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NSC

Center Parcs sports steel

Vol 21 No.4 July/August 2013

Moorgate's tubular columns

New energy for Exeter

Steel supports supermarket site

High speed steel for rail

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New Steel Construction keeps designers and contractors abreast of all major steel construction related developments and provides detailed technical information on key issues such as the introduction of the Eurocodes. NSC will be the first place most people hear about advances made by the extensive research and development efforts of the steel construction partners – Tata Steel, the British Constructional Steelwork Association, and the Steel Construction Institute, as well as other researchers.

Each issue of NSC is a blend of project reports and more in depth technical material. Taking up our free subscription offer is a guarantee that you will be alerted to significant developments in a sector that retains a commitment to continuous development in knowledge and techniques for timely delivery of cost effective, quality projects across all sectors of construction.

Each issue of NSC is typically 44 pages and contains four pages of news, developments related to Eurocodes, cutting edge project reports from site, and the latest technical updates from the Steel Construction Institute in its Advisory Desk Note series. One of the most popular features is 50 Years Ago, looking at key projects of the past by revisiting the pages of 'Building With Steel'.

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Position

Company

Address

Postcode

Telephone

Email

Cover Image
Moorgate Exchange, London
Client: Telex Sàrl
Client monitoring architect:
Pringle Brandon Perkins + Will
Architect: HKR
Steelwork contractor:
Severfield -Watson Structures
Steel tonnage: 2,900t

BCSA

TATA STEEL

SCI Steel Knowledge

NSC
July/August 2013 Vol 21 No 4

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Awards show steel quality is maintained

Nick Barrett - Editor

The London Olympic year crop of entries for the Structural Steel Design Awards was always going to be a hard act to follow, after the Olympic Stadium itself and the Velodrome were winners. But the judges of this year's awards were delighted once again with the standard of projects that they were invited to pass verdict on.

This year there were four Awards and three Commendations from a short list that included another nine strong entries. The variety of type of structure given Awards was as impressive as ever, including a high quality commercial and retail development behind a historic retained façade in London's West End; a new home for the famous Cutty Sark that gives visitors views of its innovative hull that were not possible before; the Emirates Air Line that provides a cable car crossing of the Thames for the first time; and the strikingly iconic Twin Sails Bridge at Poole.

The Awards, Commendations and short-listed projects are all described in a special supplement from the BCSA and Tata Steel that accompanies this issue of NSC, and which will be distributed with leading construction magazines over the coming weeks. Digital versions of the supplement will be available for download on the free, online steel construction website *www.steelconstruction.info*, where you can also find NSC.

Sceptics would have been justified in thinking that the worst and longest recession the construction has suffered would mean a dramatic reduction in the quality and diversity of type of entry to the SSDA. The judges report no sign of that though, and the proof is in the photographs and descriptions in the supplement.

Chairman of the Judges David Lazenby CBE and his fellow judges – all eminent architects, engineers and steelwork contractors – make great efforts to ensure that all the short-listed projects, 16 of them this year, are visited. They demand a high standard, and in theory they could decide that no project is worthy of award or commendation. There was no likelihood of that with this year's strong crop of entries though, or with any other year in the 45 years that the awards have been running.

One of the trends over the years commented on by David Lazenby this year is the closer and more cooperative relationships within project teams, a professional approach to training and qualifications, and proper tracking and certification of processes and materials.

All of these are prevalent in steel construction, where adopting Building Information Modelling for example is all the easier because of the sector's early adoption of computing techniques for design and fabrication. The industry is also ready for the introduction of CE Marking, as detailed in the freely downloadable guide to CE Marking that can be found at *www.steelconstruction.info*.

The diversity and quality of this year's entries shows why steel construction is the method of choice for the widest range of structures. As long as the flexibility, economy and sustainability of steel construction allow architects and structural engineers to express their vision and to realise the ambitions of their clients, this will surely continue.

NSC

EDITOR
Nick Barrett Tel: 01323 422483
nick@newsteelconstruction.com
DEPUTY EDITOR
Martin Cooper Tel: 01892 538191
martin@newsteelconstruction.com
CONTRIBUTING EDITOR
Ty Byrd Tel: 01892 553143
ty@barrett-byrd.com
PRODUCTION EDITOR
Andrew Pilcher Tel: 01892 553147
admin@newsteelconstruction.com
PRODUCTION ASSISTANT
Alastair Lloyd Tel: 01892 553145
alastair@barrett-byrd.com
NEWS REPORTER
Mike Walter
COMMERCIAL MANAGER
Sally Devine Tel: 01474 833871
sally@newsteelconstruction.com

CHANGES TO THE MAILING LIST
If you wish to notify us of a change:
Members BCSA and Non Members
Telephone BCSA on 020 7747 8126
Members SCI Telephone SCI on 01344 636 525

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The British Constructional Steelwork Association Ltd
4 Whitehall Court, Westminster, London SW1A 2ES
Telephone 020 7839 8566 Fax 020 7976 1634
Website *www.steelconstruction.org*
Email *postroom@steelconstruction.org*

The Steel Construction Institute
Silwood Park, Ascot, Berkshire SL5 7QN
Telephone 01344 636525 Fax 01344 636570
Website *www.steel-sci.com*
Email *reception@steel-sci.com*

Tata Steel
PO Box 1, Brigg Road, Scunthorpe,
North Lincolnshire DN16 1BP
Telephone 01724 405060
Website *www.tatasteelconstruction.com*
Email *construction@tatasteel.com*

CONTRACT PUBLISHER & ADVERTISING SALES
Barrett, Byrd Associates
7 Linden Close,
Tunbridge Wells, Kent TN4 8HH
Telephone 01892 524455
Website *www.barrett-byrd.com*

2013 SSDA winners announced

Four projects scooped a top prize at the 45th Structural Steel Design Awards (SSDA), hosted by the BCSA and Tata Steel and held at Madame Tussauds.

Air W1, London; Emirates Air Line connecting Greenwich Peninsula to The Royal Docks; The Cutty Sark, and the Twin Sails Bridge, Poole all won an Award.

The judges praised all 16 short-listed projects and Judges Chairman David Lazenby CBE said he was particularly impressed by the professionalism of the industry and the winning teams.

Commendations were awarded to three further structures: Brent Civic Centre, Wembley; Marlowe Theatre, Canterbury and The Saints Stadium Bridge, St Helens.

Television news presenter Emma Crosby gave out the awards, including Student Awards for three categories – Building Structures, Bridges and Architecture.

A comprehensive report on the SSDA presentation, as well as descriptions of all 16 short-listed projects can be found in a special supplement distributed with this issue of *New Steel Construction*.

W1, London

The Cutty Sark, Greenwich

Photo: © Dave Morris Photography

Twin Sails Bridge, Poole

Emirates Air Line connecting Greenwich Peninsula and the Royal Docks

Students page added to steel encyclopedia

To further support the education and training for the next generation of construction professionals, a resources for students page has been added to *www.steelconstruction.info* - the free encyclopedia for UK steel construction information.

The new *Resources for students* page contains articles specifically prepared for engineering and architectural students, providing the ideal introduction to the wealth of other material available on the steel information website.

For engineering students there are guides to multi-storey buildings and single storey buildings. Both guides contain a wealth of in depth design information as well as articles and video case studies on relevant UK projects.

An architectural student resource is coming soon, and will contain sections on framing schematics, expressed structural forms, connections, cladding systems and fire protection.

There are also a number of external links, including Student Awards, Steel Construction's YouTube channel, teaching resources from Tata Steel, SCI education services and Steel University – a free e-learning resource.

Steelwork creates giant equine sculptures

The Falkirk skyline is about to change dramatically as two 30m high steel plated equine sculptures, known as The Kelpies, take shape.

Steelwork contractor S H Structures (SHS) is currently erecting the two giant horses' heads, which will be Scotland's tallest works of art, with completion scheduled for end of August.

Each sculpture needs more than 150t of structural steelwork and this will require more than 100 component deliveries to the site from SHS's North Yorkshire fabrication facility.

Off site manufacture of the Kelpie parts is critical to ensure the highest level of quality control as well as enabling onsite erection to be achieved in the shortest possible timeframe.

Main contractor Balfour Beatty Civil Engineering previously constructed the foundations, on which The Kelpies sit, a job that included the installation of a series of 32m long piles.

The Kelpies form an important part of the overall Helix project, a £43M scheme to transform a 350 acre site beside the Forth and Clyde Canal.

Lincolnshire renewable energy plant nears completion

Steelwork has played a leading role in the construction of a straw fired power plant in Sleaford, Lincolnshire that is set to go online before the end of the year.

The facility will burn bales of straw and woodchip to produce enough electricity for 65,000 homes. Ash from the processes will be recycled into agricultural fertiliser.

Caunton Engineering has erected approximately 1,600t of steel for the project, as well as stair towers, ladders, platforms, metal flooring and more than 1km of handrails.

The entire facility, owned by EC02 Lincs, is based around a series of predominantly steel framed buildings. These include two straw barns, a turbine hall, boiler house, flue gas area, straw conveyor and an office unit.

NEWS IN BRIEF

The BCSA has announced that **CE Marking** capability is now a condition of membership for associate members, as from 1 July 2013. The requirement applies to steelwork contractor members from 1 July 2014. This means clients and main contractors can have confidence in the complete supply chain for steel construction from manufacture of the sections and other products, through distribution to fabrication and erection.

The **Leadenhall Building** (Cheesegrater) in the City of London has topped out after reaching its final 224m height. The building's tapered profile, designed to protect sight lines of St Paul's Cathedral, means the structure has already become a landmark in the square mile. The building is a joint venture between British Land and Canadian company Oxford Properties, and Severfield-Watson Structures has erected the steelwork.

Lindapter has launched its high clamping force (HCF) Hollo Bolt, an enhanced version of its original expansion bolt for structural connections. The Hollo-Bolt HCF is available as standard in sizes M16 & M20 and features Lindapter's patented HCF mechanism that is said to produce a typical clamping force three times higher than the same sized product without the mechanism.

SCI member **Consteel** has launched the STABLAB software package that is said to provide analysis and evaluation of the stability and buckling modes of a structural model. Basic analysis capabilities include: all types of buckling modes – flexural, torsional, lateral torsional buckling of members, buckling sensitivity analysis and complete second order analysis using buckling mode based imperfections. To register and download a free trial visit: *www.stablab.net*

Leach Structural Steelwork has extended its workshop and purchased a new **Voortman** V330C fully automatic combined drilling and plate cutting system equipped with an oxy fuel and plasma torch. Eric Leach, Leach Structural Steelwork Managing Director said: "We decided to equip the machine with both plasma and oxy fuel for the larger and thicker parts. With this machine we are better positioned for the markets we're active in."

AROUND THE PRESS

The Structural Engineer
July 2013
Suspension Bridges: past and present
With a depth of only 3m, the revolutionary Severn box girder deck was an all welded construction, which further reduced the weight of steel required. In addition, the 18m long and 118t closed box girder segments were buoyant, and could therefore be floated out into the Severn Estuary without recourse for any barges.

Construction News
14 June 2013
Twice as high for office replacement
[Bevis Marks] "An eight-storey concrete building was demolished and replaced with a 16-storey steel one using the existing foundations," says Waterman Structures director Julian Traxler. "We couldn't have achieved that and the net lettable areas required by the client if we hadn't used a steel frame – it just wouldn't have been viable."

Construction News
14 June 2013
Tram plan calls for bridge variety
[Nottingham tram extension] The bridges have been designed to enhance their environment. "We considered carefully the look and function of these structures as part of the design process and chose steel because we wanted to achieve something with a contemporary feel," says Nottingham City Council project director Chris Deas.

Building Design
3 May 2013
They've got it all covered
[The choice of steel for aspects of Brent Civic Centre] - "We picked the material that suited the vision," says URS regional director Mike Pauley. "Where we were getting the 15m spans, concrete became too heavy visually to achieve that [vision]."

Building Magazine
24 May 2013
A lot of history
[Stonehenge Visitor Centre] – The steel structure of the pods was erected in tandem with a birdcage scaffold covering the entire footprint of the visitor centre. This allowed Vinci to work on the canopy and the pods at the same time.

All change at London Bridge

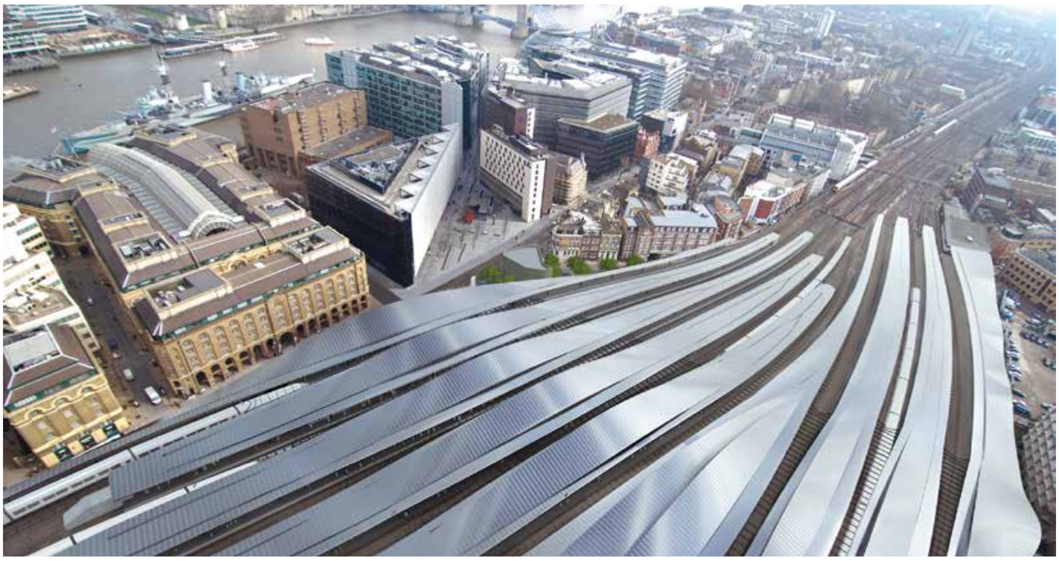
A £6bn redevelopment programme of London Bridge Station, the country's fourth busiest station, is now under way.

Because of the complexity of the work and the need to keep as much of the station operational as possible, all of the work is being phased with overall completion set for 2018.

The work includes a new and bigger concourse, which will have 66% more space for retail and station facilities. A reconfiguration of the tracks will result in nine through platforms and six terminating platforms.

Network Rail says this will mean more trains to more destinations including a connection to Crossrail services.

Two major steelwork packages, one for bridge decks and another for platform canopies and associated areas, are currently being finalised by main contractor Costain.



War Museum gets more exhibition space

The Imperial War Museum (IWM), one of London's most popular tourist attractions, is currently undergoing a major refurbishment to create additional exhibition space.

Bourne Construction Engineering, working on behalf of Lend Lease, has been on site at IWM since the beginning of March, erecting staircase structures, columns and additional floors - all inside the existing building.

The new floors, supported by feature columns, are being constructed to create new exhibition spaces and terraced galleries that will enlarge the museum's current facilities.

The work will also transform the existing atrium, creating a contemporary and easy to navigate visitor experience.

The steelwork project forms part of the wider £35M scheme that will create new ground breaking First World War galleries in time to mark the centenary of the outbreak of the conflict in 2014.

Additional galleries will also be used to cover conflicts from the Second World War onwards, as well as dedicated events space for private corporate hire.

Technology centre for Glasgow university

An £89M Technology and Innovation Centre is being built at the University of Strathclyde in Glasgow city centre.

The facility will bring together academics, researchers and project managers from the university and its leading industrial partners to find solutions to challenges in sectors central to economic regeneration, including power and energy, health and advanced engineering.

In order to maximise the building's footprint, the steel framed structure, being erected by Fisher Engineering, is wedge shaped.

Michael Dyke, Executive Director of main contractor Lend Lease said: "The building will be a global centre for research excellence and will bring economic, sustainable benefits to the local community through the involvement of small businesses, social enterprise groups and employment in construction."

Advance brochures updated and available

New *Advance®* section brochures from Tata Steel are now available for download free of charge at ***www.tatasteelconstruction.com***

The *Advance®* section range has been developed to reflect current structural design practice and make it easier to specify Tata Steel CE Marked sections compliant with the EU Directive on Construction Products.

There are two brochures, one version supports designs in accordance with BS 5950, while an EC version follows the design specification, and nomenclature laid out in the Eurocodes. Compared to previous brochures the new versions have capacities and examples based on S355 material, acknowledging that this is now the predominant steel grade in the UK.

