedicated supported by a cable truss system.

Taking the Limelight is the nine-storey drum-shaped civic building. Surrounded by open terraces with a central lantern feature nestled in the centre, the spaces created are breathtaking. The architectural intent was clear from day one - high spec finishes and carefully detailed connections. Every detail is expressed, says Bourne Construction Engineering construction director Charlie Bowell. He adds that the 1,000 tonnes of steel in the project are a testament to the building’s overall structural and architectural scheme.

The public will enter the development via the full-height atrium, which is topped by ETFE pillows the plastic material made famous by the biomes of Cornwall’s Eden project, which also spans across the civic drum.

A step up
A grand set of steps rise up from the ground floor of the atrium to reach the council services and offices. The civic drum, which will house a library, community hall, café, council chambers and shops, is also accessed via the atrium.

Interfaces between the structural steelwork and structural concrete elements of the building were a challenge due to different tolerances, particularly on the two end bays of the 1.8-shaped office block, which feature steel-framed and cross-braced glass walls.

The external columns and cross-bracing steelwork was erected prior to casting of the edge beams, so the end bays had to be supported by falsework until the floors had been post-tensioned and the edge beams cast, says Skanska senior project manager Paul Roberts.

Temporary supports were also required to support a suspended membrane roof between ground and first floor of the office block. When the slab was cast, the post-tensioned, steel hangers from first floor level could be connected up to steelwork to support the temporary supports removed.

The 31 m high atrium roof is supported by 30 m long steel plate girder beams. These are supported at their ends by columns on the interior face of the office block and civic drum. At 960 mm deep and 180 mm wide, the beams and their associated steelwork create a 75 m grid which is in-filled by ETFE pillows.

Steel members were designed to arrive on site in their longest possible lengths to reduce the amount of time spent on site splicing sections together, as well as to reduce the risk of working at height. The beams each arrived in 5 m long sections and were lifted using tower cranes, which were designed specifically for the weight and reach required to install these members.

Running along the top of these beams are steel fittings which support insulated gutters. Since the ETFE pillows are under constant pressure to stay inflated, the gutters also have a structural function to resist this pressure. As a result, the gutters have been made using 8 mm-thick plate and are 4 m long, along straight lengths of beam. Cruciform-shaped gutters measuring 1.5 m square complete the grid at intersections.

Connections made
Perimeter columns at ground floor support the first floor slab in the civic drum, above which a steel pinned connection receives an almost impossibly slender 23 m long steel circular hollow section column. This 406 x 10 mm-thick circular hollow section arrived on site in two pieces – a lower section 15 m long and an upper section at 8 m.

The columns, which support only the ETFE roof steelwork, were supported using temporary struts until all connections were made. When incorporated into the concrete/steel interfaces, careful sequencing was required.

“Because we had to accommodate a lot of movement, we can’t rely on concrete columns during full column construction and pin plates were welded on after post-tensioning to achieve the millimetre accuracy required to connect with (atrium) steelwork,” says Mr Roberts.

Being so close to Wembley Stadium meant that erection of some of the external columns had to work around match days.

“Due to the constraints of the project programme, we had to sequence it very carefully so that we could erect the columns during the FA Cup final,” recalls Bourne senior site manager David Loan.

Mobile cranes were mobilised into the street outside the stadium just as the match started and the column had to be erected and plant cleared before the match finished.

“We were hoping for extra time, even penalties,” he jokes. “The slick operation was only made possible because the steel could be programmed to arrive just in time and be fixed to connections already prepared in the existing structure.

“There was a lot of pre-planning and consideration for access and plant, but when it came to erection, the columns went up really easily,” says Mr Loan.

The building will be completed in June 2013.

Steel Spotlight

A complex project

A double-storey height, 22 m-diameter community hall occupies the first floor of the civic drum (see diagram below). This column-free 1,000-seater space has been achieved using an elegant, exposed braced steel structure to support the level one three floor slab, which was cast on a deep-though profiled metal deck.

A section of this slab involved supporting it on temporary works prior to the braced steel structure being fixed.

The braced steelwork takes the form of cranked radial steel tubes which are supported of a perimeter ring-beam at mid-height of the room. Steel rods form a tension ring at the point where the tubes crank and are used to provide cross-bracing between the tubes.

