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NSC

Girders span Aldgate development

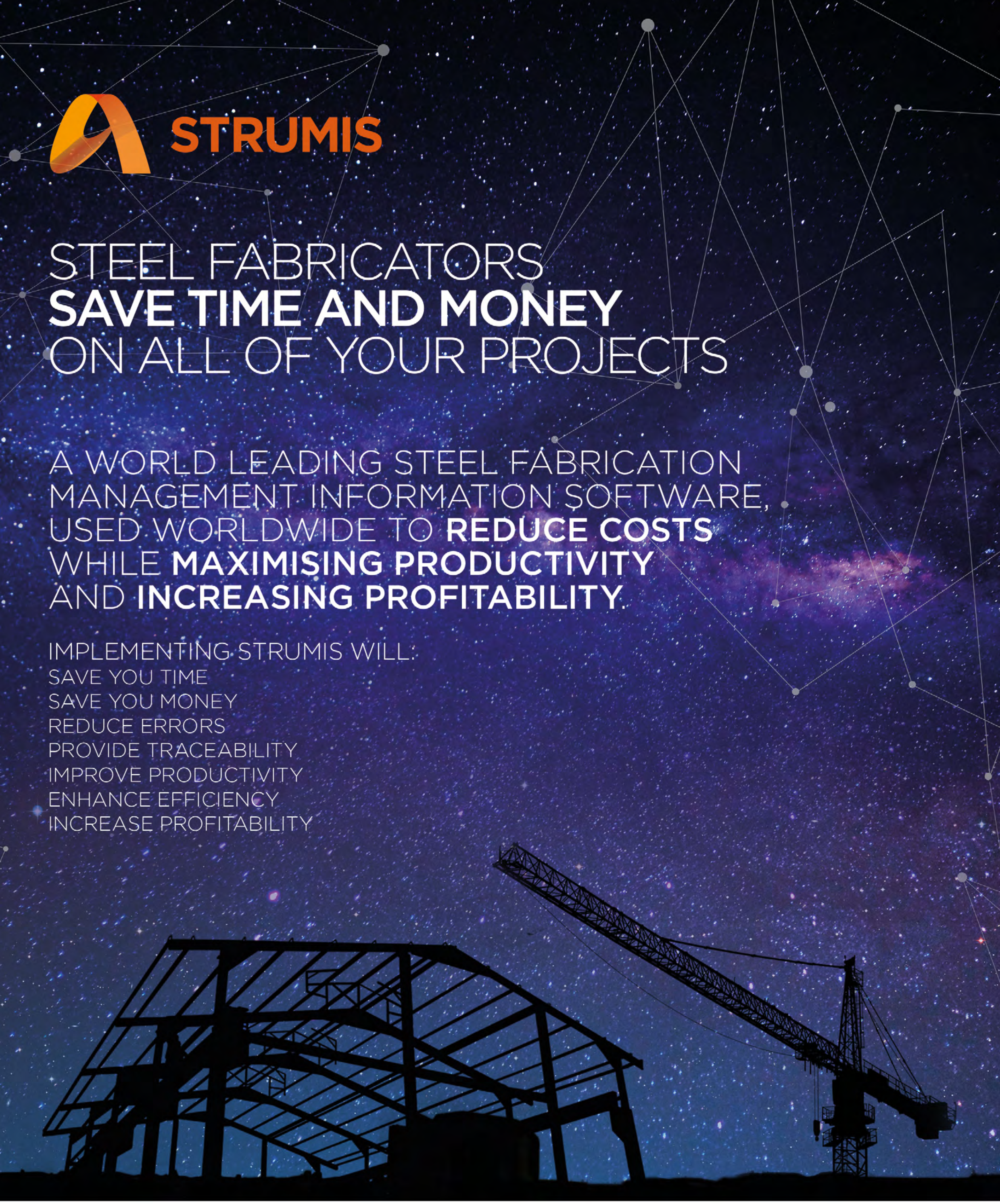
July/August 2019
Vol27 No7

Liverpool accommodates steel

New roof at Trafford Centre

Theatre production in Shoreditch

Education boost for Kent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Cover Image
Blundell Street residential scheme, Liverpool
Main client: Brickland
Architect: Tim Groom Architects
Main contractor: ISG
Structural engineer: Clancy Consulting
Steelwork contractor: Walter Watson
Steel tonnage: 1,200t

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LENGTH	6,780mm	7,550 mm	7,840 mm	8,100 mm	8,500 mm
WIDTH	2,430 mm	2,490 mm	2,490 mm	2,500 mm	2,500 mm
HEIGHT	3,050 mm	3,050 mm	3,050 mm	3,180 mm	3,200 mm
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MAX LIFTING WEIGHT	4,999 kg	7,000 kg	4,999 kg	4,999 kg	5,500 kg

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Steel ready for new digital challenges

Nick Barrett - Editor

The Structural Steel Design Awards (SSDA) celebrated 50 years of outstanding steel construction achievements last year. Entering the second half of this first century, some may have wondered whether the Awards' unrivalled quality could be maintained.

The entries to this year's Awards have now all been carefully scrutinised, a shortlist has been selected (see News), and the answer to the quality question is an undoubted yes! It was a bumper crop of entries and the judges were demanding as always, but they still selected no fewer than 20 steel projects as potentially worthy award winners.

A look at the shortlist immediately confirms that the SSDA is as relevant as ever, containing shining examples of quality steelwork at the leading edge of modern construction. They are a diverse collection of construction excellence. Among the 20 are a number of footbridges, steel structures on a bypass, and major multi-storey buildings in Birmingham as well as in London. There are some high-profile leisure sector projects and, in what is surely a first for the Awards, a seal hide in Middlesborough. Wimbledon No 1 Court's new roof makes the shortlist, as does Tottenham Hotspur's new stadium.

As BCSA Director General Sarah McCann-Bartlett said announcing the shortlist, the structural steelwork sector has evolved significantly in the past 50 years, but steel's ability to deliver the most efficient and cost-effective solution for a building or structure, while also providing practical, flexible and beautiful spaces, has been a constant. Winning projects over the years have demonstrated engineering excellence, innovation and attention to detail; the same could probably be said of all of the shortlisted projects over the years, but the judges do set the bar high for the ultimate accolade of an SSDA prize.

The winning projects will be announced in October.

Looking ahead, changing demands on construction that couldn't have been envisaged 50 years ago should assure steel's leading role in the provision of the UK's built environment. Thanks to steel's offsite capabilities the drive towards modern methods of construction means steel is better placed than any alternative framing material to meet that growing demand.

The digital landscape is constantly changing and steel is strongly placed to play a full role in new digital innovations. Long association with CNC fabrication means steel is also well placed to respond to more complex levels of design for manufacture and assembly. In short, the quality of the SSDA shortlist could be scaling new heights in years to come.

As Richard Fletcher, Managing Director of SSDA sponsor Trimble Solutions (UK) Ltd, said when welcoming the shortlist, steel is at the forefront of technological advance in construction, delivering projects of high complexity and scale through data driven design, manufacture, assembly and erection. The sector is well prepared for the push towards digitalisation of the construction workflow.

Other challenges will undoubtedly arise for construction as the pace of modernisation picks up across all industries that the steel sector will be expected to play its part in. On the evidence of this year's SSDA shortlist, the response is already underway.

SSDA shortlist highlights steelwork's appeal

The shortlist for the 51st Structural Steel Design Awards (SSDA), jointly sponsored by the British Constructional Steelwork Association (BCSA) and Trimble Solutions (UK) Ltd, has been announced.

The Awards have again seen a strong number of submissions and the 20 shortlisted projects all showcase steel's flexibility and versatility in a number of varying applications, spread across the entire UK. (See p10 for a full pictorial list.)

The winners will be announced at an evening reception in London on 1 October.

Commenting on the shortlist, BCSA Director General Sarah McCann-Bartlett said: "The structural steelwork sector has evolved significantly since the SSDAs were launched in 1969, however one constant has been the ability of steel to deliver the most efficient and cost-effective solution for a building or structure, while also providing practical, flexible and beautiful spaces. As the original offsite framing material, structural steel is now looking to the future to deliver a more complex level of design for manufacture and assembly."