Steel ensures foundation reuse for City development

By opting for a steel framed design for the new 6 Bevis Marks development in London, main contractors Skanska and Waterman Structures have been able to reuse the foundations of an old eight-storey structure and replace it with a 16-storey building.

Maximising the lettable space is one of the project's main aims and using steelwork has also allowed the project team to create long open floorplates throughout the structure.

William Hare has erected 2,100t of steel for the job, with the frame consisting of concrete filled CHS sections in the centre of the building and RHS at the perimeter. Under a separate contract Tubecon is erecting the tubular steelwork frame for the project's feature sky garden.

Aiming for a BREEAM 'Excellent' rating, Bevis Marks is due to be completed by the end of this year.

Big beams create energy plant for Welsh capital

Barnshaw Section Benders, working in conjunction with ASD Westok, has supplied some of the deepest cellular beams ever requested to Fisher Engineering for a new energy from waste plant in Cardiff.

The largest curved cellular beams were 23m long and 1,594mm deep, formed from one of the biggest sections that Tata Steel produces, a 1,016 × 305 × 438kg UKB.

As well the curving for ASD Westok, Barnshaws has also been bending a number of bars direct for Fisher Engineering, which included a variety of sections and sizes ranging from 457mm deep beams, to 400mm deep rectangular hollow section (RHS).

Both cellular beams and sections took Barnshaws three to four months to complete and in total they weighed approximately 500t.

Diary

For SCI events contact Jane Burrell, tel: 01344 636500 email: *education@steel-sci.com*

SCI Steel Knowledge

Thursday 26 September
Portal Frame Design
Oxford

SCI Steel Knowledge

Tuesday 8 & Wednesday 9 October
Essential Steelwork Design (2 day course)
London

Waste solution with steel

A large braced steel structure will house Devon's first energy from waste plant. Martin Cooper reports.

Work is progressing on schedule on a new energy from waste (EfW) plant in Exeter that once operational will process 60,000t of household refuse per annum for Devon County Council.

More and more of these facilities are being built throughout the UK as local authorities seek to find environmentally friendly alternatives to landfill.

As well as processing approximately one third of the county's non recyclable municipal waste, the plant will enhance its green credentials by the fact that it will also recover value from the refuse with up to 3MW of electricity generated for the National Grid.

EfW facilities are invariably built with a steel frame because they are housed in large open plan structures, a form of construction best suited to steelwork.

The Exeter plant is no exception being a large beam, column and braced framed structure measuring approximately 24m wide by 80m long and with a maximum height of 35m. It is supported by piled foundations or from reinforced concrete frames forming the waste bunker, waste feed structure, offices and plant rooms.

All of the project's steelwork has been galvanized. This ensures it is safe from corrosion caused by contact with inert gases and gives the material a minimum 25 year lifespan in this harsh environment.

Prior to any of the structural steelwork being erected on site by the Bourne Group, eight months of preliminary works were carried out.

"The site had originally been occupied by an incinerator and transfer station, but this had already been demolished by the time we started on site in early 2012," explains Phil Moss, Chilworth Construction Management Construction Director. "Initially we did some piling and groundwork before the concrete superstructure was cast, this then allowed the main steelwork package to begin last January."

Before the main steel programme commenced Bourne erected approximately 50t of steel to support a mezzanine level and the facility's silo. This was followed by the erection of the boiler support frame and access walkways a couple of weeks later.

"The silo support steelwork was initially freestanding and was later connected to the main frame," explains Rod Potts, Bourne Group Contracts Manager. "Installing this steel early in the programme allowed the fit out of the plant's equipment to proceed on schedule."

Towards the end of last year most of the large equipment for the facility was installed. This included a 120t combustor unit that was delivered to site in one load and then lifted into place by a 1,000t capacity crawler crane. The plant's 65m tall chimney was also delivered to site and installed during the same period.

With all the major heavy lifting completed the main steel erection package was able to

Feature V-shaped columns form the sloping rear façade

The project's steel frame in its entirety

Much of the steel frame sits on top of a concrete superstructure

start in January with the frame being installed around and over the facility's installed equipment.

"One of the main design challenges with the steel frame was ensuring coordination with the process equipment, while providing adequate support for elevated floors, mezzanines and platforms," says Brian Melia, Project Engineer for Melia Smith & Jones.

"The advantages of using steel are the speed of construction and its flexibility," adds Mr Moss. "The main steelwork went up while the fit out continued inside the facility, and some cold rolled sections, which aren't structurally integral, have been left out temporarily to allow equipment to continue to be installed."

As part of its main frame steel erection programme, Bourne is also carrying out the connection and cladding design as well as installing a series of internal crane beams.

These beams, for the refuse hall, must meet BS EN 1090-2 Execution Class 3 standard (fatigue rated beams with higher levels of quality control).

Possible fatigue on the steel frame had to be taken into account during the design, as the waste crane will be in continual use for the life of the facility.

"We had to liaise closely with Bourne to make sure the structural members were not affected by the connection details and vice versa," says Mr Melia.

The steel frame has also been designed to resist loading from the waste and ash cranes, product silos, wind, snow and imposed loading from operations and maintenance.

Bourne's scope of works also includes installation of 5,800m^2 of cladding, 3,600m^2 of roof cladding, 3,000m^2 of decking, gutters, rainwater pipes, windows, louvres, mansafe roof systems in addition to the industrial and personnel doors.

Great care and attention has had to be taken during all lifting operations due to the site's location. The plant is nestled between a major power line and the main rail route between London and Cornwall.

Bourne has used a variety of mobile cranes, ranging from 50 tonners up to 100t capacity units. With up to four cranes on site at any one time, the main challenge has been to erect steel without over slewing the rail lines or the power line.

"We also had to position our cranes on either side of the structure as the centrally positioned chimney had to be manoeuvred around during the lifting in of the roof beams," explains Mr Potts.

The structure's main perimeter columns all arrived on site in three sections and the completed section has two bolted splices. These members support the roof that is formed by a series of 24m long Westok cellular beams.

The rear elevation of the facility features an outward sloping façade. To achieve this architectural component Bourne has installed a series of V-shaped column bases along the elevation; these bases each support a spliced raking member and a vertical member.

Overall stability of the frame, as well as for the rear elevation is achieved via horizontal roof and floor bracing, along with composite steel and concrete floors and reinforced concrete two way spanning slabs acting as diaphragms. These transfer lateral loads to vertical steel tubular bracing and reinforced shear walls.

The facility is expected to be processing waste by summer 2014.

FACT FILE

Exeter energy from waste plant

Main client: Viridor
Main contractor: TIRU
Construction manager: Chilworth Construction Management
Structural engineer: Melia Smith & Jones
Steelwork contractor: The Bourne Group
Steel tonnage: 570t
Project value: £2.6M

Nearby power lines have made lifting operations challenging

Hybrid design for leisure park

The sports hall has a curved elevation adjoining the hotel

The requirement for lightweight flexible structures has resulted in steel being used on all leisure facility buildings at the latest Center Parcs development.

Center Parcs is constructing its fifth UK village at Woburn Forest near Milton Keynes, a project that is being aided by steel construction for its leisure facility buildings.

The £250M development is one of the largest leisure projects in the UK and will eventually create 1,500 jobs. During the construction process it is providing employment for 1,200 workers.

A series of exposed V-shaped columns form one of the sports hall's elevations

Overall the job has been divided into three main contracts, with infrastructure and civils being undertaken by Birse, the construction of 625 accommodation lodges by ISG while Bowmer & Kirkland is responsible for the £93M contract to deliver leisure buildings.

The leisure facilities consist of three parts and steel tonnage wise The Plaza (next to the watersports lake) is the largest component of the contract requiring approximately 1,000t of the material. Hambleton Steel is the steelwork contractor working on behalf of Bowmer & Kirkland for this part of the project

A large sports hall is one of the most prominent parts of this area, with a series of 32m-long Westok beams forming this column free space. Weighing 6.5t each, these beams were brought to site in two pieces bolted up on the ground and then lifted into place as one section.

Another feature of the sports hall is the curved shape of the structure as it follows a radial grid. Each column is set out individually as the connecting 14m-high beams are faceted to form the curving elevations.

The inside elevation is formed by a series of V-shaped columns, an architectural steel feature which will remain exposed within the completed building. These columns were fabricated by Hambleton Steel in two pieces; one with a V-shaped base and the other a straight column that was connected via a bolted connection to form the final

Tailored solution for roofs and envelopes

Tata Steel's Kalzip is said to be the world's leading aluminium standing seam roofing and wall cladding system. It is a precision engineered, multi component system with proven durability, high performance and low maintenance.

A range of materials, finishes and shapes are available offering a multitude of designs. The product is also said to combine functionality with stunning aesthetics on both small uncomplicated designs as well as world famous, award winning projects.

Alternative products include; a full range of fabrications, Hi-Point - Kalzip's off site roofing system and Falzinc, a lightweight fully supported raised seam roofing and cladding system that combines a pre weathered zinc layer with an aluminium core.

For more information visit: *www.kalzip.co.uk*

A steel roof floats above the dome's main rafters

The domed swimming zone will house six pools

FACT FILE
Center Parcs Woburn Forest (leisure buildings)
Main client: Center Parcs
Architect: Holder Mathias
Main contractor: Bowmer & Kirkland
Structural engineer: Peter Brett Associates
Steelwork contractors: Hambleton Steel, Shipley Fabrications, B&K Structures
Steel tonnage: 400t

double column element.

Behind these feature columns the sports hall includes a two-storey zone housing a ground floor crèche and offices on the upper floor.

The outer curved elevation of the sports hall adjoins the hotel which is being constructed with in-situ concrete. Following the curvature of the sports hall the hotel has three levels and will be topped with a steel framed roof.

"The steel braced sports centre was first to be erected in this area," explains Bill Poole, Bowmer & Kirkland Project Manager. "Everything else, including the hotel, followed on afterwards."

One end of the sports hall connects into a large two-level venue area which is being constructed with an in-situ concrete podium and a steel framed upper level.

The podium will house a supermarket and some smaller retail units, while the above steel framed level will accommodate a conference centre.

Explaining the hybrid design of the venue structure, Fergal Kelly, Peter Brett Associates Engineer says: "The conference facilities require some long spans that are more economically formed with a steel frame."

A few hundred metres away along a woodland road is the Village Square development that is divided into two sectors, north and south. The former is a two-storey retail, restaurant and bowling complex, while the latter is a large domed swimming pool structure known as the Subtropical Swimming Paradise.

Steel is playing an integral role in the construction of both of these two adjacent structures. Steelwork for the Village Square north side is being fabricated, supplied and erected by Shipley Fabrications with 170t

> *"Steel has been used where a lightweight and flexible solution was required."*

required for this part of the project.

The upper level of the Centre One North is steel framed and it is mostly founded on top of a concrete podium level. As the building incorporates the site's sloping topography, approximately one third of the structure only has the steel framed level.

The single storey element of the building will house a diner, while the two-storey part will accommodate retail outlets within the podium and a bar and a bowling alley on the upper level.

Coordination was key to the construction of this structure as Glynn Shepperson, Shipley Fabrications Director says: "While we erected the diner, the podium was being poured simultaneously. We then continued erecting the steel frame for the upper level by following on behind the concreting team."

The steel frame is on a 7.8m × 7.8m grid, matching that of the concrete frame, within the podium. The only exception is the bowling alley where a series of 20m long 3t cellular beams create the necessary larger column free grid.

"The cellular beams have all been fabricated with tapered end sections to suit the varying roof/ceiling profiles," says Mr Shepperson.

Meanwhile, the Village Square south side is destined to become one of the Village's focal points. The large steel and timber clam-shaped dome Subtropical Swimming Paradise will house six pools of varying sizes.

Shipley Fabrications is also responsible for the swimming pool's changing room facilities, a structurally independent but adjoining 90m-long building that follows the dome's 90 degree quadrant perimeter.

Similar in design to the Village Square north side, the facility has a podium housing the pool's changing facilities, with a steel framed upper level with restaurants.

The swimming pool's large dome has been created by a series of 70m long glulam rafters, while spanning around and in between the timber is a steel hollow section ring beam and roof.

"The steel is supported vertically by the glulam beams and has been designed to look like it is floating," says Mr Kelly.

The centre point of the circular roof structure, where the beams meet is supported by a series of feature 16m long pencil shaped tubular columns.

The majority of the roof will be clad with Kalzip and ETFE for the roof, however the front elevation – overlooking a lake – will be fully glazed to a height of 16m.

This large feature façade is formed by a series of 12 steel bowstring trusses.

Excluding the changing room facility, the roof structure has been designed and constructed by B&K Structures (a wholly owned subsidiary of the Bowmer & Kirkland Group).

Summing up, David Gallimore, Holder Mathias Project Architect, says the reasons for choosing a hybrid design for the leisure buildings is because Center Parcs has a similar design philosophy for all of its developments.

"However, steel has been used in areas where a lightweight and flexible solution was required."

Center Parcs Woburn Forest is scheduled to open in spring 2014.

Center Parcs Woburn Forest facilities

The Center Parcs' leisure facilities consist of three parts, the Village Square is a large clam shaped Subtropical Swimming Paradise, containing pools of varying sizes attached to a two-storey changing room and restaurant building.

Close by is the Village Square north side, a two-storey retail, dining and bowling alley complex.

The Plaza is a stand-alone collection of facilities which includes a large indoor sports hall, conference facilities, a supermarket and a 75-bed hotel.

Under a separate contract ISG is building 625 lodges for the project, while the overall civils contract will see Birse create seven miles of new roads for the new Center Parcs.

Retail banks on regeneration

Situated on a large embankment, a new retail development is dependent on a large steel truss to not only provide the necessary shopping space, but also the stability to an adjacent piled wall.

A large truss forms the roof of the main retail floor and supports the piled wall

The former South Wales mining town of Bargoed is in the midst of a £30M regeneration scheme, a programme that aims to revitalise the community and bring new job opportunities to the area.

A new relief road and connecting viaduct, as well as a bridge over the Rhymney River have recently been completed, improving transportation links and removing traffic from the previously congested main streets of Bargoed.

Central to the overall plan is the rejuvenation of commerce and this will be achieved with a large scale retail development, based around a 5,200m2 Morrisons supermarket being constructed in the town centre.

Known as the Retail Development Plateau, the 2.2 hectare site is situated on a 300m long × 20m high reinforced embankment, said to be the largest of its type in the UK.

The plateau over looks the Rhymney River valley and backs onto Bargoed's main shopping street. The plateau was cut into the hillside by main contractor Simons, a job that saw 23,000m^3 of spoil to be excavated and removed.

The face of the cutting is formed with a contiguous piled wall, 11m at its highest and 130m long. This had to be reinforced with temporary anchors during excavation.

Steelwork contractor Caunton Engineering has a design and build contract for this project and it designed the structural frame to support the piles.

"The temporary anchors have to remain in place until the steel frame is complete and the concrete decking is on, then the diaphragm action will also help to support the wall," explains David Wilson, Simons Senior Project Manager.

"Steel's speed of construction is important as the quicker the frame is up the quicker the contiguous piled wall is permanently supported."

