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 27-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 known as B0.

Bam Construction began work on site in April 2012 installing 415 piles after contractor Bam Nuttall had cleared the former gas works and installed a perimeter 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 lorries 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 18.6 m.

"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"

MICK KELLY, BAM CONSTRUCT

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 Construct construction manager Mick Kelly. He adds that another tower crane may have been required 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 Pancras 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 Mr Kelly, particularly the provisions required for buildings B5 and B6 which will be on site much later than the rest of the project. Fisher Engineering was also 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. These fix directly onto baseplates which sit on pilecaps, 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 150 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 speculatively.

Excavation for Building B1 is currently under way, requiring 50 lorry journeys a day to remove the spoil from the area. These lorries traverse the site at basement level of the podium. At level 1, the slab is being prepared for the structural topping and the final waterproofing layers.

By February 2013, the podium structure will be an access road for construction traffic serving mainly Building B1. By 2016, the podium will begin a new lease of life as Pancras Square.

About 600 tonnes of steel was erected in eight weeks to create the podium

6
Weeks saved by using steel rather than concrete for the podium

SITE FACTS

- Only 60 per cent of the land will be built on. Public realm including gardens, paths and the Regent's Canal will make up the remaining 40 per cent
- Just over half the built area will be occupied by offices – a quarter will be residential and the remaining is occupied by retail, leisure, cultural, educational facilities and a hotel
- The Regent's Canal splits the site into northern and southern sections
- The southern section is occupied mostly by office blocks and retail space. It is flanked by St Pancras International to the west and King's Cross station to the east
- In 2014 Camden Council and BNP Paribas Real Estate will move into two of the new office buildings at Pancras Square
- The larger northern section is already home to Central Saint Martins College of Arts and Design, Granary Square, new homes and restaurants. More homes, student accommodation, shops, offices and public spaces will open in 2013 and after that schools, cultural and leisure facilities
- Fifty new and restored buildings and structures, 20 new streets and 10 new public spaces are being created
- By 2016 up to 30,000 people will be studying, living and working in King's Cross

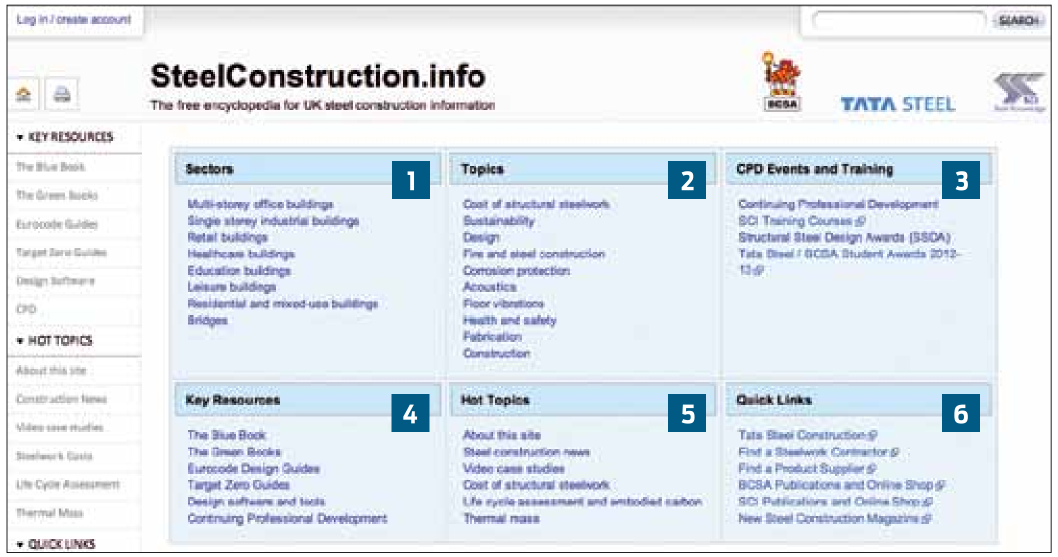
"The steel solution has fewer steps to accommodate the change in height across the site"

MIKE HAYES, BAM DESIGN

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 'Wikisteel'

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 steelwork on one Wikipedia-style website, www.steelconstruction.info. Current information on topics such as embodied 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.

Dubbed "Wikisteel", the site uses the same format as Wikipedia to disseminate information. However, very different to the way Wikipedia has been set up, steelconstruction.info references material from a traceable set of expert sources such as the BCSA, the Steel Construction Institute and Tata Steel.

At the heart of the new site are more than one hundred interlinked articles written by industry experts and external consultants on topics 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 through multiple links to detailed resources.