Trimble Solutions (UK) Ltd Managing Director Richard Fletcher added: "The projects shortlisted once again celebrate our world class structural steel industry within the UK and Ireland. At the forefront of technology within construction, our industry continues to deliver projects of high complexity and scale through data driven design, manufacture, assembly and erection."

The SSDA 2019 shortlist is:

160 Old Street, London
Aga Khan Centre, London
Battersea Arts Centre
Chiswick Park Footbridge
Coal Drops Yard, London
Ely Southern Bypass
Fenchurch Court, London
G W Annenberg Performing Arts Centre
Greatham Creek Seal Hide, Middlesbrough
Ingenuity House, Birmingham
Kettner's Townhouse & Soho House Greek Street
Neuron Pod, London
Project Mint at the O2
River Thames Footbridge, Taplow
Royal Academy of Music, London
Telford Central Footbridges
The Macallan Distillery
Tombola HQ, Sunderland
Tottenham Hotspur Football Club, New Stadium
Wimbledon No.1 Court

Steelwork contractor named for major Glasgow commercial development

Following on from its previous success on phase 1 of Bothwell Exchange, BHC has been appointed as the structural steelwork contractor for phase 2 of the Glasgow city centre development.

177 Bothwell Street will be a Grade A office scheme within the heart of Glasgow's financial district, for which BHC will be fabricating, supplying and erecting almost 4,000t of steelwork and installing over 30,000 m^2 of metal deck flooring.

In addition, BHC will also be laying the concrete upper floor slabs, covering 30,908 m^2 with 4,636 m^3 of concrete reinforced with a further 557t of steel reinforcement.

The development will have extensive cycle provision and what is said to be Glasgow's first rooftop running track.

The building's large flexible open-plan floorplates will have extensive floor-to-ceiling glazing to maximise daylight and allow tenants to have views across the city.

According to the developer, the sustainability of the development is a key consideration and the specification of structural elements, building fabric (both external and internal) and the selection of mechanical and electrical equipment will be carefully considered to provide a robust, easily-maintained building which achieves an appropriate balance between capital expenditure and life-cycle costs.

Approximately 40% of the building has already been pre-let to Clydesdale Bank.

Installation begins for Cornish castle link

Spanning approximately 70m, a new steel footbridge that will link Tintagel Castle with the Cornish mainland is beginning to take shape.

The castle's remote location and challenging landscape have called for an innovative approach to the construction.

Formed by two cantilevers, which reach out and almost touch in the middle, the bridge is being installed without scaffolding or free-standing supports.

The erection programme is being carried out with a cable crane, which uses technology pioneered in the Swiss Alps. Previously, the crane delivered materials to the site, put in place rock anchors and helped build the bridge's foundations.

The bridge has been divided into 12 fully fabricated sections, each weighing up to 4.5t. Working on behalf of the main contractor, Underhill Engineering began the offsite fabrication of the sections last Autumn.

English Heritage Head of Historic Properties in Cornwall Georgia Butters said: "Following the arrival of the first pieces, we will quickly see the bridge take shape. It will be a spectacular new addition to the site, and will hugely improve the experience and access for our visitors."

The remains of the 13th Century Tintagel Castle are located on both the mainland and small island, which were once united by a narrow strip of land. The footbridge will follow the path of the original land bridge and will replace a steep staircase, which currently provides the only access to the island.

BCSA President lauds steelwork's efficiency and adaptability

Speaking at the British Constructional Steelwork Association's (BCSA) 42nd National Dinner, sponsored by William Hare, BCSA President Tim Outteridge (pictured above) reminded attendees that steel delivers the most efficient designs and allows for the design of longer, flexible internal column-free spaces.

Mr Outteridge said future needs are also an important economic consideration, with steel buildings the most easily adaptable and flexible, offering future-proofed design solutions.

"Studies show that steel is the most cost-effective framing material for buildings and structures of all types.

"Steel for Life and AECOM's most recent cost study shows that on a typical city centre office building, the cellular steel composite beam and slab option was 7% lower than the concrete alternative."

Mr Outteridge said: "We always say that steel is the original offsite framing material. The structural steelwork sector has been manufacturing offsite for years, in controlled factory conditions with fully integrated design and management software, and automated equipment.

"Some of our biggest member companies have delivered complex projects using fully integrated steel modules that contain M&E to deliver the benefits of greater collaboration and integration between trades, and faster installation, leading to less time on site, and improved safety."

"BCSA along with its members, SCI, designers and M&E contractors are now in the process of developing a design guide for integrated offsite steel modules that will allow this concept to be extended further into the more mainstream building markets."

In addition, he added the BCSA's Digital Technology Group is keeping members on top of new technologies and at the forefront of change.

"However, some things won't change," said Mr Outteridge. "Like the individual project by project benefits that using a BCSA steelwork contractor brings to clients and main contractors."

"BCSA members are pre-assessed, which means that clients and contractors can be assured they have the specialist experience and qualifications for the job."

"I see BCSA membership as a benchmark for professionalism and the can-do attitude BCSA members have."

Eden Project plans to go north

Plans have been submitted to Lancaster City Council for an £85M Eden Project to be built on Morecambe Bay.

It is proposed that the destination will combine indoor and outdoor experiences, connecting people with the internationally significant natural environment of Morecambe Bay while also enhancing well-being.

Housed in five large domes that would reach a height of 37.3m, the project will reflect Morecambe's rich heritage, offering a vision of a seaside resort for the 21st Century including re-imagined lidos, gardens, performance spaces, immersive experiences and observatories.

Eden Project North would also have a 4,000-capacity outdoor arena designed for live music and entertainment.

David Harland, Chief Executive of Eden Project International Limited, said: "This is an important milestone for Eden Project North. Having a positive impact on the internationally significant environment of Morecambe Bay is fundamental to our vision for this project. This report is the next step towards making Eden Project North a reality.

"We have been overwhelmed by the support we have had from the local community and we look forward to working closely with everyone in the coming months and years as Eden Project North takes shape."

The project is due to open in spring 2023, following a two-year construction period.

NEWS IN BRIEF

The Steel Piling Group has recently updated its popular guide, Durability of Steel Piles (P422). The guide, published by the Steel Construction Institute provides an in-depth guide to corrosion performance of steel piling in various environments. It can be downloaded at: *www.steelpilinggroup.org*

Viridor has announced plans to build a ground-breaking £65M plastics recycling plant at Avonmouth. The facility, which will process pots, tubs and trays, will be powered by energy generated on site, creating a true circular economy energy park.

Severfield has reported a 5% rise in underlying operating profit before tax to £24.7M for the year ending 31 March 2019, compared to £23.5M for the previous 12 months. Revenue also increased for the year to £274.9M against £274.2M in 2018.

Celtic Football Club has applied for planning permission to redevelop its training centre in the East End of Glasgow. The work at the Barrowfield site, located near to Celtic Park, would see the club unveil new training facilities, including one of the largest indoor football arenas in Scotland, featuring a FIFA approved top-of-the-range full-sized artificial surface.

St. Modwen and **Winvic Construction** have started work on the first phase of an 83,500m^2 industrial and logistics park. Known as St. Modwen Park Gloucester, it is adjacent to junction 12 of the M5 motorway and the first phase consists of three units totalling 16,100m^2.

PRESIDENT'S COLUMN

One of the 'problems' with technology today is that we all get bombarded with information, which we either delete or file away to look at later. And then we forget about it. Even as BCSA's President, I sometimes have trouble keeping track of all the useful publications that BCSA has produced. So I thought that this month, I would provide you with a summary of some of the really useful documents that BCSA has produced for the industry recently.