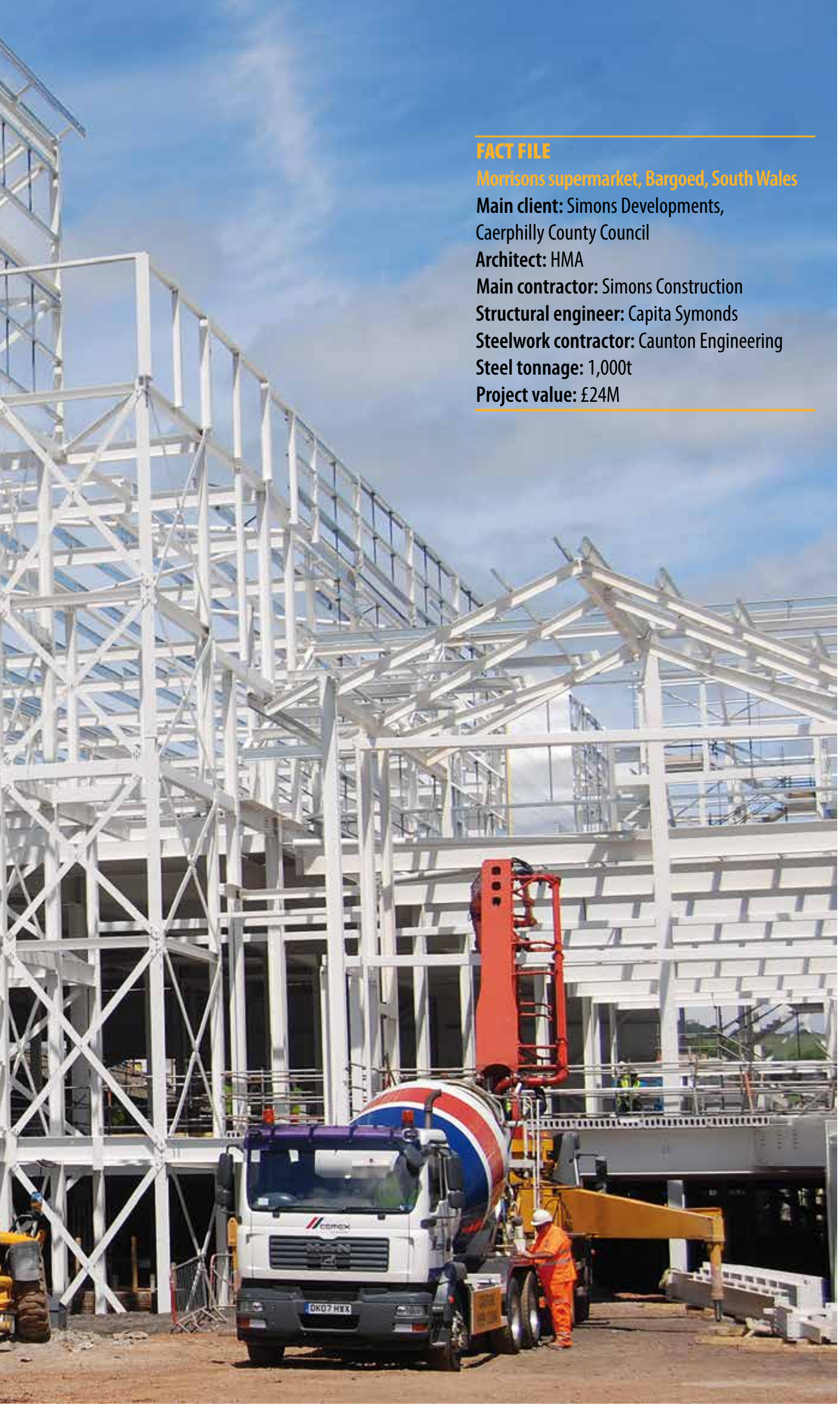
In order to allow the completed steel frame to resist the loads from the piles, a 24m deep horizontal truss has been installed and concealed within the project's retail floors.

The truss spans the full length of the wall and is connected into it via cast-in plates. The massive loads from the wall will be transferred through the truss via a series of large welded nodes, some of which have up to 14 incoming members.

"We had to design the truss and the nodes to absorb up to 700kN/m," explains Matthew Shimwell, Caunton Engineering Lead Designer. "The nodes also simplified the overall steel design and the fabrication detail."

The nodes also enable the truss and the

FACT FILE
Morrisons supermarket, Bargoed, South Wales
Main client: Simons Developments, Caerphilly County Council
Architect: HMA
Main contractor: Simons Construction
Structural engineer: Capita Symonds
Steelwork contractor: Caunton Engineering
Steel tonnage: 1,000t
Project value: £24M



Prefabricated nodes have allowed the project team to quickly erect the site's main truss

steelwork to follow the sloping topography of the external retail deck. The site has a slight slope which follows the height of the retaining wall. In order to keep the steel frame in line with the wall, each floor level is stepped and the sloping horizontal truss fits within these floors.

"The nodes allow the frame to accommodate this eccentric floor design," adds Mr Shimwell.

Brought to site in individual sections, the truss was erected along with the rest of the project's steelwork, with no steel element weighing more than 3t.

For the steel frame and for the erection programme it has had two mobile cranes working on site. The cranes are also being used to install the precast floor planks and the stairs.

"As we already have the craneage on site it makes sense for us to install the planks and stairs," comments Andrew Austen, Caunton's Site Manager. "It also means there are less trades on site which speeds up the erection programme."

Sitting on top of the plateau and abutting the retaining wall, the steel framed retail development consists of a lower level undercroft car park for 400 vehicles, with the main Morrisons retail floor positioned above along with second car park level.

Above the main Morrisons supermarket floor are a series of further decks, set back from the valley elevation, accommodating independent retail outlets and rooftop plant areas.

The retail outlets will be accessed via Bargoed's main shopping street – as they sit on the retaining wall, consequently providing a continuation to the existing shop frontage and enhancing the town centre.

The majority of the frame is based on a 9.5m × 7.5m structural grid. This was deemed suitable and large enough not only for the car park but also the retail levels above. The exception is the area where the lower level car park has the first floor level outdoor parking area above, here a large 16.5m × 7.5m grid has been accommodated.

The main Morrisons retail area is topped by a series of portal roof frames situated along the elevation overlooking the valley. These feature elements provide a signature to the development, as this part of the scheme will be the most visible to people approaching the town.

Helping the project to progress seamlessly, the job has been fully managed and constructed using Building Information Management (BIM). According to Andrew Watson, Caunton Engineering 3D Project Coordinator, this enabled architect's and engineer's models to be fully integrated with Caunton's steel detail and design models.

"This helped the development process on the project and allowed complex geometry and data to be easily transferred among the team. Design meetings were far more productive as we could take integrated models and present them on site to solve problems quickly."

"Steel's speed of construction is important as the quicker the frame is up the quicker the contiguous piled wall is permanently supported."

Summing up the project, Welsh Government Housing, Regeneration and Heritage Minister Huw Lewis says: "Town centre renewal is a key priority and I am delighted to support this development which will help breathe new life into Bargoed, support new and existing businesses, stimulate the local economy and provide jobs in the retail sector."

The development is due to open in early 2014.

Visualisation of the completed scheme

The use of fabricated nodes in the Bargoed supermarket development

Dr Richard Henderson (SCI)

An early scheme for the restraint of the contiguous piled wall involved permanent rock anchors which however could not be relied on for the life of the development. Controlled transfer of load at construction stage was a more reliable option than transfer on failure of the anchors at some unpredictable future date. The truss in the plane of the retail floor steelwork is therefore designed to support the piles in the permanent condition.

The truss spans about 85m with the depth between booms of over 16m: two bays of floor beams. The bracing members are cruciform in arrangement such that some bracing members resist tension and others compression (Figure 1). The truss is designed for stiffness and the mid-span deflection is limited to about 50mm. The shear forces are transmitted to the ground at each end through vertical tension only bracing which also provides the wind restraint to the development. Piles and 15m square pile caps resist the tension forces.

Two lines of retail floor beams act as the truss booms and consist of 914, 838 and 762 UKB serial sizes. The retail floor slopes slightly across the site and the slope is accommodated by stepping the beams at points away from the principal nodes in the truss. At the changes in level, the beams are designed for the bending moment due to the eccentricity in the line of the axial force. The bracing members, all set in one plane, are formed from UKC sections of 305 serial size, also with their webs vertical. The approach taken to detailing the truss was to concentrate the fabrication in the nodes and make the elements as simple as possible. This approach resulted in truss elements with extended end plates for bolted connections, detailed with shims to allow for erection tolerances. Fasteners are mostly M30 and M36 grade 8.8 bolts.

The truss nodes were designed to carry the forces efficiently in direct tension and compression and avoid bending. The truss boom forces are carried by stubs of the same shape. Horizontal stiffeners are placed in line with the flanges of the incoming diagonals. Column elements are spliced above and below the nodes and the flange forces carried through vertical stiffeners. Mating end plates and cap and base plates are provided for each incoming element (see Figure 1).

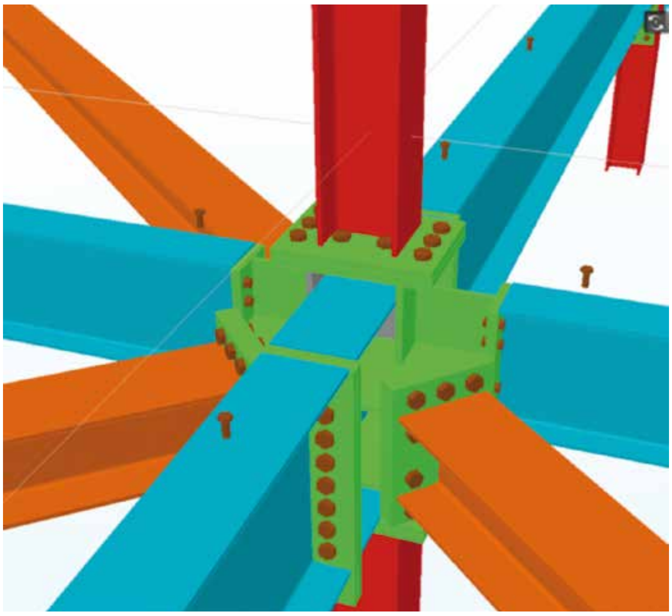


Figure 1: Example of node arrangement (Figure courtesy of Caunton Engineering)

A series of portals crown the development

Viaduct replacement

Using steel helped the project team assemble the bridge off site and then launch and slide the structure into place

The rail line heading west from Swansea has been significantly improved with the opening of the new steel composite Loughor Viaduct.

FACT FILE
Loughor Viaduct, South Wales
Main client: Network Rail
Main contractor: Carillion Rail
Structural engineers: Tony Gee & Partners
Steelwork contractor: Mabey Bridge
Steel tonnage: 1,200t

Opened in early April, the new replacement steel composite designed Loughor Viaduct has reinstated a double track rail service across the South Wales estuary, improving travel times between Swansea and Llanelli and boosting the local economy.

Originally constructed in 1852, the 236m long Viaduct was initially a wooden structure and a fine example of Isambard Kingdom Brunel's once numerous timber viaducts.

However substantial redesigns and strengthening works in subsequent years had altered the bridge and most of the recently demolished viaduct dated from around 1910.

Importantly in recent times detailed site investigations had determined that the old viaduct had reached the end of its life and was no longer able to function and support the expected amount of modern rail traffic.

For capacity the double track bridge had been reduced to a single track, which proved to be inconvenient as the region still required a robust rail link over the estuary.

In order to improve rail services and restore the line to a double track configuration Network Rail, working with Carillion Rail, opted to replace the entire structure as part of a £48M scheme.

A primary consideration was how the new viaduct could be constructed within a limited 250-hour possession provided by Network Rail.

"Before commencing the steelwork on site we had to construct our temporary works and the new bridge piers in a high flow tidal estuary working from both sides of the existing viaduct," says Jon Kite, Carillion Rail Senior Project Manager. "Our piling rigs and cranes worked from jack up barges in the river working between trains as necessary so as not to disrupt the operational railway."

The work included the installation of twelve 1,200mm diameter permanent steel cased piles to form the foundations for the new viaduct.

At the same time as this work was being undertaken steelwork contractor Mabey Bridge began a three month programme, fabricating the structural steelwork and walkways at its facility in Chepstow.

Mabey Bridge was also contracted to oversee site assembly, including the temporary pier cross beams to support the launch of the new structure. These beams were installed atop six temporary piers that had been installed on the north side of the existing viaduct.

The fabricated steelwork was transported to site by road in girder sections up to 24m long. The new bridge was then assembled in four sections in a laydown area on the west side of the estuary, ready to be launched alongside the existing viaduct.

To facilitate the launching process, the assembly area had previously been excavated and sheet piled, to ensure it was at the same level as the existing rail track and viaduct.

Space was at a premium and each of the four viaduct sections was assembled individually. Each section was a different length and consisted of two outer plate girders connected by a series of crossbeams. Steel walkways were also attached to each side of the structure. A total of 26 girders were needed (13 on each side) to construct the entire 236m long viaduct.

"Once the first section was fully assembled we launched it, using strand jacks, over the river onto temporary piers," explains Roger Walker, Mabey Bridge Project Manager. "We then assembled the next section, bolted it onto the previous section and launched the structure a bit further over the river."

This process was repeated a further three times, to position the entire new viaduct, spanning the Loughor estuary adjacent to the old existing structure. The steelwork was then jacked down onto its permanent bearings. The deck was concreted, waterproofed, ballasted and tracks laid.

The 250-hour rail possession was then initiated and work began to demolish the old structure. After putting protective rubber matting over the rail tracks, Carillion Rail used the new bridge as a working deck for its demolition equipment.

Once the old structure had been dismantled and new abutments constructed the new viaduct was slid sideways on its bearings to its permanent location using hydraulic rams.

After the viaduct opened one of Carillion Rail's final tasks on site was to construct a heritage monument to reflect the old structure. Positioned on the west bank of the estuary, the monument consists of two of the original spans mounted on three of the original trestles.

"The monument captures an element of a unique structure in history that used early steel in its deck with support from timber trestles," sums up Mr Kite.

The new structure was slid sideways into the position of the old bridge

Design and launch

Mabey Bridge held a series of planning meetings with structural engineers Tony Gee & Partners and main contractor Carillion Rail to establish the suitability of steelwork for the launching and sliding process. Design discussions at these initial meetings covered the number of launches, nose and tail design, splice design and positioning.

Following agreement on design, Mabey Bridge began a three month programme of fabrication of the 1,200t of structural steelwork and walkways for the 236m long viaduct.

"The bridge has a total of seven spans, five of which are 36m long, this design was best achieved using steelwork," says Chris Young, Tony Gee & Partners Regional Director. "Plus we had to have a soffit which mimicked the existing structure's low profile for environmental reasons, again another reason for choosing steel."

The bridge was launched in four individual sections

Filling up with steel

Two steel canopies spanning a petrol filling station have provided a striking entrance feature to a new supermarket development.

Located on a site once known as Soothills and associated with the town's once thriving steel industry, a new 7,432m² Tesco store and petrol filling station has opened in Corby, Northamptonshire.

The store is one of the largest in Corby and boasts plenty of environmental features, but it is the adjacent petrol station that immediately captures the eye.

Two cantilevering wedge shaped canopies cover the petrol station; the larger measuring 44m × 26m spans the forecourt while a slightly smaller one measuring 41m × 24m provides shelter for a kiosk and car wash.

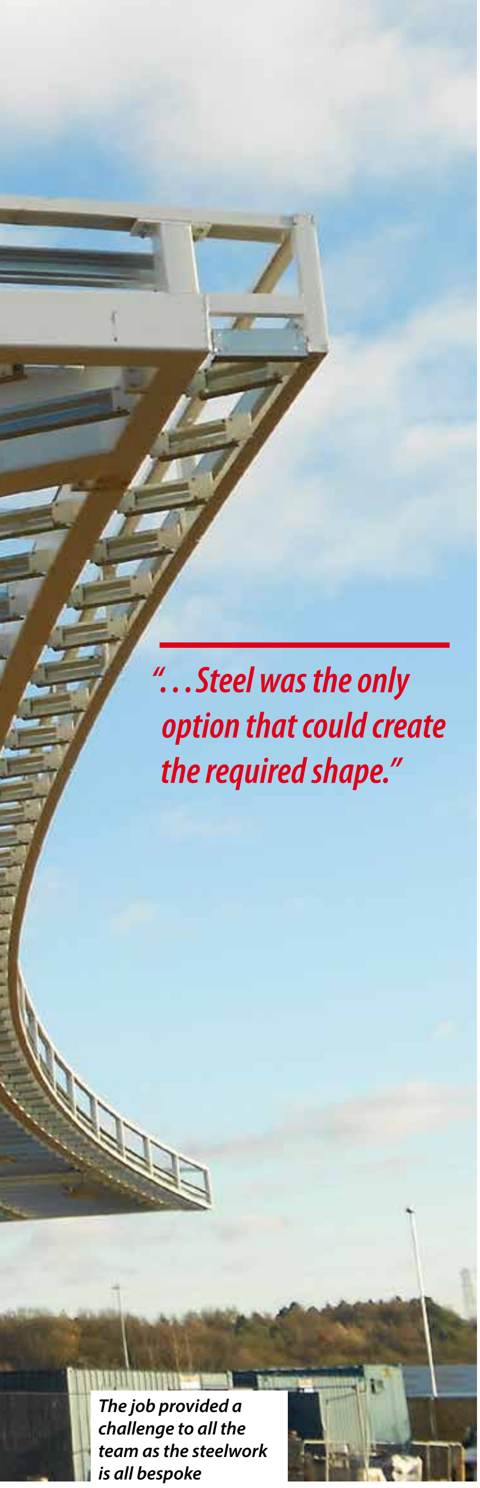
Structurally both are independent steel structures, with the larger canopy slightly oversailing the smaller canopy and so providing the facility with a standout feature.

As the Tesco store and petrol station are positioned on a busy main road, the local council's planning department wanted a striking entrance feature to the development. This would highlight the project and act as a monument to the site's regeneration.