Finished off in a micaceous iron oxide appearance top coat which painted the protection system and with exposed connections, the impression created that of a bicycle wheel, flat, due to the cranked ‘spokes’, the effect is more dome-like. A winter garden surrounds the community hall and is supported on the main frame of the drum.

The steel and glass ‘lantern’ structure rises from level five of the civic drum, providing the roof over the third floor council chambers at level three. This lantern sits in the centre of the civic drum floor plates from levels five to seven, where the last storey height of lantern (levels seven to eight) sits above the drum roof.

Erection of the lantern involved lowering the dismantled sections of a spider mobile elevating working platform onto level three, reversing it and then fitting each section to a strict sequence, including hanging some members from level seven.

“Most projects don’t require this level of attention – pinned connections had to be millimetre perfect. Due to the complexity of this project and the expertise of the engineering team on site since the end of January,” says Bourne senior site manager David Loan.
Steal strategies in case of fire

As a result of extensive testing, great advances have been made in understanding how structural steel behaves when exposed to fire and now it is easier to demonstrate structural robustness than ever before.

Understanding how critical each element is in terms of the building's overall structural stability, and how these elements interact, is the key to the structural fire resistance strategy.

"Structural fire engineers can take into account how the building is made to the structure to deal with other events (such as disproportionate collapse) when it comes to considering how the structure will perform in a fire."

He adds that Building Regulations treat every element in a building the same way and do not take into account how critical an element is within a structure. He used the example of the Shard, where simply applying fire protection to a large transfer structure would have been sufficient to meet the requirements of Approved Document B to the Building Regulations for structural stability but where the complex interaction of that element of construction with the rest of the building required computer modelling to prove how it would perform in a fire and how much protection was required to ensure that it was safe in a fire.

Dr O'Connor adds that on the Shard, fire protection is enhanced on certain structural elements to ensure they never fail, whereas elements less critical to the overall stability can have reduced levels of fire protection. Applying fire protection performs a strategic way; particularly for a large building, such as the Shard, has significant cost benefits.

The same is true on another London skyscraper, Heathrow Tower, where its triple-storey floor units had to be computer-modelled to understand the effects of fire on each building, which has a number of different types of occupants.

A BACKGROUND TO FIRE ENGINEERING

Building Regulations outline how the structure of a building should be fire-safe, but it does not describe exactly how this should be done.

For England and Wales, Requirement B3 of the Building Regulations states: “The building shall be designed and constructed so that, in the event of a fire, its structural elements will be maintained in a safe condition for a reasonable period.”

UK regional governments also publish documents which provide guidance on fire safety in buildings. Approved Document B applies in England and Wales and gives minimum structural fire resistance ratings, which building of various heights, with or without sprinkler systems, must be provided with. The ratings are based on the time of a fire, and should not be considered to represent the period of time a building may stand after in a real fire.

Approved Document B makes provision for alternative means of using fire safety engineering, since it may be the only practical way to achieve satisfactory fire safety in some large and complex buildings. The approved document B applies in England and Wales and gives minimum structural fire resistance ratings, which building of various heights, with or without sprinkler systems, must be provided with. The ratings are based on the time of a fire, and should not be considered to represent the period of time a building may stand after in a real fire.

Active protection

“Structural fire resistance is considered the last line of defence,” says Dr O’Connor, himself a structural engineer specialising in fire engineering, “and given that several other systems are a part of other strategies, such as the use of active fire protection – that is, sprinklers – or rapid intervention on the part of the fire brigade, failure or burn-through of the building envelope is critical.”

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Steel delivers a flexible approach

A mixed-use development in Gateshead town centre has been aided by the versatility of steel during a complex build programme

TRINITY SQUARE
RUBY KITCHING

Main contractor
Bowmer & Kirkland

Steelwork contractor
William Hare Structural

Structural engineer
Fairhurst

Architect
3DReid

Client
Spenhill

About £1 billion has been invested into Gateshead town centre, Tyne and Wear over the past few years in the form of new housing, a college, the Sage music and arts centre and the Baltic Exchange complex. The £150 million Trinity Square development is an extension of this, away from the river Tyne this time, and towards the heart of the town centre. The new mixed-use development is also located next to the town’s main transport interchange for buses and rail. It will comprise a 1.4 ha Tesco store, with accommodation for up to 1,000 students built above. The main contractor is Bowmer & Kirkland, working for the developer Spenhill, a wholly owned subsidiary of Tesco which delivers residential and mixed-use developments across the UK. Work on site commenced in 2011.