Cost is a fundamental consideration in the selection of structural frame material. As we all know, this selection should be based on project specific costings, but the challenge for cost consultants is to reconcile fluctuations in material prices against tender price data. The **Costing Steelwork** articles, published quarterly in *Building* magazine, outline a number of key cost drivers that should be considered in order to make steel frame rates project specific, and provide guidance on current cost ranges for different building types and locations.

https://www.steelconstruction.info/Cost_of_structural_steelwork

The *New Steel Construction* **Technical Digest 2018** brings together all of the Advisory Desk Notes and Technical Articles from the steel construction sector published in NSC magazine last year. Advisory Desk Notes are essential reading for all involved in the design of constructional steelwork as they reflect recent developments in technical standards or new knowledge that designers need to be made aware of. The longer Technical Articles offer more detailed insights into what designers need to know.

https://www.steelconstruction.info/images/5/5a/NSC_Technical_Digest_2018.pdf

Typical Welding Procedure Specifications for Structural Steelwork outlines the most common weld joint types, in material grades up to and including BS EN 10025 – S460N, and details the route to qualifying them in accordance with the current European Standard. The book contains 20 preliminary Welding Procedure Specifications and 49 partially completed Welding Procedure Specifications.

https://www.steelconstruction.org/shop/typical-welding-procedure-specifications-for-structural-steelwork-second-edition/

We all agree that commercial teams should be properly educated about construction law. A great place to start is BCSA's recently updated **Construction Contractual Handbook (5th edition)**. This comprehensive Handbook aimed at sub-contractors covers all the important aspects of construction law in a compact and accessible way.

https://www.cip-books.com/product/construction-contractual-handbook-5th-edition

Of course, BCSA also produces member only guidance on a wide range of issues on an almost daily basis, to guide its members on commercial, technical, health & safety, training and business issues. These are an important part of membership and ensure that BCSA member companies are aware of new regulations, understand what best practice looks like, and have the knowledge to put it all into practice.

Tim Outteridge
BCSA President and Jamestown Manufacturing

Engineers streamline HS2 station roof design

Lead engineers on HS2's Old Oak Common station, WSP, have revealed a 27% reduction in the structural steel needed for the station roof at the west London super-hub.

Having undertaken a value engineering exercise on the station designs in partnership with architects WilkinsonEyre and SME Expedition Engineering, it was concluded that structural thicknesses and profiles in the roof could be modified to allow for less material.

The team said a total steel reduction of over 1,000t is possible, which represents a significant reduction in embodied carbon and a cost saving of £7M.

WSP Project Director Adrian Tooth said: "Taking the benefits from wind tunnel testing and snow modelling, we have been able to make small incremental changes and reductions in material thicknesses of the roof resulting in a significant saving in the cost of the station."

HS2 Programme Director Matthew Botelle said: "By challenging the standard design approach, the team have realised savings in the roof steelwork tonnage that has significantly reduced cost, construction complexity and embodied carbon.

"This work is a great example of how the latest design thinking and techniques are being used on the HS2 programme to provide best value to the UK taxpayer."

The roof at Old Oak Common comprises a series of tapered vaults with glazed rooflights to provide ventilation and daylight for the station.

Spanning up to 65m, the vaults are formed from fabricated steel box section arches and are supported on box section primary beams founded on tapered steel columns.

Fabricated using weathering steel, the visible parts of the roof steelwork will be painted for aesthetic reasons.

Ground broken on Milton Keynes engine design centre

A ground-breaking ceremony has heralded the start of construction for automotive manufacturer Integral Powertrain's new and purpose-built steel-framed technical centre.

The 4,360m[2] building is expected to be completed by early 2020, and will require 200t of structural steelwork, which will be fabricated, supplied and erected by H Young Structures.

The technical centre is being created to meet the company's e-Drive business growth following its success in developing electric motors and inverters for firms such as McLaren, Aston Martin and Triumph Motorcycles.

Integral Powertrain Director John McLean said: "The new centre represents a major milestone for Integral Powertrain. The new site is more than three times the floor area compared to the existing engineering centre, and will be used to house our growing teams, provide new conference areas, much greater stores and build capacity, a larger e-Drive test centre, new materials and R&D facilities and larger machining / fabrication areas.

As well as providing an excellent environment for staff and clients alike, it will allow most of our engineering and support teams to be located on one site, bringing efficiency that will enable us to develop innovative products to meet growing customer demand in the e-Drive sector."

Frame erection begins on £500M south coast power station

Working on behalf of Morgan Sindall, Elland Steel Structures has begun the erection of 1,250t of structural steelwork for the IFA (Interconnexion France Angleterre) number 2, at Lee-on-the-Solent in Hampshire.

Including five steel-framed buildings, the IFA2 will help the National Grid obtain a second link across the English Channel to France in order to share energy supplies.

The link is formed by subsea cables that run for more than 100 miles between the two countries and connect to a converter station (IFA) at either end.

Once operational, the IFA2 will be capable of exchanging 1,000MW of power between the UK and France, enough to run approximately 1,000 homes.

Steel complete for Wolverhampton station phase one

The steel frame for phase one of Wolverhampton's new railway station building has been completed.

Working on behalf of Galliford Try, Adstone Construction fabricated, supplied and erected the steelwork.

This first phase of the new station building is expected to become operational to customers later this year, when phase 2 of the programme – bringing down the remainder of the current station building and completing the new build – will also start.

The new state-of-the-art railway station building will be fully open in summer 2020.

Councillor John Reynolds, Cabinet Member for City Economy, said: "The steel framework of the new railway station building is already sitting proudly on the city's skyline and these are exciting times for regeneration in the City of Wolverhampton.

"There is more than £3.7 billion of investment on site or in the pipeline across the city, and the railway station development is a big part of how we are re-imagining and re-inventing our city centre.

Somerset contractor expands production facility

Taunton Fabrications said in order to meet an increasing demand for its products and services, it is building an additional 700m² steel-framed factory space at the firm's Galmington premises in Somerset.

The new building will primarily house the company's finishing and offsite pre-build activities, but will also be used as an overflow facility for welding and fabrication.

Requiring around 30t of structural steelwork, the entire project, including design, civils, manufacture, erection and fit-out is being managed completely in-house.

The building will include two 5t-capacity overhead cranes, a new paint spraying system, roof-mounted solar panels and electric charging points.

Taunton Fabrications Managing Director Jason Rigby said: "The new facility will greatly increase our efficiencies, and our plan is to have our new pre-build assembly and despatch area operational by September - ready to begin painting and assembling balconies and staircases for two large contracts we have in Bristol and Cardiff."

Diary

For SCI events contact Jane Burrell, tel: 01344 636500 email: *education@steel-sci.com* web: *https://portal.steel-sci.com/trainingcalendar.html*

Tuesday 10 September 2019
Joints between hollow sections
This webinar will be based on a typical truss, demonstrate the calculation of joint resistance in accordance with BS EN 1993-1-8 and show how alternative choices may be made so that expensive reinforcement is avoided.
Webinar

Wednesday 18 September 2019
Steel Frame stability
Frame stability concerns the significance of second-order effects and is highlighted as an essential check for all frames in BS 5950 and EC3.
Bristol

Thursday 7 November 2019
UK Steel Construction Day 2019: Innovative Steel Solutions
At this event we will look at a range of different solutions that address the multiple needs to build with improved speed, quality, safety, predictability, and using less materials. Some of these solutions are already being applied, others are for the future. London

SSDA Shortlist 2019

A total of 20 diverse projects from around the UK that highlight steelwork's numerous attributes have made it onto the shortlist for the 2019 Structural Steel Design Awards, which are jointly sponsored by the British Constructional Steelwork Association and Trimble Solutions (UK) Ltd.