Initially two locally based architectural and engineering firms developed the petrol station scheme along with the store. However, once Barr Construction was awarded the contract it decided to employ its own teams to redesign and deliver the job.

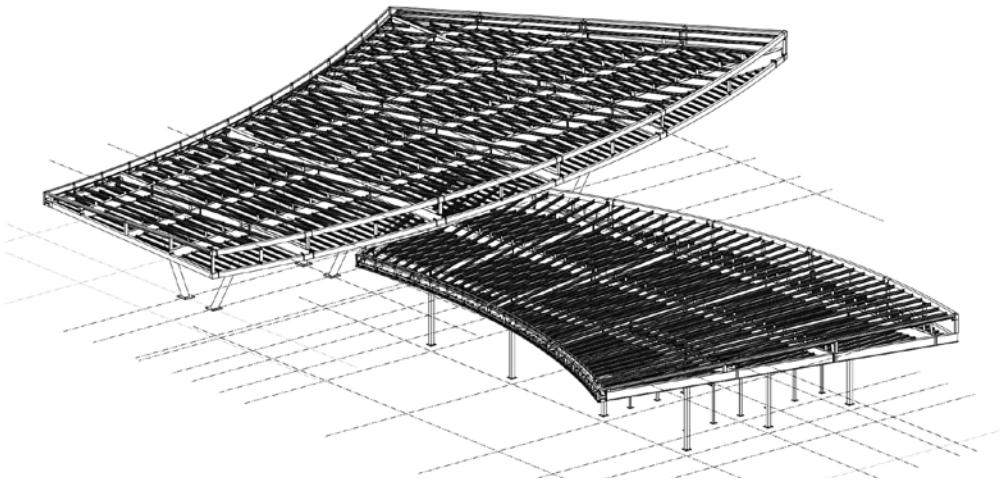
"We decided we needed to deliver a safe and buildable structure based on the original design and steel was the only option that could create the required shape," Robert Mackay, Barr Construction Engineering Design Manager.

The canopies are curved in plan and wedge shaped in section, therefore every purlin cleat and soffit cleat is a different size



The job provided a challenge to all the team as the steelwork is all bespoke

"…Steel was the only option that could create the required shape."



and had to be fabricated at individual angles to suit the design.

"This was one of our most challenging projects, technically and erection wise, as all of the steelwork is bespoke and individual," says Ian Elliott, Border Steelwork Structures Senior Project Engineer.

The smaller canopy is supported by a series of vertical square hollow section columns, but the large canopy has four pairs of distinctive 8m raking CHS columns.

The raking columns have fixed base connections for stability of the structure, resulting in larger foundations than would normally be required.

The roof is wedge shaped, with a flat soffit so the heads of each of the CHS columns had to be at the same level. Keeping the steelwork level but aligning the purlins to provide the required profile achieved the shape of the roof.

The steelwork for the canopy roofs includes a series of cantilevered beams. They are designed as continuous, where possible, to reduce the moment at the column connection by balancing the forces.

"Trying to coordinate the design and illustrate on plans the simplest way to build the canopies was the biggest challenge," says Mr Mackay. "This is why we kept the canopy roof steel flat across the column pairs, which gave us level setting out points along the grids."

However, the roof wedge shape was made difficult by the fact that the curved sides are different radii with differing centre points; therefore, there was no simple solution to the purlin layout but to 'fan' them about one of the radii. This meant almost every purlin cleat was a different height.

Limiting deflection was another challenging aspect to the project. Horizontal deflection had to be controlled with the column and foundation stiffness, as there is no bracing. At the same time vertical deflection had to be controlled at the tips of the long cantilevers, the shallowest roof depth is therefore dictated by the beam section required to limit the deflection.

Border Steelwork Structures erected the small canopy first and then the larger structure, with the latter requiring temporary propping due to the large cantilevering steelwork.

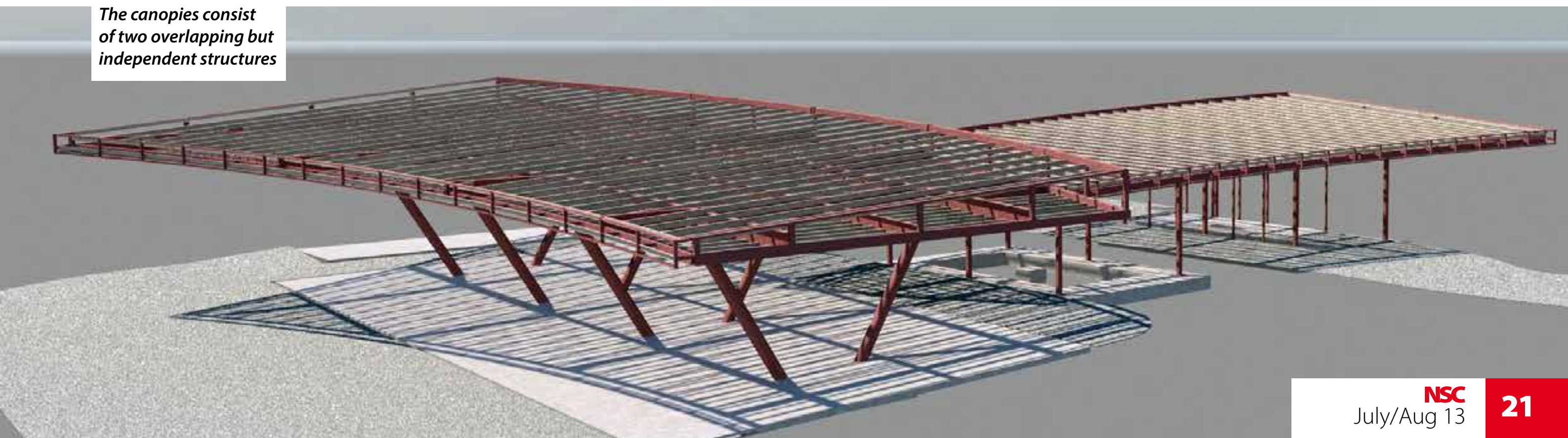
"The larger canopy had to be erected in a certain sequence to allow the columns to act against each other in balance," says Stuart Airey Border Steelwork Structures Senior Contracts Manager. "Once the canopy was fully erected the frame became stable and temporary works were removed."

For aesthetic reasons both structures feature deep gutters formed within the steelwork along the edges of each canopy. This means the gutter is mostly hidden with only the edge facia visible.

Drainage connections have also been coordinated to go through the steel edge beams and routed within the canopy to column positions. The only evidence of any drainage are the exposed downpipes positioned adjacent to the columns.

The Tesco store and petrol filling station has been open since May and according to the local council the canopy's design has achieved the desired landmark effect.

FACT FILE
Tesco petrol station, Corby
Main client: Tesco
Architect: Barr Construction
Main contractor: Barr Construction
Structural engineer: Barr Construction
Steelwork contractor: Border Steelwork Structures
Steel tonnage: 100t



The canopies consist of two overlapping but independent structures

Steel exchange

"A major feature of the development is the central atrium, positioned midway between the structure's two cores."

The building's large open plan floorplates wrap around the atrium

The structure's shape is a response to the rights to light entitlement of the adjacent Barbican Housing

Large open plan floorplates and a sloping terraced façade are just two feature elements adorning the City of London's latest Grade A office development. Martin Cooper reports from Moorgate Exchange.

FACT FILE
Moorgate Exchange, London
Main Client: Telex Sàrl
Client monitoring architect: Pringle Brandon Perkins+Will
Architect: HKR
Main contractor: Skanska
Structural engineer: Ramboll
Project manager: GVA Second London Wall
Steelwork contractor: Severfield-Watson Structures
Steel tonnage: 2,900t

Some parts of the UK have seen a significant slump in the number of office developments being undertaken in recent times, but this can't be said of the City of London.

New landmark structures seem to be continually rising up within the Square Mile and a current example is Moorgate Exchange, a 12-storey office building on the site of an old telephone exchange.

MGPA, an independent private equity company, and CarVal Investors in conjuction with Quadrant Estates are speculatively developing the site.

Architect HKR has designed a large rectangular block which will stand out from its more sober looking neighbours as its roof line is dominated by an angled façade containing stepped gardens on the six upper levels.

The feature V-shaped columns are connected to an 11t node at ground level

Designed to achieve a BREEAM "Excellent" rating, the 20,252m^2 steel framed building will have uniform, square open plan floorplates arranged around a central atrium and two main cores. The design ensures flexibility, as all of the floors can be subdivided if necessary.

Floor sizes vary from 2,229m^2 to 743m^2 on the topmost office level. The building will also include two rooftop plant equipment floors and a two-storey basement.

Overall, the structure has been designed to achieve a BREEAM "Excellent' rating.

At ground level, the most striking visual elements of the building are two rows of V-shaped columns, positioned along the two longest elevations.

The two-storey high raking columns were fabricated from square hollow sections which were encased in concrete, producing members that taper from 900mm to 600mm.

These columns were initially designed into the scheme as a way of avoiding an old subterranean telecommunications chamber that intrudes into the southwest corner of the project's footprint.

"We suggested raking columns for this one area of the building, the architect then liked these features and decided they would add symmetry to the structure by running the length of the two main elevations," explains Iain Sproat, Ramboll Design Engineer.

In total there are four pairs of V-shaped columns on each side of the building. Weighing 11t each, the columns were erected individually and are bolted to a ground level two-way node that helps form the desired V formation. The nodes weigh 3t each, and will eventually be encased within a concrete base. At the top, each raking column is connected to the underside of the second storey beam by a welded connection.

Steelwork contractor Severfield-Watson Structures had to temporarily support each raking member during the erection process.

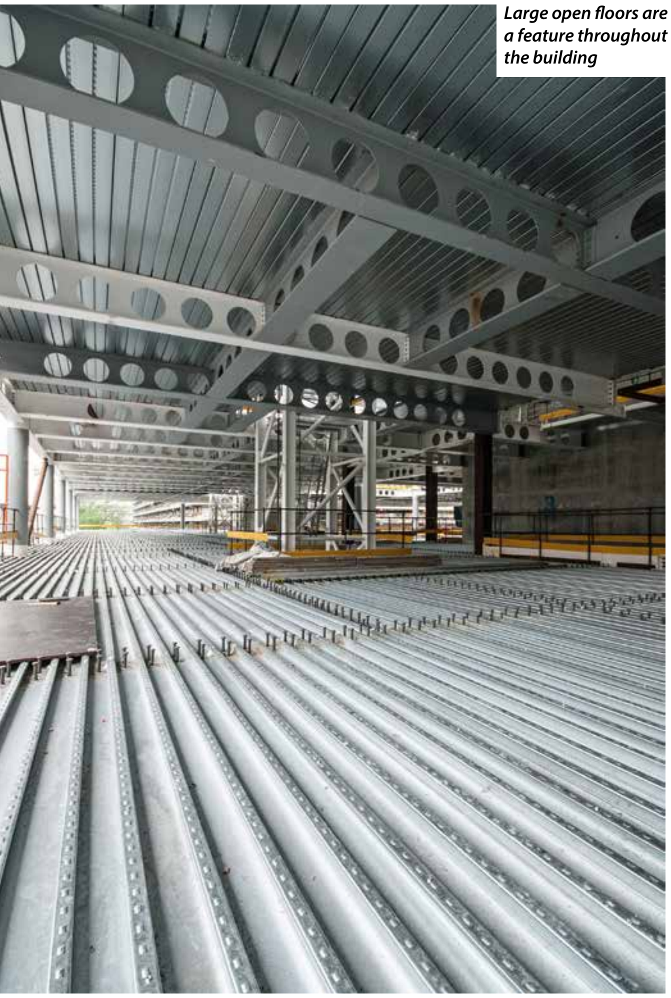
"Once each pair of columns was connected top and bottom they were released from their props and we could then move onto the next pair," says Terry Barnett, Severfield-Watson Structures' Site Manager.

Within the structure, long span open column free areas dominate the design. The client wanted to maximise the floorspace and consequently typical spans in the building are 15.5m long.

The majority of the columns are 457mm diameter CHS members to maximise the available floor space. They have been in-filled to achieve the required fire rating and left exposed by the architect as part of the design.

Dynamic behaviour needs to be

The upper floors will feature outdoor terraced areas (right) with greenery supplied by plant boxes (left) to be retrofitted to the steelwork



Large open floors are a feature throughout the building

considered on such long spans and Ramboll decided to use stiffener beams to achieve the required floor response.

"By inserting secondary or stiffener beams at midspan between the main beams, we stiffened the floor without adding much more mass and successfully reduced the response factor," says Mr Sproat.

Stiffener beams and the large open grid pattern remains the same all the way up to the top office level. However, above level six each floor steps back, creating a sloping façade on the northwest elevation.

This creates outdoor terraces that require a deeper floor zone, due to waterproofing and drainage. The structural design however requires that the upper floors keep to the same floor to ceiling heights as the lower levels.

To achieve both these aims, the Fabsec floor beams were reduced in depth on these floors, with a shallower but heavier section being used.

As the useable floor plates get progressively smaller above level six, a lightweight steel frame is being added to the main frame. This light steelwork framing cantilevers out by 1.5m and extends the office floorspace.

Close coordination with the cladding installation is key to this part of the project, as the light framing material has to meet the tight glazing tolerances.

A major feature of the development is the central atrium, positioned midway between the structure's two cores. This large void penetrates the building's heart, starting at level one and topping out with a glazed roof halfway up the sloping façade at level eight.

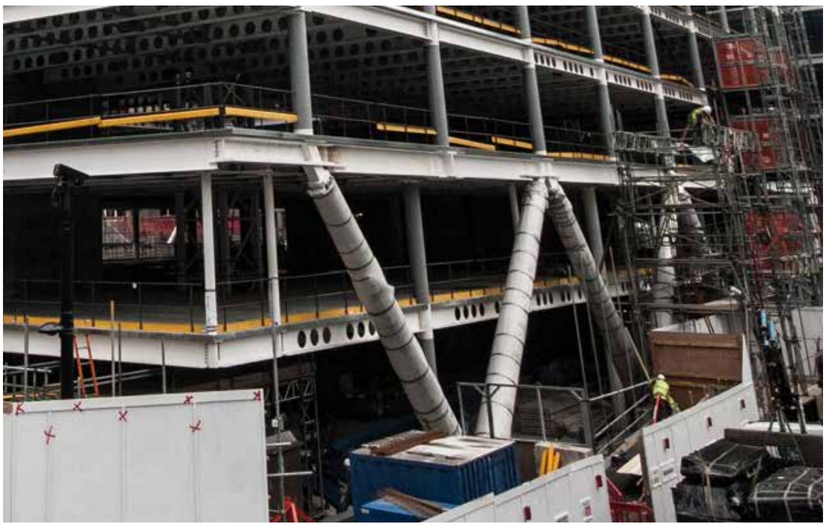
Richard Norris, Project Director for Skanska says: "Over the years the team has built up its knowledge and expertise from working in the City of London on major commercial projects that involved complicated steel frames. We have applied this experience to the Moorgate Exchange project and worked with all stakeholders to plan for any challenges that a complicated structure like this can create, to ensure a seamless project delivery for our client.

"The relationship between Skanska and Severfield-Watson has developed and strengthened over the years because employees from both companies have worked together on previous projects.

"The coordination of the steel structure with the cladding interfaces was a complex and extensive job; however, due to everybody's proactive and positive approach to the challenges involved it was completed successfully."

Severfield-Watson's 20 week steel erection programme is due to be completed in early September. The entire Moorgate Exchange project will be completed in the first quarter of 2014.

Step back and admire the columns



A transfer system at second floor level enables the steel frame to step back 1.5m on two elevations, meaning the V-shaped columns are outside of the main façade line, thereby emphasing their aesthetic appeal.

The transfer structure has also been used to create a column free entrance area by hanging the first floor above the entrance foyer from a series of steel hangers. This means no columns need to be installed within the main lobby.

Designing deeper cellular floors beams for the second floor level has helped form the transfer system. Overall the structure has 550mm deep beams, but here the depth has been increased to 700mm.

The building's first floor will be used as a trading floor and will therefore require more services than the other office floors. Deeper beams with larger services holes were more efficient, not only to form the transfer system, but also to accommodate the extra services.

A rational design approach to fire safety

Structural Fire Engineering, a rational and scientific approach to ensuring the safety of buildings, is increasingly popular, as delegates to a series of seminars have been hearing. Nick Barrett reports from the Fire Safety Engineering seminar in Glasgow.