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, eventually leading to links to external documents that can be downloaded or viewed online.

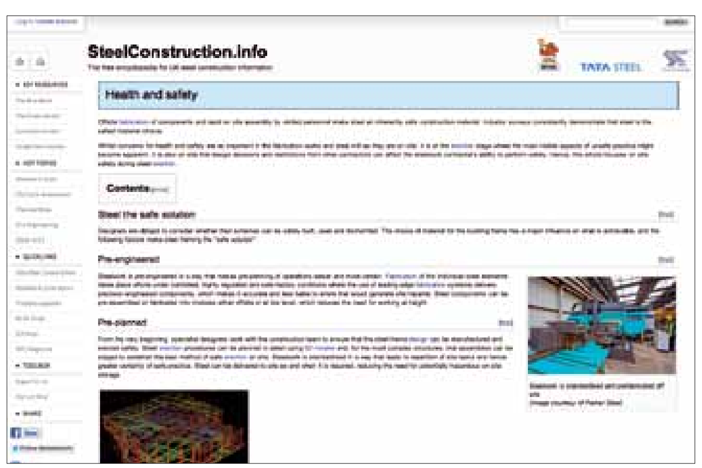
For example, by clicking on retail buildings, you could refine your interest to fire engineering, then single-storey buildings in fire boundary conditions, followed by space separation in boundary conditions and eventually be led to a downloadable design guide: Approved Document B, (Fire Safety) 2006. Department of Communities and Local Government.

One of the website's strengths is that the search function uses predictive text to encourage any enquiry to be as specific as possible. Documents as well as websites are also searched for any enquiry.

Quick links to well-used technical guides such as the blue books for steelwork design and green books for connection design are on the home page.

Chapters are embellished 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 on 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 #steelcoinfo on Twitter or the steelconstruction.info group on LinkedIn."



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

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 Read 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
One of the most frequently asked questions on the Tata Steel technical hotline can now be answered on the website through the cost content section developed by Gardiner & Theobald and updated each quarter. For example on 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 sq m for a composite structure or a post-tensioned structure.

Initially the costs relate to a City of London building, but adjustment factors are given to help cost a building in any other major city.

Lifecycle assessment – essential for all good building design and specification
The website explains embodied carbon, end-of-life scenarios and where to source reliable data. By searching under this topic, LCA and embodied carbon data can be found for steel plate, sections, tubes, purlins and side rails.

Thermal mass
Research shows that sufficient benefit from thermal mass can be gained from a composite (steel and concrete) building as for a concrete framed one.

The website references the Target Zero reports. 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, mainly because everyday concrete finishes are often not of a high aesthetic standard.

If a metal deck floor is used, the metal deck will require some cleaning after the concrete is poured. 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 Colorcoat® deck instead, where the metal deck has a plastisol coating applied before profiling (similar to cladding). This option eliminates on-site treatment of the decking.

Fire engineering
Much research 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, or to contain fires until the arrival of the fire service. A link will then take you to, say, Approved Document B[2] for England & Wales, which states that almost all buildings over 30 m tall are required to have a life safety sprinkler system installed.

Structural Steel Design Awards 2012
Find out about the best examples of steelwork design and erection from this year's winners.

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 link for this can be found on the website to gain access to a searchable directory of the member companies of the BCSA.

Bridgework contractors can be found on the register of qualified Steelwork Contractors Scheme for Bridgeworks, which is administered by the BCSA and is open to any suitably competent steelwork contractor with a fabrication facility in the EU.

You can also switch on search filters for capabilities to help choose a contractor.

CPD BOX

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-framed buildings. Users can also request in-house lunchtime CPD seminars online.

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

BRENT CIVIC CENTRE
RUBY KITCHING

Main contractor Skanska
Steelwork contractor Bourne Construction Engineering
Structural engineer Fairhurst
Architect URS
Client Brent Council
Architect Hopkins

Local town halls have certainly changed with the times and London Borough of Brent's new £100 million BREEAM Outstanding council offices, which are being built on the site of a former car park, are no exception.