160 Old Street, London

Architect: Orms
Structural engineer: Heyne Tillett Steel
Steelwork contractor: Bourne Steel Ltd
Main contractor: Wates Construction
Client: Great Portland Estates plc

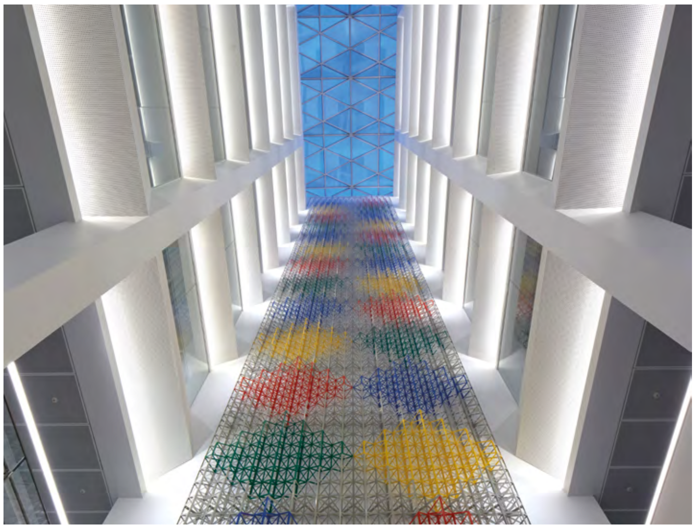


Photo © Edmund Sumner

Aga Khan Centre, London

Architects: Maki & Associates and Allies and Morrison
Structural engineer: Expedition Engineering
Steelwork contractor: Severfield
Main contractor: BAM Construct UK Ltd
Clients: AKDN and Argent

Battersea Arts Centre

Architect: Haworth Tompkins
Structural engineer: Heyne Tillett Steel
Main contractor: 8Build Limited
Client: Battersea Arts Centre

Photo © Jill Tate

Chiswick Park Footbridge

Architect: Useful Studio
Structural engineer: Expedition Engineering
Steelwork contractor: Severfield
Main contractor: Lendlease
Client: Blackstone

Photo © Hufton+Crow

Coal Drops Yard, London

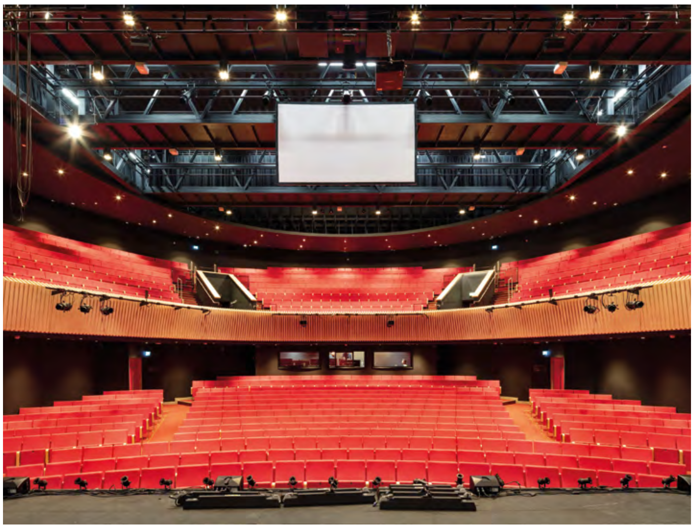
Architect: Heatherwick Studio
Structural engineer: Arup
Steelwork contractor: Severfield
Main contractor: BAM Construction
Client: King's Cross Central Limited Partnership

Ely Southern Bypass

Architect: Knight Architects
Structural engineer: Tony Gee & Partners
Steelwork contractor: Severfield
Main contractor: VolkerFitzpatrick Ltd
Client: Cambridgeshire County Council

Fenchurch Court, London

Architect: Eric Parry Architects
Structural engineer: Arup
Steelwork contractor: William Hare
Main contractor: Sir Robert McAlpine
Client: Generali Saxon Land



G W Annenberg Performing Arts Centre

Architect: Studio Seilern Architects
Structural engineer: PBA now part of Stantec
Steelwork contractor:
Advanced Fabrications Poyle Ltd
Main contractor: Beard Construction
Client : Wellington College

Photo © Vicky Mathers

Greatham Creek Seal Hide, Middlesbrough

Architect: Abstract Machine (Leeds Beckett University)
Structural engineer: BMMJV (BAM Nuttall/Mott MacDonald JV)
Steelwork contractor: S H Structures Ltd
Main contractor: BMMJV (BAM Nuttall/Mott MacDonald JV)
Client: Environment Agency

Photo © Arup

Ingenuity House, Birmingham

Architect: Sheppard Robson
Structural engineer: Arup
Steelwork contractor: Billington Structures Ltd
Main contractor: Interserve Construction Ltd
Client: Interserve Construction Ltd

Kettner's Townhouse & Soho House Greek Street

Architect: Studio of Design & Architecture (SODA)
Structural engineer: EngineersHRW
Main contractor: In House Design & Build Ltd
Client: Soho Estates Ltd

Photo © Jonathan Cole

Neuron Pod, London

Architect: aLL Design
Structural engineer: AKT II
Main contractor: Total Construction
Client: Queen Mary University

Project Mint at the 02

Architect: CallisonRTKL
Structural engineer: BuroHappold Engineering
Steelwork contractor: Bourne Steel Ltd
Main contractor: ISG
Client: AEG and Crosstree

Photo © Simon Winson

River Thames Footbridge, Taplow

Architect: Knight Architects
Structural engineer: COWI
Steelwork contractor: S H Structures Ltd
Main contractor: Land & Water
Client: Berkeley Group

Royal Academy of Music, London

Architect: Ian Ritchie Architects
Structural engineer: WSP
Main contractor: Geoffrey Osborne Ltd
Client: Royal Academy of Music

Telford Central Footbridges

Architect: Nicoll Russell Studios
Structural engineer: Jacobs
Steelwork contractor: S H Structures Ltd
Main contractor: Balfour Beatty
Client: Telford & Wrekin Council

The Macallan Distillery

Architect: Rogers Stirk Harbour + Partners
Structural engineer: Arup
Steelwork contractor: S H Structures Ltd
Main contractor: Robertson Construction
Client: The Macallan

Tombola HQ, Sunderland

Architect: Ryder Architecture
Structural engineer: s h e d
Main contractor: Brims Construction Ltd
Client: Tombola

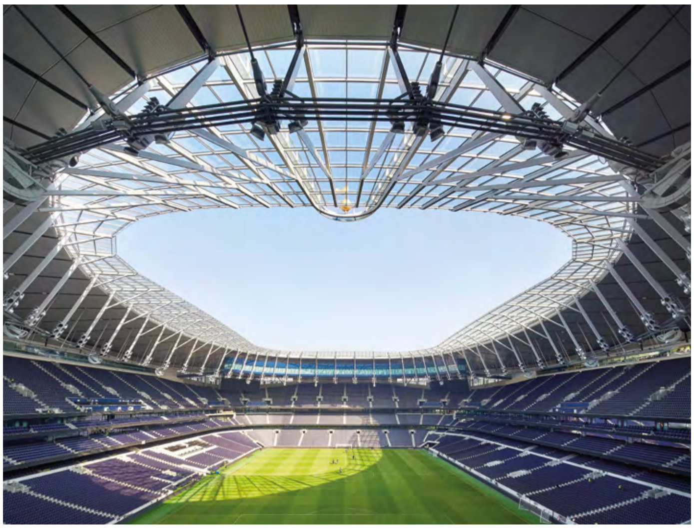


Photo © Hufton+Crow

Tottenham Hotspur Football Club, New Stadium

Architect: Populous
Structural engineers: BuroHappold Engineering, schlaich bergermann partner
Steelwork contractor: Severfield
Main contractor: Mace
Client: Tottenham Hotspur Football Club

Photo © AELTC/Simon Bruty

Wimbledon No.1 Court

Architect: KSS
Structural engineer: Thornton Tomasetti Ltd
Steelwork contractor: Severfield
Main contractor: Sir Robert McAlpine
Client: The All England Lawn Tennis Club

Steel at home

Residential schemes are helping to transform Liverpool's Baltic Triangle

A residential scheme in Liverpool's creative and digital quarter is using a steel framing solution due to the material's spanning qualities and ability to create complex details. Martin Cooper reports.

FACT FILE
Blundell Street residential scheme, Liverpool
Main client: Brickland
Architect: Tim Groom Architects
Main contractor: ISG
Structural engineer: Clancy Consulting
Steelwork contractor: Walter Watson
Steel tonnage: 1,200t

Liverpool has become something of a byword for regeneration in the UK as a myriad of projects have either been completed or are currently transforming the port city into a viable and important economic centre.

One area that has been a focus for redevelopment is the Baltic Triangle, which occupies a pivotal location just south of the city centre and is positioned between a number of Liverpool's other strategic regeneration investments.

Historically, the area was used to handle goods being transported via the docks as well as being a thriving industrial area. By the 1970s, with much of the port in decline, many of its former warehouses had become derelict, with some of them being demolished and replaced with small scale industrial units.

Steel was chosen for its spanning qualities

Since 2012, more than £128M has been invested in new developments within the Baltic Triangle, with a further £62M currently on site.

Consequently, the area has been transformed and now accommodates an eclectic mix of indigenous businesses such as car repair workshops, mechanics, welders and tradespeople. These sit alongside the newer creative businesses such as digital media agencies, PR companies, architects, designers and musicians which have arrived over the last decade.