John Dowling, BCSA Fire and Sustainability Manager

Neal Butterworth, Arup Fire

At the seminar BCSA Fire and Sustainability Manager John Dowling explained the legislative background that covers the use of fire safety engineering, and current trends in its use. He said that Building Regulations, Approved Document B for England and Wales and Technical Handbook 2 in Scotland, tell designers what to achieve, but not how to do it.

Designers were not however restricted to the use of the Building Regulations – they could use BS 9999 instead, which in many cases allowed fire resistance requirements to be reduced while maintaining the safety of a building in fire.

BS 9999 is based on an understanding of how different factors affect the risk of fire. It describes how fire ratings change depending on building height, the familiarity of the occupants with the building and whether occupants sleep on the premises; and the degree of their mobility. Fire load, compartment size and whether or not sprinklers have been fitted are also taken into account. Recently a new height category of over 60 metres has been introduced.

"Fire engineering should be considered for all buildings, and fire should be considered at all stages of the design."

A point well made by several speakers including Mr Dowling was that fire safety engineering can provide an alternative approach to the prescriptive requirements of the Building Regulations, and may in fact be the only practical way to achieve a satisfactory level of safety in some large and complex buildings.

Mr Dowling quoted an Institution of Structural Engineers description of fire safety engineering, which says it supports a rational, scientific approach that ensures fire protection is provided where it is needed, rather than just applied in line with universal prescriptions that may over estimate its need in some areas while possibly under estimating it in others.

The use of intumescent coatings to protect steel, now dominates the UK market with around a 70% market share, with off site applied material contributing 20% of that figure. Board protection was still popular but historic techniques such as cementitious sprays had all but died out in the UK.

"There has been a lot of research and development by a lot of companies over the past decade or so, and the resultant sharp fall in the cost of fire intumescent protection has ensured its dominance in the market," he said.

Four key issues

Wilf Butcher, chief executive officer of the Association for Specialist Fire Protection, highlighted four key issues that building designers and owners had to consider in relation to fire safety.

The ASFP has just published a guide called ASFP Guide to Inspecting Passive Fire Protection for the Fire Risk Assessor that explains the appropriate regulations and fire risk assessment in more detail.

Third party certification is not mandatory but, said Mr Butcher, all those in the design and installation process are better protected if such product and installation certification is in place.

Dr Florian Block, Buro Happold

Simplified approach based on comprehensive full scale tests

Dave Chapman, Regional Technical Manager in Tata Steel Europe's Structural Advisory Service, explained some of the testing, principles and practice associated with performance based structural fire engineering. He said the new approach to fire engineering meant that structures were designed to resist fire, rather than having protection added to a design afterwards. Structures were designed for wind loading, rather than having protection against wind added later, and fire should be treated in the same way.

He described how the lessons of how steel framed buildings behave in fire were well established at the Broadgate fire in the City of London in 1990, and later at the Cardington tests.

Richard Dixon, Manager of Tata Steel Europe's Structural Advisory Service, outlined a simplified approach to structural fire engineering, focusing on using the TSlab design tool, which is a simple semi empirical tool, and the Vulcan Lite design software which is derived from the University of Sheffield's fire engineering modelling software that is capable of analysing non rectangular grids and producing detailed real time outputs.

Vulcan Lite provides full information about the structural response to a fire. Both consider a single structural bay and need only very simple input of data. TSlab is best suited for initial assessments while Vulcan Lite is the preferred tool for rigorous analysis, so they are ideally used in tandem.

Complex structures

The only practical way of achieving a satisfactory level of fire safety in some large and complex structures and in buildings housing a variety of uses may be by using fire engineering.

The fire engineering design of large and unusual structures was the subject of Buro Happold's Dr Florian Block's presentation. Dr Block took delegates through the approaches adopted on projects like the atrium steelwork assessment of the Foster+Partners designed ME hotel in Aldwych, London, and an assessment of the D Y Patil School of Management in Mumbai, India. He said that most prescriptive approaches to fire protection guidance are for 'normal' structures made of beams and columns which might not be applicable for 'unusual' structures. To get over this issue the impact of fire on a structure should be assessed from first principles early in the design process, he argued.

Mr Dowling also delivered a presentation on structural fire engineering on The Shard on behalf of Dr Mark O'Connor of WSP, structural engineers on the project. There are seven different types of occupancy in The Shard, each with its own fire protection requirements. Using the structural fire engineering approach was not about cutting costs by eliminating fire protection, he explained, but about ensuring that the appropriate, possibly enhanced, protection is applied where it best ensures the safety of a building's occupants.

Concluding the Seminar

Arup Fire's Neal Butterworth said seeing things in terms of a prescriptive versus a performance based approach leads to preconceived ideas. He emphasised that structures should be well designed, whichever approach is chosen. "Using a prescriptive approach doesn't mean that a designer doesn't have to think," he said. Leeds Arena did not need fire protection on its roof trusses, according to building codes, but a performance based analysis was carried out and the roof was given fire protection as its integrity was considered key to the safe evacuation of the building.

Selection of less combustible materials for use in acoustic insulation cladding was a measure also not required by codes but was done for good design reasons. "When should a fire engineering approach be adopted? We might as well ask when is a good design required. I say fire engineering should be considered for all buildings, and fire should be considered at all stages of the design."

The seminar was also repeated in Bristol on 20 June.

The Shard - a primary example of how Fire Engineering can enhance occupant safety

Photo: Andy Rogers

For more information about fire engineering visit *www.steelconstruction.info/Fire_and_steel_construction*

Curved rafters form the station's feature front elevation

All change at Wakefield

The delivery of new station facilities at Wakefield Westgate station is reliant on steelwork's speed of construction.

Widespread changes are afoot in Wakefield as the city continues to regenerate large parts of its commercial centre.

Recent developments have included a number of steel framed projects such as a new covered market (NSC April 2008) and the large Trinity Walk shopping mall (NSC June 2010). Currently under construction is a new Westgate station, one of the city's two railway stations.

The £8M redevelopment of Wakefield Westgate is being built on a new site to the north of existing station buildings. It forms part of the much larger Merchant Gate scheme, which recently delivered a new 900 space steel framed multi storey car park for rail users.

Dan Guiher, Network Rail Commercial Sponsor, says: "The new station will provide rail travellers and station staff with modern, enhanced facilities utilising a highly sustainable design."

One of the main components of this sustainable design blueprint is steel. The main station building - which will house a large open foyer, retail outlets, coffee shop and a first class lounge – a pedestrian footbridge and associated lift shaft and staircases have all been built using structural steelwork.

"The long spans required for the retail areas and the foyer, as well as the speed of construction meant the project was ideal for steel," says Anthony Hall CJCT Project Architect.

Billington Structures erected all of the steelwork during a four week programme. Prefabrication helped speed up the work, but also meant the steelwork programme had to be phased, in order to accommodate erection of these elements.

"We erected half of the main station building, then installed the footbridge, and then returned to completing the building," explains Alan Dutton, Billington Structures Project Manager. "If we hadn't scheduled our programme in this manner we wouldn't have had enough room to position the large crane needed to lift in the bridge structure."

Site access for large vehicles and deliveries is limited to one side of the rail tracks, where the new buildings are being erected. A laydown area is located where the new taxi rank and drop off point will be positioned.

The footbridge, the lift shaft and its associated lobby (shelter) were also delivered to site as prefabricated units. They were both lifted into place during an overnight rail possession that took place a week after the bridge was installed (see box).

The lift shaft weighed 9t and for ease of transportation it had to be delivered to site by truck in a horizontal position. This meant two cranes were needed for the installation, one to lift the shaft into an upright position and another to then lift it across the tracks to its final location.

Two prefabricated staircases have also been delivered to site and

FACT FILE
Wakefield Westgate Station
Main client: Network Rail
Architect: CJCT
Main contractor: Buckingham Contracting
Structural engineer: Amey
Steelwork contractor: Billington Structures
Steel tonnage: 300t


Much of the work has had to be coordinated around rail services

West elevation - Entrance

North elevation

installed either end of the footbridge. One 9t staircase has been installed within the new station foyer, while on the other side of the tracks a larger 23t staircase provides access to the station and bridge.

One of the main architectural features of the station building are the long uninterrupted spans in the retail areas and in the foyer. The steel frame has been erected around 7m × 15m grid pattern, which allows plenty of column free internal space.

The station building is a single-storey structure, with a large double height space in the centre to accommodate access to the footbridge.

A curved wave like frontage adorns the station's main elevation. Here a series of CHS columns support curved braced box sections to form the project's feature element.

"Creating this part of the project in anything other than steel would have been difficult," says Simon Walker, Amey Project Engineer. "Curved steel sections were simply brought to site and bolted into place."

Summing up Peter Box CBE, Wakefield Council Leader says: "The new Wakefield Westgate Station is fantastic news for the district. The rail station has always been an integral part of the master plan for the redevelopment of the area. It will be a key gateway into the city, providing improved transport facilities for residents and visitors."

Footbridge

Connecting the station's two platforms, the new footbridge was fabricated in two 14m long sections by Billington Structures. The sections were then transported to the cladding contractor's facility, where they were clad with a distinctive bronze sheeting, before being spliced together and trial erected.

Once main contractor Buckingham had signed off the erection procedure and the bridge structure, it was dismantled back into two sections again and delivered to site.

On site it was spliced together again and lifted into place by a 500t capacity mobile crane. Such a large crane was needed to provide the necessary lifting radius as the structure had to be jibbed over the rail lines. The lifting was completed in one overnight weekend rail possession.

The future of live load reduction – part two

In Part One (in the previous issue - NSC Vol 21, No 3) Alastair Hughes examined how the new regime of EN 1991-1-1:2002, together with its National Annex, makes provision for live load reduction (LLR) in UK buildings designed to the Eurocodes. Some anomalies and questions of interpretation were identified. In Part Two he proposes a way forward for the future.

Unlike Part One, Part Two is a proposal by Alastair Hughes which is aimed not at the designer but at the committee responsible for the standards.

Where next?

The UK committee decision to retain traditional LLR rules for the time being will, sooner or later, have to be reviewed. We have an obligation to progress in the direction of harmonization.

One possibility, which can be presented both as politically correct and as a simplification, is to integrate storey-based LLR into area-based LLR for all members including columns. A slight drawback is that the reduction factor α could vary from one column to another at the same level, but that is manageable.

For this course to be taken, it would be necessary for us in the UK to reconsider our approach to area-based LLR, in particular the 25% limit ($\alpha_A \geq 0.75$). There is surely no argument, except perhaps locally in crowd loaded areas, against the traditional 50% as a limit to be approached as the area increases; any debate would concern the rate of approach.

That rate of approach is exceedingly rapid if the recommended values are adopted: for instance, a column supporting just 50 m^2 of floor at each of two qualifying levels would enjoy α_A of 0.6 (40% LLR). This compares with the current 10%. To look at it another way, 40% LLR would become available just two floors down instead of the current five. Most of us would side with the UK committee and regard the European formula as sailing too close to the wind.

On the other hand, current UK area-based LLR is unduly handicapped by its 25% limitation. So here is a **suggestion** to the Code committee(s):

$$\alpha = 1 - na/1000$$
$$\geq 0.5$$

in which n is the number of qualifying ('occupied', non-storage) levels, a is the total area supported at each, in m^2, and α can be shorn of any subscript.

This eliminates the artificial distinction between two kinds of LLR. Of course A, the total area supported by the member in question, could substitute for na to make it obvious that this is simply an extension of the traditional UK formula for area-based LLR beyond its traditional 25% limitation.

If this suggestion were to be adopted, a column supporting 100 m^2 at each of five qualifying levels could earn the maximum 50% LLR, and successive stages of the same column would get 40%, 30%, 20%, 10%, more or less as now except that the supported area per level, as well as the number of levels, would enter the calculation – which seems entirely rational. The same formula, with n = 1, would apply to beams, and to the length of column just below the topmost qualifying level (which could be the roof if it is an occupied one, such as the top deck of a multi-storey car park).

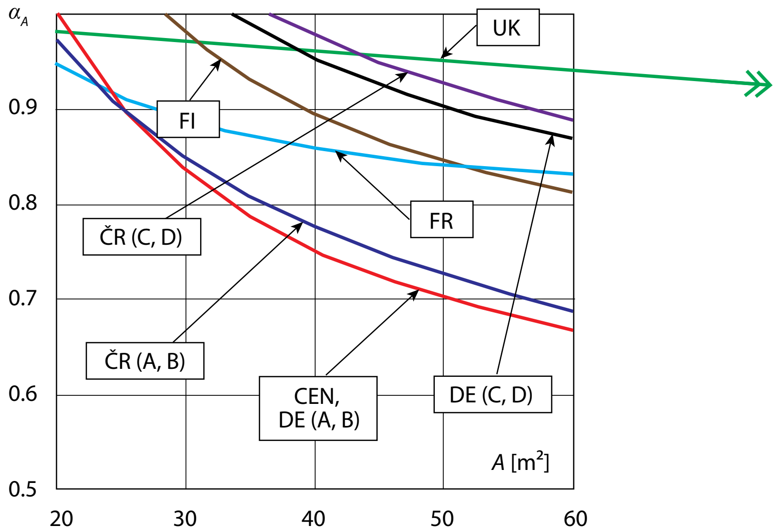


Figure 1 Area-based LLR

What's 'A', exactly?

A point that needs clarifying in this context is whether or not it is intended that A (or na) in the formula is equal to the 'tributary' area customarily used to assess the load in the column (or beam). The Eurocode refers variously to 'loaded area' and 'area supported' which, taken literally, must be interpreted as the **total** supported area – the area whose load adds to the effect being designed against. A typical interior column is only fully loaded if all four complete panels of floor that surround it are fully loaded; that's four times the tributary area, so the distinction is important. Which is correct? Arguably, the answer is 'whichever the committee had in mind when formulating the rules'. We haven't been told, and the same criticism could be levelled at BS 6399. Could lack of a common understanding have exaggerated the national differences so evident in Figure 1?

For practical purposes it is simpler to base the rules on total supported area, as defined in Figure 2, opposite, which unlike tributary area is the same for the beam as for the reactions at its ends. Moreover it isn't always possible, with complex beam arrangements and/or cantilevers in play, to outline tributary areas in the normal way.

Whatever the intention, it deserves to be spelt out unambiguously in any future revision.

The harmonization challenge

We could also reflect that the scope for LLR is not unconnected with any generosity in the assessment of design imposed load. Nobody told the office floor whether it was designed for 2.5 or 5 kPa, and the load it actually experiences is, on average, rather less than 1 kPa regardless. This is no secret; every survey there has ever been has reported the same conclusion. Some examples of load intensity survey results can be found, amid much theorizing, in a recent report from which Figure 3 (over the page) is extracted. Graphs like these present the case for LLR cogently, and make the UK's straight line formula (the green line on Figure 1) look rather conservative. However these are surveys of normal occupancies in normal use. What the occupants might occasionally get up to is another matter, not so amenable to statistics but not to be disregarded. For example, think back to the seventies, when the office party actually took place in the office. Furniture was stacked against one wall, old Rolling Stones records were played and the cleared area of floor was subjected to energetic load testing by the people whose weight had, earlier in the day, been distributed around the rest of the building. Even if Facilities Management wouldn't allow this nowadays, it may explain and, to a considerable extent, justify the UK's relative caution towards area-based LLR. If you prefer a more up to date example, think of the recent pop-up café-bar phenomenon.

Historically, BS 6399's approach was even more grasping; until 1996 area-based LLR began at $A = 40$ m^2, with a straight line to $\alpha_A = 0.75$ at $A = 240$ m^2. In practice, for most designers most of the time, self-denial probably extends well beyond 40 m^2 to this day, as percentage reductions remain in single figures until A reaches 100 m^2.

In future, which occupancy categories should qualify for LLR? The current rules (discussed in Part One) are confusing. Common ground is that categories A to D should qualify and that non-occupied roofs (category H, accessible only for maintenance and repair) should not.

Category E includes both storage, traditionally denied LLR for good reasons, and plant/industry, whose floor loadings are commonly project-specific. Will any of us rise in protest if this category is excluded?

Category F is currently a victim of neglect, but in principle LLR seems applicable to multi-storey car parks. Seven 20 kN cars per 15.6 × 7.5 m bay equates to just 1.2 kPa, and the average car with occupants weighs less than 20 kN. Unless the client is a distributor of 'Chelsea tractors', why hesitate?

Although category G is similarly neglected, there is little to be gained from LLR in areas frequented by vehicles heavier than 30 kN.

It seems reasonable that an 'occupied' roof (category I) should be granted associate membership of its corresponding floor category, if that would qualify.