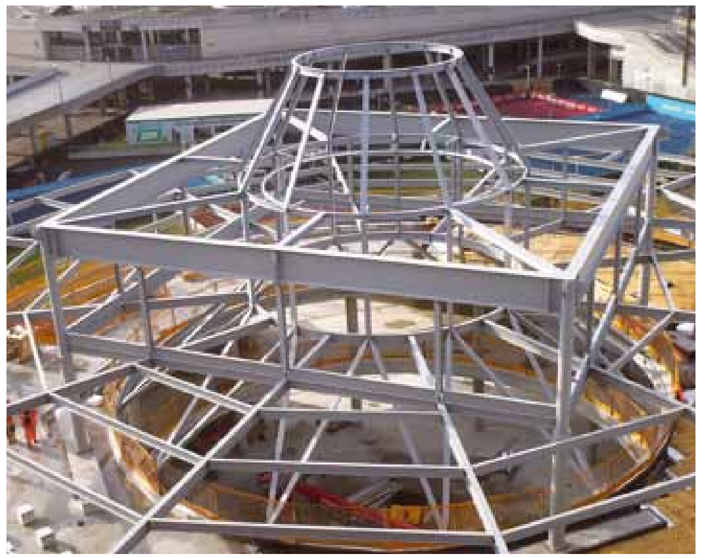
Brent Civic Centre, the greenest public office building in the country (see below), is as much a place for the council to carry out its operations as it is for the community to come together to use library services, a café and public gardens.

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.

CENTRE'S HIGH SCORE

The Civic Centre has received a BREEAM Outstanding rating from the Building Research Establishment with a score of 92.55, making it the greenest public office building in the country and the fourth greenest building worldwide. It has achieved this by incorporating sustainable materials, natural ventilation, a green transport plan including 250 cycle spaces, rainwater harvesting and a combined cooling, heating and power plant that uses waste vegetable oil.


A steel and glass 'lantern' structure rises from level five of the civic drum

An L-shaped office block, with its long leg to the back of the site, will neatly accommodate up to 2,300 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 delicately 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 Rowell. He adds that the 1,000 tonnes of steel in the project are prominent in 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 in 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.

> **"The architectural intent was clear... every detail is expressed"**
> CHARLIE ROWELL, BOURNE CONSTRUCTION

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 L-shaped office block, which feature steel-framed and cross-braced glazed 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 mezzanine level between ground and first floor of the office block. When the mezzanine slab had been post-tensioned, steel hangers from first floor level could be connected up to support the slab, and the temporary supports removed.

The 31 m-high atrium roof is supported by five, 30 m-long steel plate girder I beams. These are supported at their ends by columns on the interior face of the office block and civic drum. At 950 mm deep and 350 mm wide, the beams and their associated steelwork create a 7.5 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 15 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 stool fixings 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 6 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 it came to the concrete/steel interfaces, careful sequencing was required.

"Because we had to accommodate a lot of movement, we cast endplates into concrete columns during column construction and fin plates were welded on after post-tensioning to achieve the millimetre accuracy required to connect with [atrium] steelwork," says Mr Roberts.


The community hall roof steelwork is finished with an intumescent coating

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.

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 three floor slab, which was cast on a deep-trough profiled metal deck. Construction 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 off 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 also used to provide cross-bracing between the tubes.

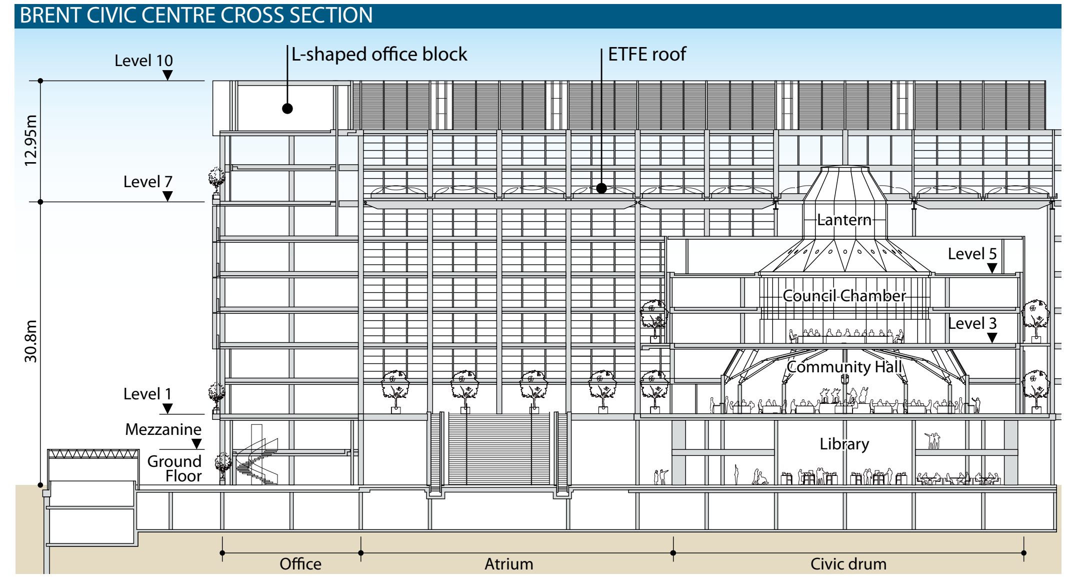
Finished off in a micaceous iron oxide appearance top coat which is part of the fire protection system and with exposed connections, the impression created is that of a bicycle wheel. But, due to the cranked 'spokes', the effect is more dome-like and ethereal. A winter garden surrounds the community hall and is supported off the main frame of the drum using composite steel construction.