Major residential regeneration investments are also now emerging due to the area's high profile location, distinctive rich heritage and historic character.

One of these residential schemes is currently being constructed by ISG and consists of a nine-storey, 200-unit apartment block with a project value of £24M.

Located on Blundell Street, the steel-framed structure also includes two levels of basement car parking, with the uppermost of these floors also accommodating an entrance lobby, resident's lounge and gym.

The project's plot was previously used as a surface car park and when ISG started work on site last year minimal groundworks were required before the steel erection began.

"Typical for a Liverpool site, there is sandstone directly below the surface, which has excellent load bearing qualities. This meant we only needed to install a series of 1,200mm-deep pad foundations," explains ISG Project Manager Ross Sangster.

ISG has recently completed a similar scheme near Liverpool's Lime Street station and a number of lessons learnt on that job have been used on this scheme.

The most important of these lessons was the off-setting of the steel frame from the site boundary, which avoided complex temporary works and prevented intrusive works on the highways.

Favourable ground conditions along the site boundaries allowed the project team to utilise the rock and existing brick retaining walls to keep the excavations for the basement car park open and allow for the placement of bases and the steel frame.

As Clancy Consulting Engineer Callum Sale explains: "This meant none of the existing walls needed to be demolished, which saved valuable time on programme.

"Temporary propping was further limited by utilising the steel frame to provide fixing

The outer tips are slightly lower at seven-storeys high

Visualisation of the completed scheme

points to temporary perimeter props, which assisted in restraining an existing retaining wall as well as providing the contractor with valuable working space.”

The residential block is U-shaped on plan, with the open end facing northwards. The opening leads directly to a landscaped courtyard, which is supported – along with residences – by the ground floor podium deck.

The majority of the structure reaches the maximum nine-storeys, apart from two seven-storey sections at the two outer tips.

Using a column grid of 8.9m × 7.5m for the entire car park and residential zones, the structural design uses shallow floor-to-floor depths in conjunction with long span beams, and uses UC sections around the perimeter, as opposed to traditional UBs.

There is network of dropped (lower) slabs for balconies and roof terraces within a very tight structural zone. This results in a complex arrangement of secondary steelwork that required a high level of coordination between the designers and steelwork contractor Walter Watson.

“A steel framing solution was considered as the most appropriate option given the size of spans between columns and in terms of achieving the complex perimeter details, particularly to inset balconies due to the material’s flexibility,” says Mr Sale.

“Steel is also quicker, needs less lead-in time and requires fewer deliveries, which means less impact on our neighbours,” adds Mr Sangster.

Stability for the steel frame is provided by a combination of traditional flat bar cross bracing in the lower floors and moment frames for the two upper levels.

This hybrid design was chosen in order to assist ISG in ensuring that materials needed by the follow-on trades could be easily transported within the upper floors, while maintaining full stability to the structure during the construction stage.

By avoiding moment frames on the lower levels, column sizes were slightly reduced which kept the steelwork tonnage as small as possible.

In keeping with the street’s former industrial heritage, the completed structure will be brick clad to match the nearby surviving warehouses. The project is due to complete in summer 2020.

Manchester residences

ISG is also constructing another residential scheme for Brickland in the Cornbrook area of Manchester.

This £48M, 363-apartment scheme consists of two residential towers reaching heights of 16-storeys and 19-storeys.

It comprises one and two-bedroom units, as well as duplex and townhouse apartments.

Designed to foster strong community bonds, the development includes a co-working space, library, gym, two rooftop gardens and a resident’s lounge.

Steelwork contractor Walter Watson is fabricating, supplying and erecting 1,700t of steelwork for this project.

Retail mall goes undercover

Glazing installation proceeds on the steel-framed roof

A £75M transformation of intu Trafford Centre's Barton Square is in full swing, as a new glazed roof and dome now span the previously open mall. Martin Cooper reports.

FACT FILE
Intu Trafford Centre's Barton Square redevelopment, Manchester
Client: intu
Client architect: Leach Rhodes Walker
Design & build architect: Corstophine + Wright
Main contractor: Vinci Construction
Client structural engineer: Mott MacDonald
Design & build structural engineer: Cameron Darroch Associates
Steelwork contractor: S H Structures
Steel tonnage: 1,350t

You can view drone footage of the Barton Square scheme at http://www.newsteelconstruction.com/wp/barton-square-video

Said to be the UK's third largest retail and leisure centre, the intu Trafford Centre in Greater Manchester is currently redeveloping its Barton Square mall.

Built at a cost of £90M, Barton Square opened in 2008 (10 years after the main centre) as an annexe for furniture and homeware stores and it is connected to the main Trafford Centre via a glazed footbridge.

Originally, the steel-framed Barton Square (erected by William Hare) was conceived as four separate retail blocks, separated by open air malls and a large central courtyard. The redevelopment will see the malls spanned by steel-framed glazed roofs, while an impressive 36m-diameter steel and glass dome will cover the central courtyard.

As well as the roofs and dome, the project will also allow the upper level of Barton Square to be used for further retail and leisure uses, with new lifts, escalators and walkways providing links.

"The two-storey blocks were future-proofed in anticipation of mezzanine levels being added as there are 8m-high floor-to-ceiling heights throughout and much of the ground floor already has mezzanine floors," explains Vinci Construction Project Manager Jonathan Roberts.

"There is also provision in the structure's steel-frame and the foundations for the additional vertical loads resulting from the roof structures and dome."

Made up of 1,354 individual steel pieces, the dome is the centrepiece of the scheme and has been formed with plate girder rafters, 200mm × 200mm SHS purlins and 80mm x 80mm SHS glazing bars.

The dome structure was erected in small sections to due to the complex nature of its shape. The erection process utilised a temporary steel prop to hold the steel sections in place during the assembly. Only when all of the dome's sections were fully connected, could the prop be removed and the glazing programme begin.

As well as plate girders, a series of bifurcated RHS main ribs form the dome and support SHS ring purlins, RHS eave ties and a top ring.

"The utilisation of a bifurcated detail for the main ribs allowed the radius of the top ring to be minimised and also meant that the main ribs could be lifted in pairs, which was beneficial in terms of the erection programme," says Cameron Darroch Associates Director Neil Darroch.

A temporary prop supports the dome during steel erection

Two large barrell-vaulted roofs span the main malls

Supporting the dome are a series of rigid joint box frames extending up from the existing foundations, which also support a first-floor curved walkway and a further curved roof deck.

The two main central malls, either side of the dome, are spanned by identical barrel vault roof structures formed by 36m-long curved steel rafters supporting SHS purlins. Each of the two roofs required four rafters.

Fabricated and delivered to site in halves, each half span is formed from a pair of parallel plate girders battened together with top flange bracing and detailed with a bolted apex detail.

"The central section of the plate girders were designed as Vierendeel trusses to achieve the cellular appearance demanded by the architectural concept," says Mr Darroch.

To resist the large horizontal base reactions from each of the arches, tied thrust girders have been incorporated into the design and are supported off stub columns extending up from the existing steel structure.

More than 80 stubs were installed, with each one requiring a break-out hole that was drilled through the concrete flooring in order to locate the existing steel frame. All of this work was carried out during night time shifts to minimise the impact on shoppers and the mall, which has remained open throughout the works.

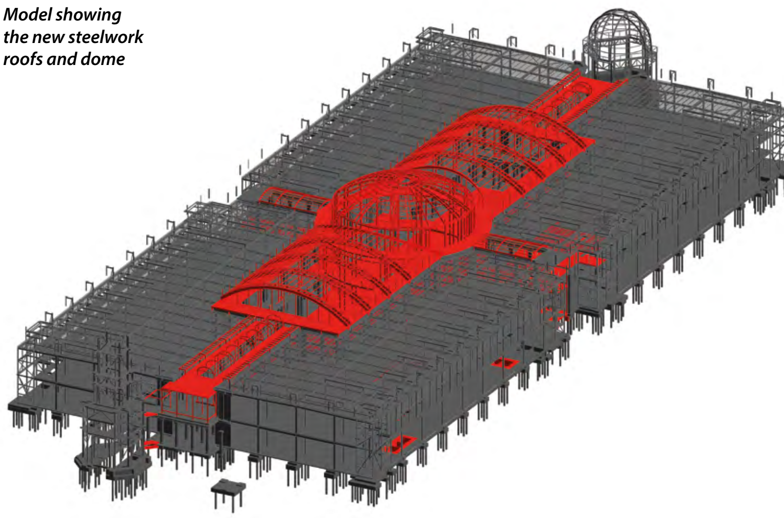
A series of proprietary sliding bearing plates have been installed to avoid any significant lateral loads being transferred from the roofs into the existing structure.