Here is how the table in Part One might recast:

	CATEGORY	OCCUPANCY	QUALIFYING FOR LLR?
FLOORS	A	Residential	Yes
	B	Office	
	C	Assembly	
	D	Retail	
FLOORS AND ROOFS	E	Storage, industry, plant	No
	F	Parking (cars)	Yes
	G	Fire appliances etc	No
ROOFS	H	(maintenance and repair only)	No
	I	As A, B, C or D above	Yes
	K	Helicopters	N/A (point loads)

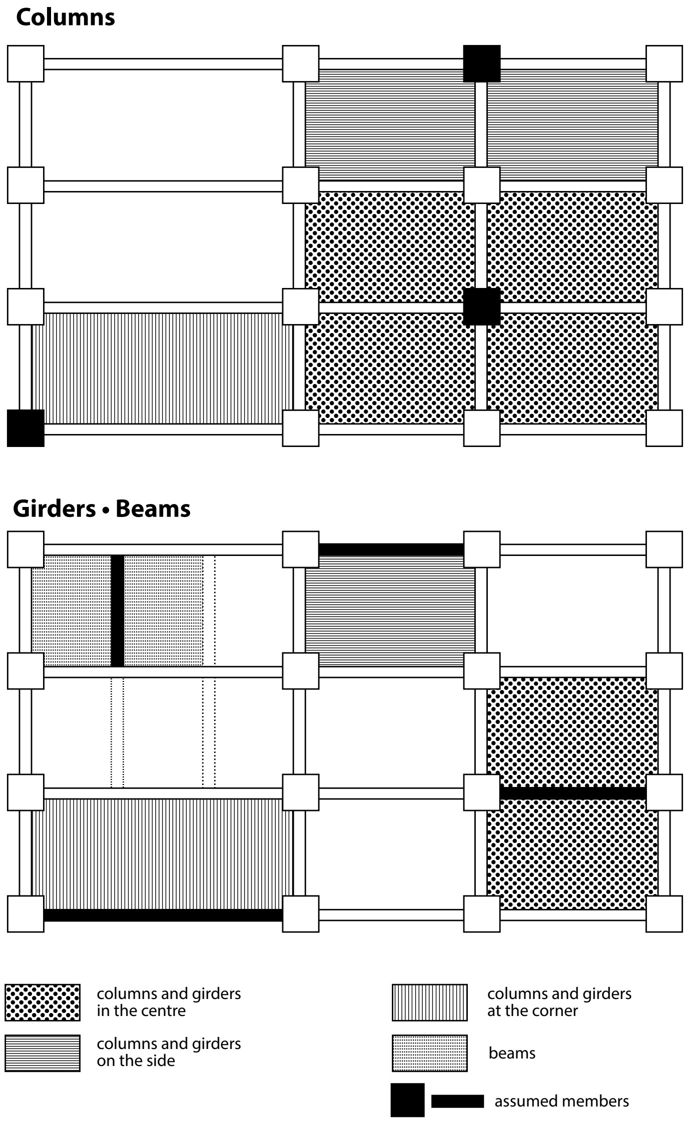


Figure 2 Definition of A

Finally, should the 50% maximum LLR ($\alpha \geq 0.5$) be varied for some categories, as EN 1991-1-1 recommends? The categories picked out are C (areas where people may congregate) and D (retail). For these it sets a 40% limit ($\alpha \geq 0.6$). So if, for example, q_k is 4 kPa for a retail floor this could not be reduced below 2.4 kPa.

No reason is given for the 40% limit. We may speculate that it is to allow for some degree of occasional crowd loading, but if so is it fit for purpose? Based on the current UKNA, $0.6q_k$ may vary between 1.2 kPa (for communal dining rooms) and 3 kPa (for bars, dance halls etc) or even 4.5 kPa (for stages), all within category C. At the lower end of this range, the safety factor would struggle to defend against overcrowding. Restricting LLR to $0.6q_k$ does not make enough of a difference, whereas a thoughtful designer will – by anticipating the possible uses to which the area may be put.

With the formula suggested here, 40% LLR corresponds to $A = 400$ m^2, which would require 600 people (average weight 0.8 kN) at 1.2 kPa or 1500 people at 3 kPa. These are comforting figures, in view of the unlikelihood of such large crowds concentrating their action effect on any one member supporting such a large area. [By contrast, the European formula grants 40% LLR at $A = 100$ m^2 so the same level of overloading could be generated by one quarter the number of people occupying a relatively modest area. This is much more plausible, prompting the observation that the restriction may have been a reaction (a misdirected one, arguably) to the generosity of the formula.]

In practice, of course, designers of assembly buildings will commonly design against unreduced load. In most of the buildings which are

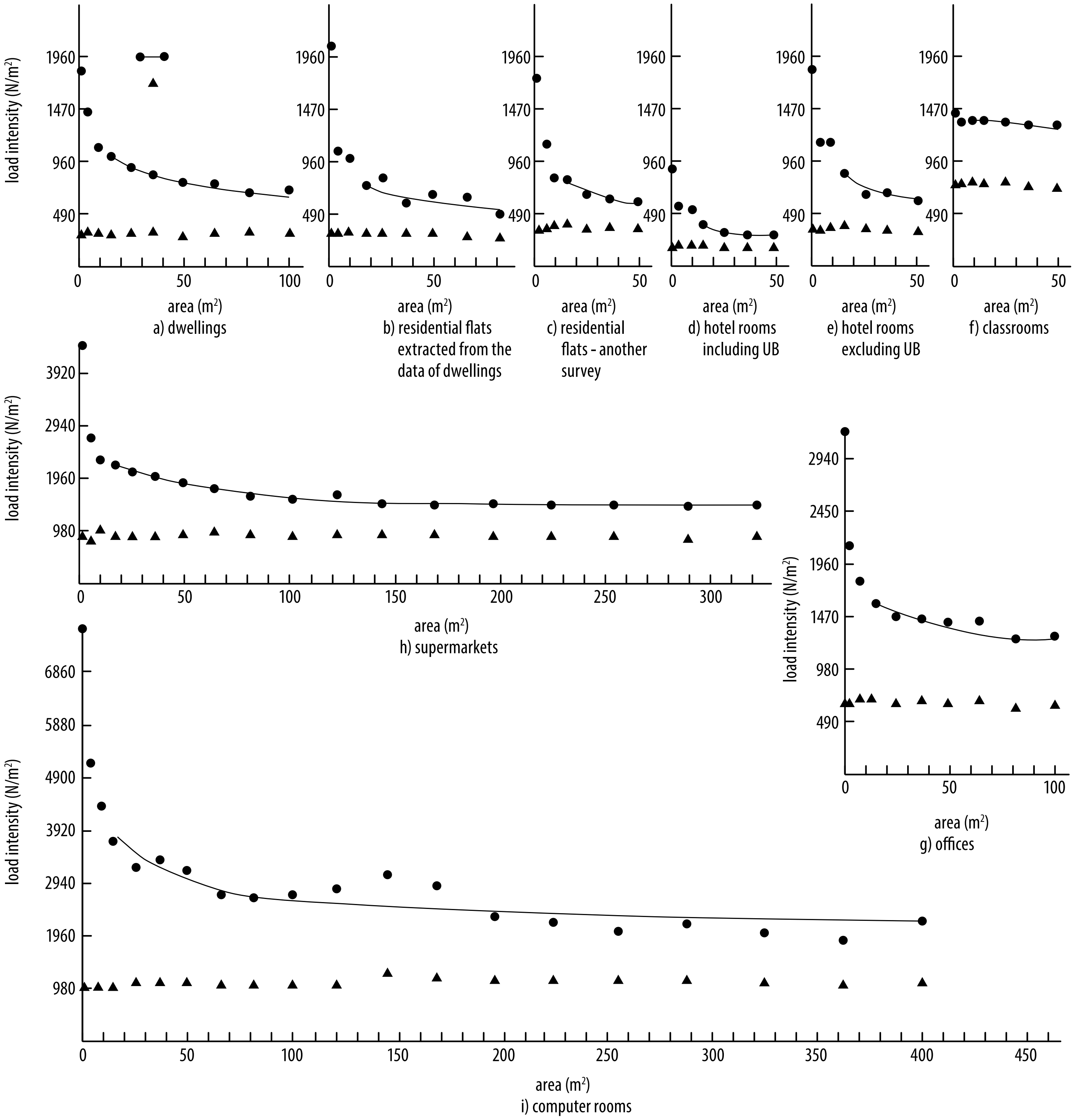


Figure 3 Load intensity surveys

candidates for LLR (and certainly those with most to gain) categories A/B will predominate, and the occasional floor of C/D could safely be allowed to participate in LLR on the same basis as all the rest. The people crowding into the 10th floor restaurant can't be in two places at once.

Whatever the original motive for the 40% limitation, it should be re-examined and, perhaps, substituted by an advisory 'floor' value of (say) 3 kPa where the area is all at one level and might, conceivably, be subject to serious crowd loading. More importantly, it has to be recognized that EN 1991-1-1's 'recommended' α_A formula, seemingly modelled on graphs like those of Figure 3, does not admit the very real possibility of exceptional local patterns of use (or abuse) which can be decidedly influential on individual members, even if unnoticed at the feet of the columns. What is called for is a drastic reduction in the rate at which LLR is initially dispensed. The straight line labelled UK in Figure 1, whose relative conservatism was remarked upon at the start of this article, now seems to offer as good a solution as any.

This article must stop short of any detailed discussion of the actual values set for q_k, but readers are invited to take a glance at EN 1991-1-1 Table 6.2, with its credibility-stretching ranges for national choice. A couple of examples: office areas, 2 to 3 kPa; railway station forecourts, 3 to 5 kPa. Until a consensus is reached on what the imposed loads should be in the first place it may be unrealistic to attempt to harmonize their reduction.

Terminology

Should it be 'variable action reduction' from now on? Surely not. Long live LLR!

New and revised codes & standards

From BSI Updates June & July 2013

BS EN PUBLICATIONS

BS EN 13381-4:2013
Test methods for determining the contribution to the fire resistance of structural members. Applied passive protection products to steel members
Supersedes DD ENV 13381-4:2002

BS EN 13381-8:2013
Test methods for determining the contribution to the fire resistance of structural members. Applied reactive protection to steel members
Supersedes BS EN 13381-8:2010

PUBLISHED DOCUMENTS

PD CEN/TR 10261:2013
Iron and steel. European standards for the determination of chemical composition.
No current standard is superseded

UPDATED BRITISH STANDARDS

PD 6705-2:2010+A1:2013
Structural use of steel and aluminium. Recommendations for the execution of steel bridges to BS EN 1090-2.
AMENDMENT 1

BS EN 1998-1:2004+A1:2013
Eurocode 8: Design of structures for earthquake resistance. General rules, seismic actions and rules for buildings
AMENDMENT 1

CEN EUROPEAN STANDARDS

EN 13381-4:2013
Test methods for determining the contribution to the fire resistance of structural members. Applied passive protection to steel members

EN 13381-8:2013
Test methods for determining the contribution to the fire resistance of structural members. Applied reactive protection to steel members

DRAFTS FOR PUBLIC COMMENT

13/30277428 DC
BS EN 14399-2 High-strength structural bolting assemblies for preloading. Suitability for preloading

13/30277431 DC
BS EN 14399-3 High-strength structural bolting assemblies for preloading. System HR. Hexagon bolt and nut assemblies

13/30277434 DC
BS EN 14399-4 High-strength structural bolting assemblies for preloading. System HV. Hexagon bolt and nut assemblies

13/30277437 DC
BS EN 14399-5 High-strength structural bolting assemblies for preloading. Plain washers

13/30277440 DC
BS EN 14399-6 High-strength structural bolting assemblies for preloading. Plain chamfered washers.

ISO PUBLICATIONS

ISO 3452-1:2013
(Edition 2)
Non-destructive testing. Penetrant testing. General principles
Will be implemented as an identical British Standard

ISO 5951:2013
(Edition 5)
Hot-rolled steel sheet of higher yield strength with improved formability
Will not be implemented as a British Standard

AD 376
Fire design of concrete-filled hollow steel columns to Eurocode 4

Depending on the constructional details, Section 4 of BS EN 1994-1-2 [1] presents three alternative design procedures for fire design:

- Tabulated data for specific types of structural members
- Simple calculation models for specific types of structural members
- Advanced calculation models.

For the fire design of concrete-filled hollow steel columns, clause 4.3.5 describes simple calculation models and clause 4.3.5.3 addresses unprotected concrete-filled hollow sections: the designer is directed to Annex H for the simple calculation model. However, the UK National Annex (NA to BS EN 1994-1-2:2005) states that Annex H of the code should not be used. This Advisory Desk note provides some background on Annex H and an update on the status of alternative guidance.

Annex H is informative and puts forward a method for calculating the design axial buckling load for concrete-filled hollow steel columns at elevated temperatures. A simple method is also given to account for the effects of eccentricity of the axial load.

Annex H follows an old method of calculating axial resistance of composite columns at ambient temperature. For fire resistance calculations, this method is particularly difficult to implement, as the composite cross section must be divided into many blocks and the calculations involve many iterations. Each round of iteration needs to use the detailed material non-linear stress-strain relationships of steel and concrete at different temperatures, for each block in the cross section.

Annex H allows for the effect of small eccentricities in axial load by introducing two modification factors, one as a function of the reinforcement ratio and one as a function of eccentricity and column dimensions.

A CIDECT research project (15Q) assessed the Annex H calculation method and found that it can be grossly inaccurate. For this reason, the UK National Annex (published in 2008), states in clause NA.3 that Annex H should not be used.

Instead, it is recommended that the column design method for the fire limit state should be consistent with that at ambient temperature [2], but a reduction in strength and stiffness of the steel and concrete should be incorporated. Such a method has been implemented in the FIRESOFT software package developed by the University of Manchester for Tata Steel. FIRESOFT software and an associated quality assurance document, giving details of methodology and validation testing are available free of charge from Tata Steel. The software and document have the status of Non-Contradictory Complementary Information (NCCI).

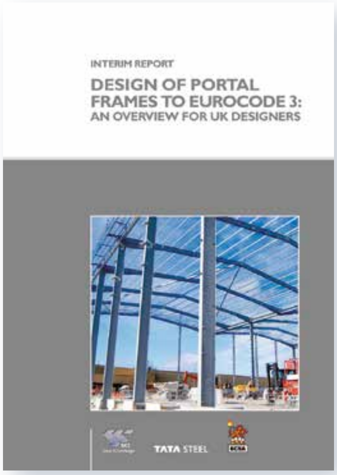
The Tata Steel design guide for concrete-filled structural hollow section columns is currently being updated and will be made available from http://www.steel-ncci.co.uk/ in due course.

Contact: **Dr Richard Henderson**
Tel: **01344 636525**
Email: **advisory@steel-sci.com**

1. BS EN 1994-1-2:2005 (Incorporating corrigendum July 2008) Eurocode 4 - Design of composite steel and concrete structures - Part 1-2: General rules – Structural fire design

2. Designers' Guide to EN 1994-1-1; Eurocode 4: Design of composite steel and concrete structures; Part 1.1: General rules and rules for buildings; R P Johnson and D Anderson; Thomas Telford Publishing.

Interim Report
Design of Portal Frames to Eurocode 3: An overview for UK designers



In the UK, designers of portal frame buildings have commonly used bespoke software specifically written for the analysis and member design in accordance with BS 5950.

The view has arisen that design to Eurocode 3 is not practical. This short guide was written to refute that impression. The guidance aims to show how existing analysis software (for use in design to BS 5950) may be utilised, with appropriate adjustments, and how (at least in the interim, until Eurocode-specific software is widely used) portal frame member design can be carried out manually at critical locations without undue complexity.