Underlying the site there is a basement car park for 750 cars which helps accommodate the fall in ground level of some 15 to 20 m across the site. The Tesco development and surrounding 48 retail units effectively sit on level three and occupy a double height space up to level five. Eight student blocks sit on the footprint of the Tesco store from level five. The car park has a reinforced concrete ground floor with steel beams and columns forming the main 15.5 m by 7.5 m structural grid. Beams are generally 400 mm to 500 mm deep while the columns are 305 sections. Steel construction was chosen to achieve these spans and column members, allowing enough headroom for the car park levels. The floor build up comprises 200 mm thick prestressed planks for speed of erection.

Specialist teamwork

Steelwork contractor William Hare won the primary and secondary steelwork design and build contract for the project, which involved co-ordinating the structure with cladding, lift and escalator specialists, as well as architect 3DReid. Faithлуш has been contracted by William Hare for much of the structural frame design. The retail units are on the same 15.5 m by 7.5 m structural grid as the car park, but are predominantly double height (6 m tall) with the provision for a level four mezzanine to suit each tenant’s needs. This means that beams and columns located adjacent to the future mezzanine level have been designed with the relevant connections to allow easier simple installation of this floor in the future. Beams at level five perform the function of a transfer structure, linking the different column spacing for the store (35.5 m by 25 m by 30 m) above.

These transfer beams are fabricated steel plate girder columns approximately 2 m deep. Columns are 500 mm square box sections made from 40 mm thick plate. The team considered numerous configurations of the number, height and locations of the student blocks during the planning stages of the design to reduce the loadings on the transfer structure and minimise its depth. Fairthistle partner Ron Bryson says: “Steel gave the flexibility that was needed to incorporate the changing grid patterns of the development.”

Since the original Tesco store was operational until April this year, all deliveries and construction had to be programmed around it until it was closed and demolished. Another issue which the steel frame had to accommodate was the late inclusion of a nine-screen cinema after construction had already begun. The cinema had to be designed to sit on a building plot which had already been granted planning permission for retail units. The new use required the removal of almost all columns and addition of deeper beam sections to create open layouts for all the auditoriums. A 1 m-deep waterproof and acoustic barrier separates the student accommodation floor from the roof of the supermarket, but external areas on the store roof have a minimum 100 mm-thick build-up. A running track, garden, paths and a five-a-side football pitch will be included on the store roof.

Servicing zone

"The student podium level over the store adopts significant lightweight build-up over the store roof to create an artificially elevated ‘ground’ level for the student village. This creates a zone for extensive servicing and drainage to fall to the perimeter of the development, avoiding drops through the retail space below and conflicts with other end-users," says Mr Bryson. Within the eight student blocks, which vary in height from seven storeys to 12, columns and beams are generally either 305- or 254-mm-deep sections. Storey height is 6 m so some blocks are up to 70 m tall. Steel was chosen for the frame to allow speedy erection, even accommodating ready-fitted out bathroom pods to save time.

The most identifiable features of the student accommodation blocks are the full-height tacking columns and curved eaves detail which from part of the façade’s brise-soleil. The external columns vary in diameter from 300 mm to 500 mm and are pin-connected to a base at level five and at the eaves. Column sections were delivered to site in 25-m-long sections where possible (the longest which can be transported) to reduce the amount of splicing on site. The roof will be clad with steel sheeting.

One of the main challenges for William Hare was to achieve the high tolerances required on the store build, since this would form the base of the student accommodation block. These blocks were built floor by floor, after which site operatives erected the curved eaves and then slotted in and spliced together the steel columns. Steelwork is expected to be completed by January 2013, with the entire complex opening in phases before summer 2014.

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RONBRYSON, FAIRHURST

The steel has been modelled by contractor William Hare