A central steel and glass 'lantern' structure rises from level five of the civic drum, providing the roof over the double-storey height 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) are visible above the drum roof.

Erection of the lantern involved lowering the dismantled sections of a spider mobile elevating working platform onto level three, reassembling it and then lifting each steel 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, we've had an entire in-house engineering team on site since the end of January," says Bourne senior site manager David Loan.

BRENT CIVIC CENTRE CROSS SECTION



Steel 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

FIRE ENGINEERING
RUBY KITCHING

Structural fire engineering is a discipline for large or complex buildings that considers the performance of structures when exposed to a heating load. This allows engineers to design structures (and applied fire protection) to achieve pre-specified performance.

In addition, when structural engineering and fire protection in buildings are assessed together, it is possible to demonstrate structural robustness, bring about efficiencies in design as well as provide considerable cost savings.

The past two decades have seen great advances in the understanding of structural steel's behaviour in fire as a result of extensive small- and large-scale physical testing. There are now numerous cost-effective ways of engineering a steel structure to meet the regulations.

"Building Regulations state that the stability of a building must be 'maintained for a reasonable period'. We have to interpret what this means," says WSP technical director Mark O'Connor, whose firm provided structural and structural fire engineering services for the Shard in London.

"For the Shard, the rule book didn't apply so we had to demonstrate how the building would perform in a fire. The approach looked at the building and the elements which make it up" (see case study opposite).

Survival scenarios

Since the Shard is both tall and mixed-use, many scenarios regarding the fire response of different structural arrangements and materials had to be considered. For example, the structure of an atrium differs from that of an office floor due to its different loadings and spans. They will also act very differently in a fire due to the size of members. In fire engineering terms, the areas will also be considered to pose different fire risks; the lobby area enclosed by an atrium will be less densely populated and with a smaller fire 'load' (anything which could contribute to a fire such as paper or electrical equipment) than an office floor, so each will require different approaches for fire survival.

Large-scale structural fire engineering, such as that seen on the Shard, considers the different scenarios which contribute to a range of possible intensities and durations of fire. These scenarios are analysed using finite element modelling software that has been validated against the findings of the large-scale fire tests carried out at Cardington, Bedfordshire between 1994 and 2003. These physical tests involved monitoring the effects of fire on an eight-storey steel-framed building with composite steel deck floors.

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 only becomes important if other strategies, such as the use of active fire protection – that is, sprinklers – or rapid intervention on the part of the fire brigade, fail.

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 advantage of enhancements 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 in this strategic way, particularly for a large building such as the Shard, has significant cost benefits.

The same is true on another London skyscraper, Heron Tower, where its triple-storey floor units had to be computer-modelled to understand how the building would perform in a fire, since the standard approach assume single-height floors only (see case study, right).

"For the Shard, the rule book didn't apply, so we had to demonstrate how the building would perform in a fire"

MARK O'CONNOR, WSP

A BACKGROUND TO FIRE ENGINEERING

Building Regulations outline how the structure of a building should perform in a fire, but they do 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 stability will be maintained 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 rating which a building of various heights, with or without sprinkler systems must be provided with.

The ratings are given in terms of time, however this is in relation to exposure to the "standard fire" and should not be considered to represent the period of time a building may stand up for in a real fire.

Approved Document B makes provision for alternative solutions using fire safety engineering, since it may be the only practical way to achieve satisfactory fire safety in some large and complex buildings or in buildings which house a number of different types of occupants.

www.steelconstruction.info

CASE STUDY: THE SHARD, LONDON

Fire and structural engineer WSP
Steelwork contractor Severfield-Rowen
Main contractor Mace
Developer Sellar

The 310m-tall Shard is a 95-storey mixed-use structure (72 floors occupiable) and is currently the tallest building in Europe. The structure is steel-framed from levels two to 40 and, to ensure the efficient integration of passive fire protection, structural engineer WSP also provided fire engineering services.