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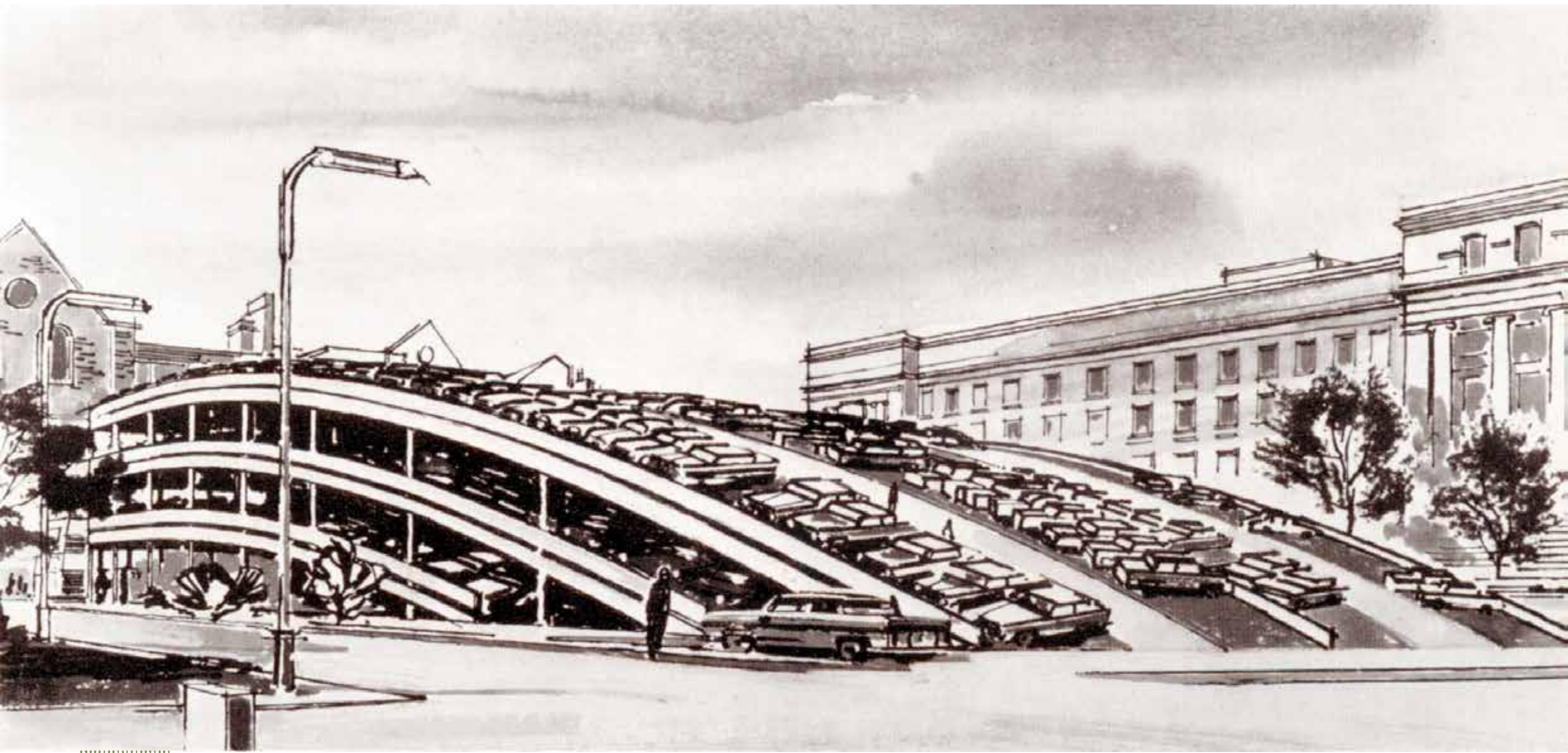


Above: Birmingham's Wheelwright park, of the folded arch or 'U'Shape, is Britain's first.

One use visualised for the Wheelwright design is the propvision of parking space in motorway median strips

"Wheelwright" Arched Car Park Design Saves Cost and Space

FROM BUILDING WITH STEEL MAY 1963

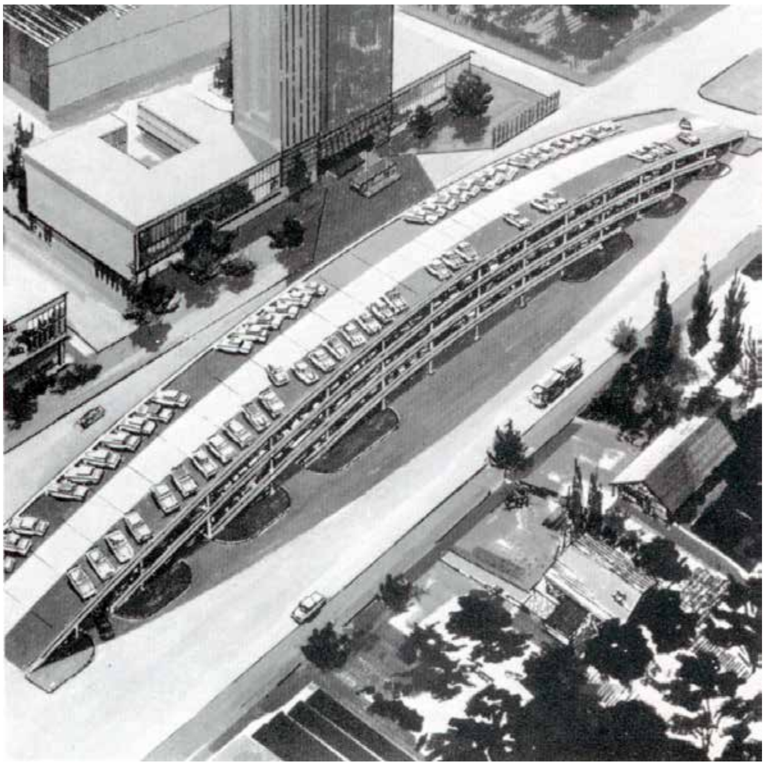
In an increasingly motorised civilisation finding space for the motorcar has become a major difficulty. Not only must new roads be built to carry the growing number of private automobiles but space must be found of created to park them once they reach their destination. And in an intensely built up country like Britain, parking space is a major problem – as any London car owner knows. Nor is the problem restricted to owners; the cost to local authorities can be staggering. In London, for instance, the City of Westminster's investment in off-street parking – the Park Lane underground garage and the multi-storey Audley Street garage – amounts to nearly £1.5 million: an average of £1,000 for each of the vehicle spaces involved.

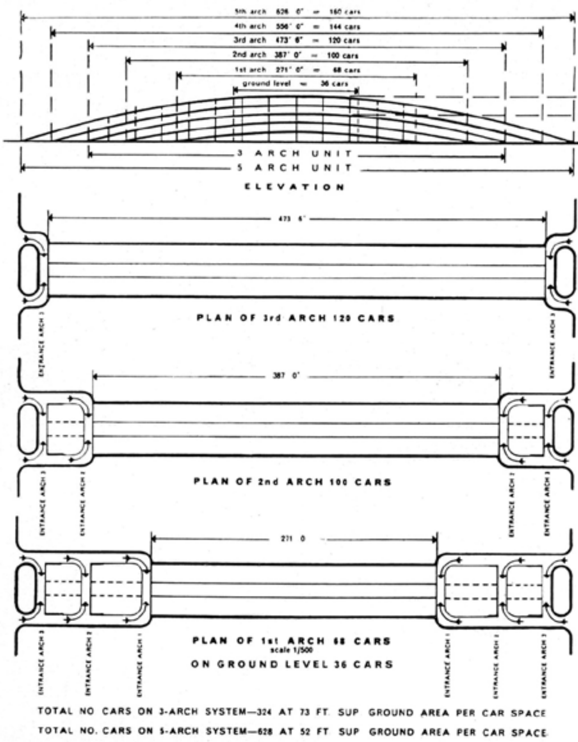
In an effort to solve the problem of providing maximum parking space at minimum cost and with minimum use of valuable urban land Birmingham has turned to a revolutionary new answer, the Wheelwright Car Park, designed by John Smith, F.R.I.B.A.

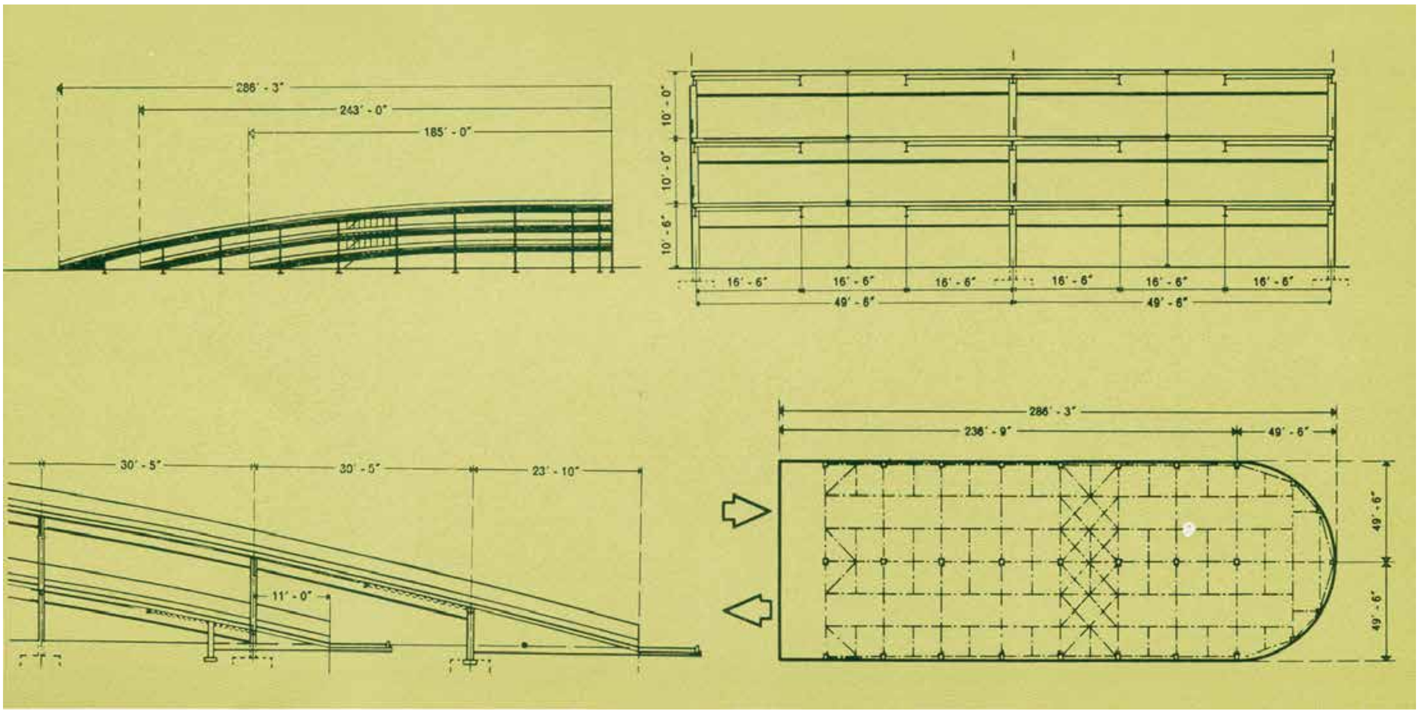
The Wheelwright design makes use of simple arches; these can be stacked one above the other without the need for spiral ramps. There are no lifts and the driver will park his own car.

The wheelwright unit – up to six ramps arranged in various patterns to fit site requirements – can be built above or below ground. If required, in fact, two complete units can be built one above the other, one being below ground and one in the open. The cost of construction per car space is about £200 and ground area per car space is modest: 82.68 sq. ft for a three-arch and 50.08 sq. ft for a five arch unit. The design can be adapted to a wide variety of sites including many that would not be suitable for other use. One suggestion, for instance, calls for locating the unit along the median strip of a divided motorway.

The Birmingham installation, Britain's first, is of the U-shaped pattern and is to be built of steel. Though the design is not necessarily restricted to steel construction, steel is preferred for several reasons. In addition to its faster erection time and the smaller space required by the supporting columns, a steel framed unit of bolted construction can – if future planning or building requirements so dictate – be easily dismantled and rebuilt at another location. The Birmingham installation is so designed, the decking being designed to lift out in sections.




5th arch 626' 0" = 160 cars
4th arch 556' 0" = 144 cars
3rd arch 473' 6" = 120 cars
2nd arch 387' 0" = 100 cars
1st arch 271' 0" = 68 cars
ground level = 36 cars
30' 0"
30' 0"
3 ARCH UNIT
5 ARCH UNIT
ELEVATION
473' 6"
PLAN OF 3rd ARCH 120 CARS
387' 0"
PLAN OF 2nd ARCH 100 CARS
271' 0
PLAN OF 1st ARCH 68 CARS
scale 1/500
ON GROUND LEVEL 36 CARS
ENTRANCE ARCH 3
ENTRANCE ARCH 2
ENTRANCE ARCH 1
TOTAL NO CARS ON 3-ARCH SYSTEM—324 AT 73 FT. SUP GROUND AREA PER CAR SPACE
TOTAL NO. CARS ON 5-ARCH SYSTEM—628 AT 52 FT SUP GROUND AREA PER CAR SPACE


286' - 3"
243' - 0"
185' - 0"
10' - 0"
10' - 0"
10' - 6"
16' - 6"
49' - 6"
30' - 5"
30' - 5"
23' - 10"
11' - 0"
286' - 3"
236' - 9"
49' - 6"

Steelwork contractors for buildings

Membership of BCSA is open to any Steelwork Contractor who has a fabrication facility within the United Kingdom or Republic of Ireland. Details of BCSA membership and services can be obtained from

Gillian Mitchell MBE, Deputy Director General, BCSA, 4 Whitehall Court, London SW1A 2ES
Tel: 020 7747 8121 Email: *gillian.mitchell@steelconstruction.org*

Applicants may be registered in one or more Buildings category to undertake the fabrication and the responsibility for any design and erection of:

- **C** Heavy industrial platework for plant structures, bunkers, hoppers, silos etc
- **D** High rise buildings (offices etc over 15 storeys)
- **E** Large span portals (over 30m)
- **F** Medium/small span portals (up to 30m) and low rise buildings (up to 4 storeys)
- **G** Medium rise buildings (from 5 to 15 storeys)
- **H** Large span trusswork (over 20m)
- **J** Tubular steelwork where tubular construction forms a major part of the structure
- **K** Towers and masts
- **L** Architectural steelwork for staircases, balconies, canopies etc
- **M** Frames for machinery, supports for plant and conveyors
- **N** Large grandstands and stadia (over 5000 persons)
- **Q** Specialist fabrication services (eg bending, cellular/castellated beams, plate girders)
- **R** Refurbishment
- **S** Lighter fabrications including fire escapes, ladders and catwalks
- **FPC** Factory Production Control certification to BS EN 1090-1
  - 1 – Execution Class 1
  - 2 – Execution Class 2
  - 3 – Execution Class 3
  - 4 – Execution Class 4
- **QM** Quality management certification to ISO 9001
- **SCM** Steel Construction Sustainability Charter (● = Gold, ● = Silver, ● = Member)

Notes

(1) Contracts which are primarily steelwork but which may include associated works. The steelwork contract value for which a company is pre-qualified under the Scheme is intended to give guidance on the size of steelwork contract that can be undertaken; where a project lasts longer than a year, the value is the proportion of the steelwork contract to be undertaken within a 12 month period.

Where an asterisk (*) appears against any company's classification number, this indicates that the assets required for this classification level are those of the parent company.