Four further smaller barrel vault roofs have also been installed as part of the overall scheme. Two 10m-wide × 20m-long roofs continue beyond the main roof structures, spanning narrower areas between the retail blocks and terminating at two entrances to Barton Square.

Either side of the central courtyard, two shorter, but slightly wider roof structures will span the cross-malls of the Centre.

Summing up, both Vinci and Cameron Darroch Associates both stress that steelwork was the only viable option for the works as it ensured the architectural vision was achieved, while also minimised the additional loads transferred to the existing foundations.

The project is due to be completed by early 2020 with Primark having been secured as the anchor tenant, trading alongside existing retailers such as Next Home, Silentnight, Homesense and the Legoland Discovery Centre and Sea Life attractions.



Model showing the new steelwork roofs and dome

Image: Mott MacDonald

Working at night and keeping sea creatures happy

Keeping the majority of Barton Square open during the construction programme has been a key challenge for the project team and consequently much of the work is being undertaken outside trading hours.

All of the structural steelwork erection has been carried out overnight by S H Structures, using cranes positioned in the central courtyard.

An extensive clean-up operation is conducted every morning and the cranes, along with other items of equipment, are positioned behind hoardings during the day to create clear circulation routes for shoppers.

"The logistics of this project have been a real challenge," says S H Structures Project Manager Chris Richardson.

"When we originally phased the installation of the project we planned on using standard trailers to deliver into site during a day shift. We very quickly realised as we got closer to our start date that site restrictions and planned erection all meant that we would have to switch to non-standard rear steer trailers and deliver and erect at night.

"This required additional resources so we could reduce loading plans per tonne but increase frequency of deliveries into an already busy area, even at night. Each erection phase had to be changed in design to accommodate what could be delivered into site and when."

As well as retail units, Barton Square also accommodates a Legoland Discovery Centre and the Manchester Sea Life Centre.

Home to thousands of marine creatures, the latter was identified as a key project challenge before the scheme began.

Vinci engaged with the attraction to identify which creatures were most susceptible to noise and vibration. The sharks and rays were considered to be the most sensitive and their tanks are monitored on a 24/7 basis, to ensure no work activities are having any adverse effects on them.

Fringe development

Located on the edge of the City of London, a 21-storey commercial building represents Phase 2 of a prestigious Aldgate redevelopment scheme.

FACT FILE
One Braham, London
Main client:
Aldgate Developments
Architect:
WilkinsonEyre
Main contractor:
McLaughlin & Harvey
Structural engineer:
Arup
Steelwork contractor:
Severfield
Steel tonnage: 3,700t

Shallow plate girders have been used throughout the building

Nestled just beyond the eastern boundary of the City of London, Aldgate has become a very desirable area for commercial and residential schemes alike.

A number of large developments have sprung up in recent times, choosing the area because of its proximity to the square mile and London's other financial district of Canary Wharf as well as its good and varied transportation links.

One of these schemes is located above Aldgate East underground station, where work is currently underway on Phase 2 of Aldgate Developments' masterplan.

This second phase consists of One Braham, (Phase 1 consisted of the adjacent Aldgate Tower, see *NSC* January/February 2014) a 21-storey office block offering 30,475m² of floor space.

Sat on a plot formerly occupied by Beagle House, main contractor McLaughlin & Harvey (McL&H) started onsite in August 2018 on what is its largest London project to date. The company inherited a cleared site, as the demolition had been completed by another contractor, along with the installation of the two-level deep concrete basement.

"As much of the preliminary works had been done, our first task was to complete the basement structure to ground floor level and construct the concrete core, in preparation for the steelwork erection to begin," explains McL&H Site Manager Darren Donnelly.

The steel frame begins at ground floor level and is based around a grid that has primary columns spaced at 9m centres with internal spans of up to 13.7m.

According to Arup Project Engineer Catriona Gillies, the building has a very constrained structural depth, resulting from planning restrictions that aim to preserve some key landmark views that would otherwise be obscured by One Braham.

Keeping within a permitted height, the design has used fabricated plate girders to support the metal deck flooring system. These girders have bespoke holes to allow all of the services to be accommodated within their depth.

"By using shallow heavy plate girders we've been able to incorporate one extra floor level into the planning envelope," says Ms Gillies.

Overall, the scheme adopts a contemporary office feel with exposed soffits throughout. Much of the completed steel frame will also be left exposed and so a lot of care has been taken to the connection details.

"The building is our second office building for the same client in the same locality. The client's brief requested a much more 'industrial feel' to the building following their experience letting Aldgate Tower

"By using shallow heavy plate girders we've been able to incorporate one extra floor level into the planning envelope."

Steel supports metal decking to form the composite floors

where many of the tenants have chosen to remove the suspended ceiling and expose the structure," explains WilkinsonEyre Director Oliver Tyler.

"This has led to an architectural approach, whereby the structural steel frame and steel decking forming the floors has been exposed. This has resulted in much closer attention being paid to steel connections and the detailing and setting out of services and their penetrations through the beams."

The design team say that greater care than normal has been paid to the detail and location of column splice joints, beam-to-column connections and the detail of steel suspension hangers.

"Great care has also been taken in working with McL&H and Severfield to specify the black paint finish, taking into account the exposed nature of the steel within the finished building," adds Mr Tyler.

For stability, the building features one concrete core, which is offset and positioned along the southern elevation. This not only maximises the available floor space on each level, but also creates an 'active' front to the building, as the core contains a scenic lift and staircase, which will be visible through the glazed cladding.

"The position of the core is also about the massing of the structure as it is located in the portion of the building that reaches the maximum height," explains Ms Gillies.

On plan, the rectangular structure is ▶20

A cantilevering walkway overlooks the entrance and is suspended via hangers

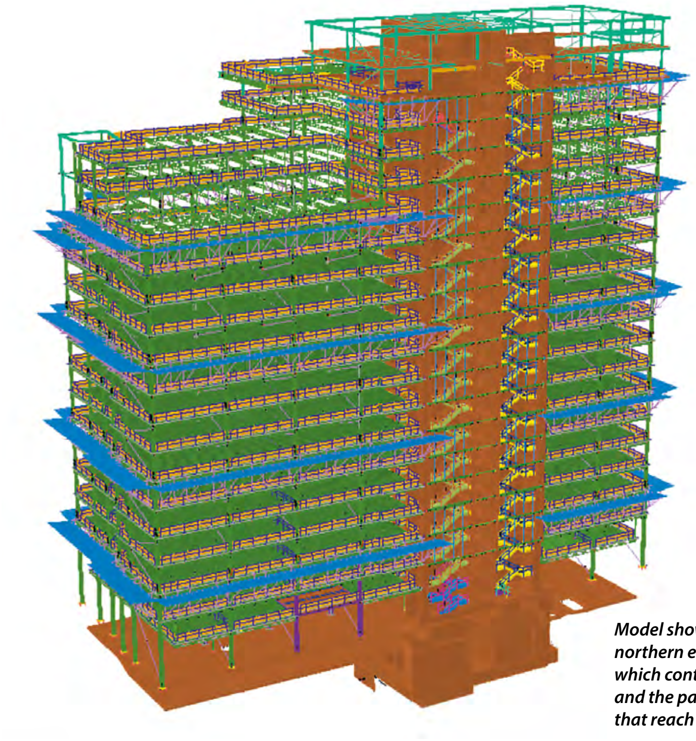
One Braham sits to the south of a new public realm

▶19 divided into four blocks with two portions on the northern elevation topping out at levels 15 and 17 respectively. Meanwhile, on the southern façade, there is a further rooftop step as one portion accommodates a two-level plant deck.