Fire is a significant safety issue in any building but especially so in tall towers. The taller the building, the longer is takes for occupants to escape. It also becomes more difficult for firefighters to tackle a fire.

"For a building of this size and nature, it was important to consider a range of approaches to ensure that the fire protection specified met the requirements of all stakeholders, while ensuring an added level of confidence that the structural fire performance of the building would be acceptable under the expected range of fire scenarios," says WSP technical director Dr Mark O'Connor.

An assessment of fire loading, ventilation and likely temperatures were made and applied to a computer model of the structure to determine which elements needed applied fire protection to meet the required stability and stress criteria.

These steel construction areas were analysed:

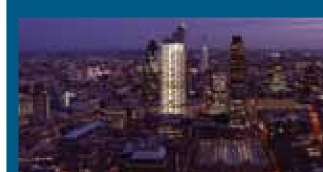
Main structural steelwork between levels two and 40 Offsite intumescent coating protection to selected members. Steelwork contractor Severfield-Rowen assisted in proposing the most economic scheme where, for example, larger section sizes would require a thinner application of the coating.

External columns at the bottom of the structure Concrete-filled fabricated steel box sections made from 100 to 125 mm-thick plate only required a thin layer of intumescent coating since the members had a significant degree of inherent fire performance due to their size and location.

Main transfer structures between main tower and 'backpack' building Since these A-frame steel elements respond differently in a fire to a single beam or column, computer modelling revealed that they needed greater fire protection than the Building Regulations prescribed. The transfer structure A-frames were encased in board.

CASE STUDY: HERON TOWER, LONDON

Fire and structural engineer Arup
Steelwork contractor Severfield-Rowen
Main contractor Skanska



This 203 m-tall tower has been designed with a vierendeel stress tube structure which wraps around the perimeter of the office floors. The office floors are supported by long span (up to 14 m) solid section beams acting compositely with a 130 mm-deep concrete floor slab. The 46-storey building features three-storey floor units, known as "villages", so a severe fire would have the opportunity to spread over three floors. Most buildings are compartmentalised floor by floor so a fire risk analysis usually considers a fire spreading over only one floor at a time.

"This is the first high-rise building we know of in which the design has deliberately considered [the potential for] three-storey fires. The Approved Document does not cover this so we undertook research to determine how the fire would spread and which elements would require more or less fire protection," says Arup senior fire engineer Graeme Flint.

Offsite intumescent coating was applied to selected members and the analysis revealed that secondary steelwork did not require protection. A further analysis revealed that using the prescriptive approach to fire protection based on the recommendations of Approved Document B would have caused some internal columns to fail, so the fire protection of these elements were enhanced using 20 mm-thick board. The approach made significant savings to the cost of fire protection, while providing a more robust fire protection strategy.

"On a similar project, using a similar approach, we saved £4 million [off the cost of fire protection], while demonstrating an acceptable robustness" adds Dr Flint.

Steel delivers a flexible approach

A mixed-used 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 bus 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 45 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 using slim beam members, allowing enough headroom for the car park levels. The floor build-up comprises 200 mm thick precast 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. Fairhurst 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 (9 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 (15.5 m by 7.5 m) to that of the student accommodation (6 m by 6 m) above.

These transfer beams are fabricated steel plate girders which are about 2 m deep. Columns are 550 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.

Fairhurst partner Ron Bryson says: "Steel gave the flexibility that was needed to incorporate the changing grid patterns and the complex phasing arrangements of the development to accommodate the constraints of the neighbouring Gateshead shopping streets and to maximise the time which the original trading Tesco [store on the site] could remain open."

The steel has been modelled by contractor William Hare

10k
Tonnes of steel used

"Steel gave the flexibility that was needed to incorporate the changing grid patterns of the development"
RON BRYSON, FAIRHURST

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.

GET SHOPPING

The Trinity Square mixed-use development is being built on the site of the former Trinity Square shopping centre, which was home to the car park, demolished in 2010, made famous in the 1971 crime film *Get Carter*.

It will comprise 2.2 ha of retail and leisure, including a 1.4 ha Tesco store with undercroft parking for 750 cars and a primary care trust building.

A new town square will be at the heart of the complex, which will also include a nine-screen cinema, cafés, bars and restaurants. Student accommodation for around 1,000 students across eight, high-rise blocks will be built on top of the Tesco store.

Elsewhere on the site, 1,860 sq m of offices will be built using a steel-framed structure which has a column arrangement suitable for converting it to a 120-bed hotel.

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 superstore, but external areas on the store roof have a minimum 800 mm-thick build-up. A running track, garden, paths and 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 203- 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 raking 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 23 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.