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	SCM	Guide Contract Value (1)
A C Bacon Engineering Ltd	01953 850611			●	●		●										2		Up to £2,000,000
Adey Steel Ltd	01509 556677				●	●	●	●		●	●			●	●	✔		Silver	Up to £2,000,000
Adstone Construction Ltd	01905 794561			●	●	●	●									✔	2	Silver	Up to £3,000,000
Advanced Fabrications Poyle Ltd	01753 653617				●	●	●	●	●	●	●				●				Up to £800,000
AJ Engineering & Construction Services Ltd	01309 671919			●	●					●	●			●	●	✔			Up to £1,400,000
Angle Ring Company Ltd	0121 557 7241												●			✔			Up to £1,400,000
Apex Steel Structures Ltd	01268 660828				●		●			●	●								Up to £800,000
Arminhall Engineering Ltd	01799 524510	●			●					●	●			●	●				Up to £200,000
Arromax Structures Ltd	01623 747466	●		●	●	●	●	●	●	●	●	●		●	●		2		Up to £800,000
ASA Steel Structures Ltd	01782 566366			●	●	●	●			●	●			●	●				Up to £800,000*
ASD Westok Ltd	0113 205 5270												●			✔	2		Up to £6,000,000
ASME Engineering Ltd	020 8966 7150				●					●	●			●	●			Member	Up to £800,000*
Atlas Ward Structures Ltd	01944 710421		●	●	●	●	●	●	●	●	●	●		●	●	✔	4	Gold	Above £6,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●	●	●				●			●	●				Up to £1,400,000
Austin-Divall Fabrications Ltd	01903 721950			●	●		●	●		●	●			●	●				Up to £400,000
B D Structures Ltd	01942 817770			●	●	●	●				●	●		●					Up to £400,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✔			Up to £1,400,000
Barnshaw Section Benders Ltd	01902 880848												●			✔			Up to £800,000
BHC Ltd	01555 840006	●	●	●	●	●	●	●			●	●		●	●	✔	2		Above £6,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●	●	●	●	●		●		✔	4	Gold	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●				Up to £3,000,000
Bourne Construction Engineering Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●			●	●	✔			Up to £3,000,000
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●				●	●	✔	4	Gold	Up to £3,000,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●		●	●	●		●	●	✔	4	Gold	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	●		●		✔	4	Silver	Above £6,000,000
CMF Ltd	020 8844 0940				●		●	●		●	●				●	✔			Up to £6,000,000
Cook Fabrications Ltd	01303 890040				●					●	●			●	●				Up to £800,000
Cordell Group Ltd	01642 452406	●			●	●	●	●	●	●	●					✔			Up to £3,000,000
Coventry Construction Ltd	024 7646 4484			●	●	●	●	●	●	●	●			●	●				Up to £800,000
D H Structures Ltd	01785 246269			●	●		●				●			●					Up to £100,000
DGT Structures Ltd	01603 308200			●	●	●	●					●		●		✔			Up to £2,000,000
Discain Project Services Ltd	01604 787276				●					●	●				●	✔			Up to £1,400,000
Duggan Steel Ltd	00 353 29 70072		●	●	●	●	●	●			●								Up to £4,000,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●	●	●	●	●			●	●	✔	3		Up to £2,000,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●	●	●	●	●	●		●		✔	4	Gold	Up to £6,000,000
EvadX Ltd	01745 336413			●	●	●	●	●	●	●	●	●				✔		Gold	Up to £3,000,000
Fisher Engineering Ltd	028 6638 8521		●	●	●	●	●	●	●	●	●	●				✔	4	Gold	Above £6,000,000
Fourbay Structures Ltd	01603 758141			●	●					●	●			●	●				Up to £1,400,000
Fox Bros Engineering Ltd	00 353 53 942 1677			●	●	●	●	●			●								Up to £3,000,000
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●				●					Up to £800,000
Graham Wood Structural Ltd	01903 755991		●	●	●	●	●	●	●	●	●	●		●		✔		Silver	Up to £6,000,000
Grays Engineering (Contracts) Ltd	01375 372411	●			●					●	●			●	●				Up to £100,000
Gregg & Patterson (Engineers) Ltd	028 9061 8131			●	●	●	●	●				●		●		✔			Up to £3,000,000
H Young Structures Ltd	01953 601881			●	●	●	●	●						●		✔		Silver	Up to £2,000,000
Had Fab Ltd	01875 611711				●				●	●	●				●	✔			Up to £2,000,000
Company name	**Tel**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**Q**	**R**	**S**	**QM**	**FPC**	**SCM**	**Guide Contract Value (1)**

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	SCM	Guide Contract Value (1)
Hambleton Steel Ltd	01748 810598		●	●	●	●	●	●				●		●		✔		grey	Up to £1,400,000
Harry Marsh (Engineers) Ltd	0191 510 9797			●	●	●	●				●	●			●	✔			Up to £1,400,000
Henry Smith (Constructional Engineers) Ltd	01606 592121			●	●	●	●	●											Up to £3,000,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●				Up to £3,000,000
Hills of Shoeburyness Ltd	01702 296321									●				●	●				Up to £1,400,000
J Robertson & Co Ltd	01255 672855									●	●				●				Up to £200,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●					●		●			4		Up to £6,000,000*
John Reid & Sons (Strucsteel) Ltd	01202 483333		●	●	●	●	●	●	●	●	●	●		●					Up to £6,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445			●	●	●	●	●	●	●	●	●		●	●	✔		orange	Up to £4,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●					✔	2	grey	Up to £2,000,000
Luxtrade Ltd	01902 353182									●	●			●		✔			Up to £800,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●				●	✔			Up to £3,000,000
M&S Engineering Ltd	01461 40111				●				●	●	●			●	●				Up to £1,400,000
Mabey Bridge Ltd	01291 623801	●	●	●	●	●	●	●	●	●	●	●	●	●		✔	4	orange	Above £6,000,000
Mackay Steelwork & Cladding Ltd	01862 843910			●	●		●			●	●			●	●	✔			Up to £800,000
Maldon Marine Ltd	01621 859000				●	●		●	●	●					●				Up to £1,400,000
Mifflin Construction Ltd	01568 613311		●	●	●	●	●				●								Up to £3,000,000
Newbridge Engineering Ltd	01429 866722			●	●	●	●								●	✔			Up to £1,400,000
Nusteel Structures Ltd	01303 268112						●	●	●	●						✔	4		Up to £4,000,000
On Site Services (Gravesend) Ltd	01474 321552				●		●	●		●	●				●				Up to £100,000
Overdale Construction Services Ltd	01656 729229			●	●		●	●			●				●				Up to £400,000
Paddy Wall & Sons	00 353 51 420 515			●	●	●	●	●	●	●	●								Up to £6,000,000
Painter Brothers Ltd	01432 374400								●		●				●	✔		grey	Up to £6,000,000
Pencro Structural Engineering Ltd	028 9335 2886			●	●	●	●	●	●		●			●	●	✔			Up to £2,000,000
Peter Marshall (Steel Stairs) Ltd	0113 307 6730									●					●				Up to £800,000
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●				Up to £1,400,000
Remnant Plant Ltd	01594 841160				●		●	●	●	●	●				●	✔			Up to £400,000
Rippin Ltd	01383 518610			●	●	●	●	●						●	●				Up to £1,400,000
S H Structures Ltd	01977 681931						●	●	●	●		●				✔	4	grey	Up to £3,000,000
SDM Fabrication Ltd	01354 660895			●	●	●	●				●			●	●				Up to £200,000
Severfield-Watson Structures Ltd	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	orange	Above £6,000,000
Shipley Fabrications Ltd	01400 251480			●	●	●	●		●	●	●			●	●				Up to £1,400,000
SIAC Butlers Steel Ltd	00 353 57 862 3305		●	●	●	●	●	●	●		●	●				✔	2	green	Above £6,000,000
SIAC Tetbury Steel Ltd	01666 502792			●	●	●	●		●		●	●		●					Up to £400,000*
Snashall Steel Fabrications Ltd	01300 345588			●	●	●	●	●			●				●				Up to £1,400,000
South Durham Structures Ltd	01388 777350			●	●	●				●	●	●			●				Up to £800,000
Temple Mill Fabrications Ltd	01623 741720			●	●	●	●				●			●	●				Up to £200,000
Traditional Structures Ltd	01922 414172		●	●	●	●	●	●	●		●	●		●	●	✔		grey	Up to £2,000,000
TSI Structures Ltd	01603 720031			●	●	●	●												Up to £1,400,000
Tubecon	01226 345261						●	●	●	●				●	●	✔		orange	Above £6,000,000*
W & H Steel & Roofing Systems Ltd	00 353 56 444 1855			●	●	●	●	●						●	●				Up to £3,000,000
W I G Engineering Ltd	01869 320515				●					●					●				Up to £200,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✔			Up to £6,000,000
Westbury Park Engineering Ltd	01373 825500	●			●		●	●	●	●	●				●	✔			Up to £800,000
William Haley Engineering Ltd	01278 760591			●	●	●			●	●	●					✔		grey	Up to £2,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●		●		✔	4	orange	Above £6,000,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	SCM	Guide Contract Value (1)

Corporate Members

Corporate Members are clients, professional offices, educational establishments etc which support the development of national specifications, quality, fabrication and erection techniques, overall industry efficiency and good practice.

Company name	Tel
Balfour Beatty Utility Solutions Ltd	01332 661491
Griffiths & Armour	0151 236 5656
Highways Agency	08457 504030
Kier Construction Ltd	01767 640111
Roger Pope Associates	01752 263636
Sandberg LLP	020 7565 7000
SUM Ltd	0113 242 7390

Associate Members

Associate Members are those principal companies involved in the direct supply to all or some Members of components, materials or products. Associate member companies must have a registered office within the United Kingdom or Republic of Ireland.

1 Structural components
2 Computer software
3 Design services
4 Steel producers
5 Manufacturing equipment
6 Protective systems
7 Safety systems
8 Steel stockholders
9 Structural fasteners

CE CE Marking compliant, where relevant:
M manufacturer (products CE Marked)
D/I distributor/importer (systems comply with the CPR)
N/A CPR not applicable

SCM Steel Construction Sustainability Charter
● = Gold, ● = Silver, ● = Member

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM
AceCad Software Ltd	01332 545800		●								N/A	
Albion Sections Ltd	0121 553 1877	●									M	
Andrews Fasteners Ltd	0113 246 9992									●	M	
Arcelor Mittal Distribution – Birkenhead	0151 647 4221								●		D/I	
Arcelor Mittal Distribution - Scunthorpe	01724 810810								●		D/I	
Arcelor Mittal Distribution – South Wales	01633 627890								●		D/I	
ASD metal services	0113 254 0711								●		D/I	
Ayrshire Metal Products (Daventry) Ltd	01327 300990	●									M	
BAPP Group Ltd	01226 383824									●	M	
Barnshaw Plate Bending Centre Ltd	0161 320 9696	●									N/A	
Barrett Steel Ltd	01274 682281								●		D/I	
BW Industries Ltd	01262 400088	●									M	
Cellbeam Ltd	01937 840600	●									D/I	
Cellshield Ltd	01937 840600							●			N/A	
CMC (UK) Ltd	029 2089 5260								●		D/I	
Composite Profiles UK Ltd	01202 659237	●									D/I	

Steelwork contractors for bridgeworks

The Register of Qualified Steelwork Contractors Scheme for Bridgeworks (RQSC) is open to any Steelwork Contractor who has a fabrication facility within the European Union.

Applicants may be registered in one or more category to undertake the fabrication and the responsibility for any design and erection of:

FG Footbridge and sign gantries
PG Bridges made principally from plate girders
TW Bridges made principally from trusswork
BA Bridges with stiffened complex platework (eg in decks, box girders or arch boxes)
CM Cable-supported bridges (eg cable-stayed or suspension) and other major structures (eg 100 metre span)
MB Moving bridges
RF Bridge refurbishment
AS Ancilliary structures in steel associated with bridges, footbridges or sign gantries (eg grillages, purpose-made temporary works)
QM Quality management certification to ISO 9001
FPC Factory Production Control certification to BS EN 1090-1
1 – Execution Class 1 2 – Execution Class 2
3 – Execution Class 3 4 – Execution Class 4
SCM Steel Construction Sustainability Charter (● = Gold, ● = Silver, ● = Member)

Notes
(1) Contracts which are primarily steelwork but which may include associated works. The steelwork contract value for which a company is pre-qualified under the Scheme is intended to give guidance on the size of steelwork contract that can be undertaken; where a project lasts longer than a year, the value is the proportion of the steelwork contract to be undertaken within a 12 month period.
Where an asterisk (*) appears against any company's classification number, this indicates that the assets required for this classification level are those of the parent company.

BCSA steelwork contractor member	Tel	FG	PG	TW	BA	CM	MB	RF	AS	QM	FPC	NHSS 19A	NHSS 20	SCM	Guide Contract Value (1)
Access Design & Engineering	01952 685162	●						●	●	✓					Up to £3,000,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	✓			✓		Up to £3,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●			●	●	✓	4			● (Gold)	Up to £3,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	✓	4	✓	✓	● (Silver)	Above £6,000,000
Four-Tees Engineers Ltd	01489 885899	●	●	●	●		●	●	●	✓	3		✓	● (Member)	Up to £2,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●	●	●	●			●	●	✓				● (Gold)	Up to £800,000
Mabey Bridge Ltd	01291 623801	●	●	●	●	●	●	●	●	✓	4	✓	✓	● (Gold)	Above £6,000,000
Nusteel Structures Ltd	01303 268112	●	●	●	●	●	●	●	●	✓	4	✓	✓		Up to £4,000,000
Painter Brothers Ltd	01432 374400	●		●					●	✓				● (Silver)	Up to £6,000,000
Remnant Plant Ltd	01594 841160	●	●	●					●	✓					Up to £400,000
S H Structures Ltd	01977 681931	●		●	●	●			●	✓	4		✓	● (Silver)	Up to £3,000,000
Severfield-Watson Structures Ltd	01204 699999	●	●	●	●	●	●	●	●	✓	4		✓	● (Gold)	Above £6,000,000
Non-BCSA member															
Allerton Steel Ltd	01609 774471	●	●	●	●	●	●	●	●	✓					Up to £1,400,000
Cimolai SpA	01223 350876	●	●	●	●	●	●	●		✓					Above £6,000,000
Concrete & Timber Services Ltd	01484 606416	●	●	●	●	●	●		●	✓				● (Member)	Up to £800,000
Donyal Engineering Ltd	01207 270909	●						●	●	✓			✓	● (Member)	Up to £1,400,000
Francis & Lewis International Ltd	01452 722200							●	●	✓	2			● (Silver)	Up to £2,000,000
Harland & Wolff Heavy Industries Ltd	028 9045 8456	●	●	●	●	●		●	●	✓					Up to £2,000,000
Hollandia BV	00 31 180 540540	●	●	●	●	●	●	●	●	✓					Above £6,000,000
Interserve Construction Ltd	0121 344 4888							●	●	✓					Above £6,000,000*
Interserve Construction Ltd	020 8311 5500	●	●	●	●		●	●	●	✓					Above £6,000,000*
Lanarkshire Welding Company Ltd	01698 264271	●	●	●	●	●	●	●	●	✓				● (Member)	Up to £2,000,000
Millar Callaghan Engineering Services Ltd	01294 217711	●						●	●	✓					Up to £800,000
P C Richardson & Co (Middlesbrough) Ltd	01642 714791	●						●	●	✓					Up to £3,000,000
Varley & Gulliver Ltd	0121 773 2441	●						●	●	✓			✓		Up to £3,000,000

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM
Cooper & Turner Ltd	0114 256 0057									●	M	
CSC (UK) Ltd	0113 239 3000		●								N/A	
Cutmaster Machines (UK) Ltd	01226 707865					●					N/A	
Daver Steels Ltd	0114 261 1999	●									M	
easi-edge Ltd	01777 870901							●			N/A	●
Fabsec Ltd	0845 094 2530	●									N/A	
FabTrol Systems UK Ltd	01274 590865		●								N/A	
Ficep (UK) Ltd	01942 223530					●					N/A	
FLI Structures	01452 722200	●									M	●
Forward Protective Coatings Ltd	01623 748323						●				N/A	
Goodwin Steel Castings Ltd	01782 220000	●									N/A	
Graitec UK Ltd	0844 543 8888		●								N/A	
Hadley Group Ltd	0121 555 1342	●									M	●
Hempel UK Ltd	01633 874024						●				N/A	
Highland Metals Ltd	01343 548855						●				N/A	
Hilti (GB) Ltd	0800 886100									●	M	
Hi-Span Ltd	01953 603081	●									M	●
International Paint Ltd	0191 469 6111						●				N/A	●
Jack Tighe Ltd	01302 880360						●				N/A	
Jamestown Cladding & Profiling Ltd	00 353 45 434288	●									M	
John Parker & Sons Ltd	01227 783200								●	●	D/I	
Jotun Paints (Europe) Ltd	01724 400000						●				N/A	
Kaltenbach Ltd	01234 213201					●					N/A	

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM
Kingspan Structural Products	01944 712000	●									M	●
Lindapter International	01274 521444									●	M	
Metsec Plc	0121 601 6000	●									M	●
MSW Structural Floor Systems	0115 946 2316	●									D/I	
Murray Plate Group Ltd	0161 866 0266								●		D/I	
National Tube Stockholders Ltd	01845 577440								●		D/I	
Peddinghaus Corporation UK Ltd	01952 200377					●					N/A	
PPG Performance Coatings UK Ltd	01773 814520						●				N/A	
Prodeck-Fixing Ltd	01278 780586	●									D/I	
Rainham Steel Co Ltd	01708 522311								●		D/I	
Sherwin-Williams Protective & Marine Coatings	01204 521771						●				M	●
Sika Ltd	01707 384444						●				M	
Structural Metal Decks Ltd	01202 718898	●									M	●
Tata Steel	01724 404040				●						M	
Tata Steel Distribution UK & Ireland	01902 484000								●		D/I	
Tata Steel Ireland Service Centre	028 9266 0747								●		D/I	
Tata Steel Service Centre Dublin	00 353 1 405 0300								●		D/I	
Tata Steel Tubes	01536 402121				●						M	
Tata Steel UK Panels & Profiles	0845 3088330	●									M	
Tekla (UK) Ltd	0113 307 1200		●								N/A	
Tension Control Bolts Ltd	01948 667700						●			●	M	
Wedge Group Galvanizing Ltd	01909 486384						●				N/A	

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