To help create the 15th floor step in the building, two large transfer girders with depths of 590mm and each weighing 11.5t have been installed to support the set-back columns above. In order to accommodate the girders into the overall shallow floor design, the beam's top flanges are exposed to the structural slab level with no concrete topping.

The step at floor 17 is close to primary columns so the floor edge is cantilevered and does not require transfer beams. The uppermost step at roof level supports two plant decks, which is off the main column line. A transfer beam is included here as there is greater structural depth available.

Adding some more interest into the building's design, One Braham also features a three-storey atrium/viewing gallery located on level 14's north western corner, offering views to the City.



Model showing the northern elevation, which contains the core and the parts of the block that reach full height

Meanwhile, the ground floor is a double-height space, accommodating the entrance lobby. The first floor, which is set back to create this large space, accommodates a cantilevering walkway overlooking the entrance. Large portions of the floor are suspended from the underside of the second floor via a series of Macalloy hangers and steel plate hangars to form recessed low level façades.

One Braham is due to complete in May 2020.

Plate girders

Richard Henderson of the SCI discusses some of the design issues

Riveted plate girders dating from Victorian times in use for long span railway bridges can still be seen. Flanges are laminated from plates and riveted angles connect flanges to webs and webs to stiffeners. Material was expensive and many such structures clearly show the distribution of internal forces.

Plate girders continue to be used for long spans and high loads (such as transfer beams in buildings) and also for elements required to meet particular geometric constraints that mean rolled sections are not suitable. Material cost is relatively less significant now and plates are more often of uniform thickness. For design, the relevant part of Eurocode 3 is part 1-5 Plated structural elements.

The possible combinations of plate size and thickness mean that phenomena not usually encountered with rolled sections may need to be considered. Wide flanges result in shear lag – where the shear flexibility of the flange outstands leads to corresponding non-uniform axial stresses across the flange. This behaviour is more relevant to box girders (eg in bridges) than in I section girders. Slender flange outstands may also lead to local buckling of the flange edges and require a design based on effective area, although use of material in such a design may not be considered efficient.

Designers of plate girders not susceptible to fatigue could use P419[1] when considering the thickness and toughness requirements of flanges. A "hybrid" approach is possible with high strength steel for flanges and a lower strength steel for the web[2]. Plate girders with a web depth selected to reduce flanges to manageable sizes may mean the section classification is 4 (slender) and the webs are susceptible to shear buckling.

Selecting webs thick enough to avoid this may not be an efficient use of material and stiffeners have to be provided. Thin webs may also mean that bearing stiffeners are required to transfer local point loads into the girder web. Plate girders with stiffened webs may therefore be an effective choice[3]. Tension field behaviour where the webs act like diagonal tension members and the stiffeners the verticals in a Pratt truss may result and require the corresponding design approach.

In buildings, deep girders designed as pin ended will require careful consideration of the end connections. Finally, in addition to sizing the plates, the web to flange welds and welds to stiffeners are the designer's responsibility.

1. Brown D G, Cosgrove T C, Brittle Fracture: Selection of steel sub-grade to BS EN 1993-1-10, SCI publication P419, 2017
2. Brown D G, The design of hybrid fabricated girders, NSC, June 2017
3. Brown D G, The design of hybrid fabricated girders – part 2, NSC, July/Aug, 2017

The steel-framed office takes shape around its centrally-positioned core

FACT FILE
The Stage, Shoreditch, London
Main client:
The Stage Shoreditch Development
Architect:
Perkins + Will
Main contractor:
CJ O'Shea and Company
Structural engineer:
Walsh Associates
Steelwork contractor:
SDM Fabrication
Steel tonnage: 1,267t

Steel takes to the stage

A steel-framed commercial building forms one of the main elements of £750M mixed-use development in Shoreditch that also includes the remains of a Shakespearian playhouse. Martin Cooper reports.

'All the world's a stage' wrote William Shakespeare and whether one agrees with this or not, one area of Shoreditch is now very much a stage.

Located in an area that is not immediately associated with dramatics – being a few miles east of the capital's main theatre-land in the West End – The Stage development in Shoreditch is named in honour and shares a site with the remains of the Curtain Theatre (see box).

During its heyday, the Curtain is said to have been the venue where Shakespeare's Henry V debuted, and as a nod to the playwright, one of the scheme's commercial blocks (Building 3) has been named The Bard.

This is one of two office blocks within The Stage development, the other being a smaller concrete-framed structure named The Hewett.

Situated between these two buildings is the main archaeological plot where a museum is going to be built to display artefacts found on the site. The Stage's other structures include a 37-storey residential block, restaurants and an art gallery housed within a former railway viaduct.

The Bard is a 12-storey steel-framed block, which will provide 12,700m² of contemporary offices along with large west-facing terraces.

Working on behalf of main contractor CJ O'Shea, SDM Fabrication is fabricating and erecting just over 1,200t of structural steelwork for the project.

"Logistics is the biggest challenge on the

Underground obstructions meant that two columns had to be designed as raking members

project, as we have a number of buildings under construction at once and just one entrance serving the site," says CJ O'Shea Project Director Fintan Hallihan.

"The advantage of using steelwork for The Bard is that all material is delivered on a just-in-time basis as there is no room for storage."

The building has a composite design, with steel beams supporting metal deck flooring and a concrete topping. Composite Profiles is supplying 15,000m² of Tata Steel's ComFlor 51 for the project along with 45,000 shear studs.

Measuring approximately 45m-long x 31.5m-wide, the building is based around a centrally-positioned concrete core, which provides the steel frame with its stability. Radiating out from the core on a 9m × 9m column grid pattern, the majority of the frame's beams are bespoke Westok plate girders.

The girders are 9m-long x 500mm-deep with a variety of flange thicknesses and weigh 1t each. They all have an array of apertures to integrate the building's services within their depth.

"Bespoke plate girders were chosen as an efficient method for spanning the internal areas," says Walsh Associates Director Peyrouz Modarres. "Although more fabrication is required, the girders gave the project a saving on the overall steel tonnage."

Sat on top of a two-level basement, the steel frame begins at ground floor podium level. This lowest level is a double-height space accommodating car parking and areas that could be used as retail units.

The main entrance foyer is a double height area, with the first-floor set-back to form the higher space. Two raking columns are positioned either side of the entrance, supporting the underside of the second floor.

"There are two utility obstructions below the entrance and columns could not be located in their intended design locations," explains SDM Fabrication Director Richard Melton. "Steelwork's flexibility allowed us to install two raking members, which had to be temporarily propped until the frame was sufficiently stable."

From floor two up to floor eight, the floorplates offer 1,170m² of office space, but above this the building steps in to form two terraces at levels nine and 11. This means the floorplates decrease, with uppermost two floors offering 911m² and 607m² respectively.

Creating the terraces has required the installation of two box section transfer structures each weighing 14.6t, at level nine and 11, to support the reconfigured column grid pattern.

"In order to maintain the same floor-to-ceiling heights throughout the building, the deeper transfer beams are installed within the depth of the concrete slab," explains Mr Modarres.

A further transfer structure has been installed along the second floor's eastern elevation. The beam forms an overhang, which is necessitated by the proximity of an existing electricity sub-station.

The Stage development is scheduled for completion in November 2021.

History unearthed and preserved

Archaeological discoveries on central London construction sites are not uncommon, but finding a long-lost Elizabethan playhouse where Shakespeare's Romeo & Juliet and Henry V were first performed is a one-off occurrence.

Known as the Curtain Theatre, the playhouse was built in 1577 just outside of the City of London in Shoreditch. It was one of the capital's premier theatres and William Shakespeare is even said to have trod the boards there himself.

History is a little sketchy on its fate, but it is believed that it closed down in the 1620s and was converted into tenements before being demolished and its exact location forgotten.

Jump forward to 2011 and preliminary works for this project unearthed remnants of a stage, the playhouse's walls and foundations along with numerous Elizabethan artefacts.

Preserving this slice of theatrical history is going to form an important element of the Stage development. The Curtain Theatre finds are being preserved and will be put on public display within a museum structure (likely to be steel-framed) which will sit next to the Bard building in the project's central plaza.

How the completed Bard building will look

Steelwork supporting precast planks was chosen as the most economic solution

Steel gives lessons in design

Steel construction's speed and ease of delivery has proven to be of upmost importance to the project team building a new academy in Kent.

FACT FILE
School of Science & Technology Maidstone, Kent
Main client: Department of Education
Architect: KSS
Main contractor: BAM Construction
Structural engineer: Kirksaunders Associates
Steelwork contractor: Elland Steel Structures
Steel tonnage: 570t

Educational opportunities in Kent are about to get a significant boost as a secondary school, offering what is said to be a unique learning curriculum, is under construction.

Due to open its doors to students in the Autumn of 2020, the School of Science & Technology Maidstone is being developed by the Valley Invicta Academies Trust (VIAT) with the support of its strategic partner, SST Singapore.

According to the Trust, students will benefit from an education specialising in science and technology in purpose-built, state-of-the-art buildings, which will allow graduates to leave with a highly desirable combination of outstanding exam results and a unique skill set.

The new school is being built on a greenfield site on the VIAT campus in Maidstone, which already includes two secondary schools.

Starting on-site in November 2018, main contractor BAM's initial task was to install access roads, to not only serve its own site, but also an adjacent plot where a steel-framed sports hall is being built by another construction team.

Once the roads were ready, BAM then had to undertake a large-scale earthmoving operation to level the previously sloping plot.

Extensive groundworks were also required before erection of the steel frame could begin.

"A geophysical mapping procedure was undertaken, as the ground is a mixture of soft clay and hard ragstone areas. We had to identify where the soft areas were exactly, so we could consolidate these parts of the ground," says BAM Project Manager James Gray.

Once the ground consolidation had been completed, pad foundations were installed to support the steel frame.

A steel-framed solution was chosen for the school building as it offered the quickest construction programme, allowing the many follow-on trades the opportunity to get started as soon as possible.

Elland Steel completed the steel erection in 10 weeks, and then installed 8,000m^2 of precast flooring planks, along with precast staircases during a further five-week programme.

Mr Gray says a precast solution for the two upper floors and roof was the preferred method as it offered an economic way to bridge the internal spans, which are predominantly up to 8m-long in most areas. Another advantage for the site team was the fact that precast plank installation requires no propping, which means it is a quick procedure and there are fewer materials and equipment on site.

The underside of the precast planks, the supporting cellular beams as well as the services, will all be left exposed within the completed school, giving the building the desired modern, industrial-looking interior.

"A steel-framed solution was chosen for the school building as it offered the quickest construction programme."

The U-shaped school will enclose a courtyard

The soffits and cellular beams will be left exposed in the finished scheme

Project architect KSS says, the internal environment will be simple, but inspiring with accent colours to aid way-finding and providing a professional backdrop to the teaching and learning, while maintaining an excellent level of passive supervision.

The school is housed in one large horseshoe-shaped two-storey structure, that required Elland Steel Structures to fabricate, supply and erect 570t of steelwork.

Overall the steel frame is one braced structure, with the majority of the bracing located in stair and lift cores. There are also some braced bays, mostly at the end of the wings, while some areas have been portalised to avoid having bracing elements interfering with the structure's many windows.

Classrooms are predominantly arranged in two rows in each of the two wings, with a central corridor providing access.

"The classrooms vary in size and do not stack-up in a regular fashion," says Kirksaunders Associates Engineer Tim Dungate. "This doesn't mean the grid pattern has to change, but the steel frame has been designed to support partitions that don't necessarily correspond with the column lines."

Some important flexibility has also been added to the school design, as partitions can be moved, if the classrooms need to be reconfigured in the future.

The area that connects the two wings together accommodates the main entrance and a large double-height space that serves as the main hall and dining area. A moveable partition wall allows this large space to be used as either one or two halls.

The hall features spans of 12m-long and the design of the moveable partition had to take into account considerable deflections because of its length.

As most of the columns in the hall and entrance areas will be left exposed in the completed scheme, slender steel members have been used as they were considered to be more aesthetically pleasing.

At first floor level, there is a viewing gallery overlooking the hall, while above, on the uppermost second-storey, there are more classrooms positioned above the hall.

VIAT Co-CEO Vic Ashdown comments: "This is a very exciting project for the Trust and we are looking forward to welcoming students to our brand-new school next year.

"We will be extremely fortunate to have some of the best facilities in the county which will benefit thousands of students from across our schools."

The steel erection programme was completed in 10 weeks

The design of tee sections in bending

David Brown of the SCI looks at the lateral torsional buckling resistance of tee sections, considering the rules in BS 5950 and BS EN 1993-1-1

A tee section? In bending?

A tee section seems an unlikely choice for a member in bending, but judging by the calls to SCI's Advisory Desk, designers do wish (or are perhaps required) to use them. Normally, a tee might be used as a tie between floor beams. The vertical web fits between floor units and the flange sits just below the units, making little impact on an uninterrupted soffit. Before hollow section trusses became popular, tees would have been a good choice for the chords of roof trusses. The web of the tee (if cut from a UB section) provides enough room to connect the angle internal members, either by bolting or welding.

This article considers the alternative ways to design a tee section in both BS 5950 and BS EN 1993-1-1, illustrated with a worked example, so that designers have a resource if faced with the challenge of an unrestrained tee in bending.

BS 5950 guidance

The verification of a tee is covered in Section B.2.8, which provides rules to calculate the equivalent slenderness for lateral torsional buckling (LTB). The first point to note is that guidance is given on when LTB should be considered, and when not. To avoid confusion with Eurocode terminology, the axis on the web centreline will be referred to as the minor axis and the perpendicular axis, the major axis.

In B.2.8.2 a), the Standard advises that if $I_{major} = I_{minor}$ LTB does not occur and λ_{LT} is zero. The same applies to doubly-symmetrical sections where there is no reason for the section to buckle in the minor axis.

The reverse is true for tees cut from a UB – major axis inertia is larger than the minor axis inertia and LTB is possible.

Part b) of the clause notes that "if $I_{minor} > I_{major}$ LTB occurs about the major axis and λ_{LT} is given by:

$$\lambda_{LT} = 2.8\left(\frac{\beta_w L_e B}{T^2}\right)^{0.5}\text{"}$$

where B is the flange breadth and T is the flange thickness. Many tees will fall into this category – notably those cut from UC sections where the web is short and the flange is wide and thick. A simply supported tee section with $I_{minor} > I_{major}$, loaded so as to put a short unrestrained stem in compression will buckle by twisting to reduce the compression in the stem.

This clause may lead to some significant confusion, because the expression for λ_{LT} for a tee is the same as the equivalent expression for a plate bent about its major axis, given in clause B.2.7. The expression is based on the St Venant torsional stiffness of the flange only; the stem of the tee and any warping stiffness are ignored, hence the similarity with the expression for buckling of a flat plate.

Finally, part c) of the clause describes when $I_{major} > I_{minor}$ (the common situation for tees cut from UB) and provides the familiar (for designers of a certain age!) expression:

$$\lambda_{LT} = uv\lambda\sqrt{B_w}$$

The clause goes on to provide expressions for the relevant section properties needed to evaluate λ_{LT}, but designers will mostly obtain these from section property tables. In this case, the warping stiffness of the section is included in the determination of λ_{LT}.

BS EN 1993-1-1 guidance

For tees, there is no change from the normal procedure. To calculate the non-dimensional slenderness $\bar{\lambda}_{LT}$ the elastic critical buckling moment, M_{cr} is needed. This challenge is conveniently addressed by using software.

Verification methods

In the particular example chosen, the tee is cut from a UB, and thus has a relatively long web. Classification to either Standard leads to the conclusion that the tee is slender (BS 5950) or class 4 (BS EN 1993-1-1).

Two approaches are then possible in both Standards. Either the design stress can be reduced until the section becomes Semi-compact/Class 3, or an effective section can be determined by neglecting the ineffective parts of the cross-section. This latter approach becomes more involved in the Eurocode, because the effective section depends on the stress ratio in the web, which depends on the position of the neutral axis, which moves as the effective section reduces – so an iterative process is needed. BS 5950 is more straightforward as uniform stress in the web is assumed.

Worked example

The tee is a 152 × 229 × 30, in S355, with a buckling length of 4 m. The applied moment is in the plane of the web about the major axis and the web is in compression. The section is shown in Figure 1.

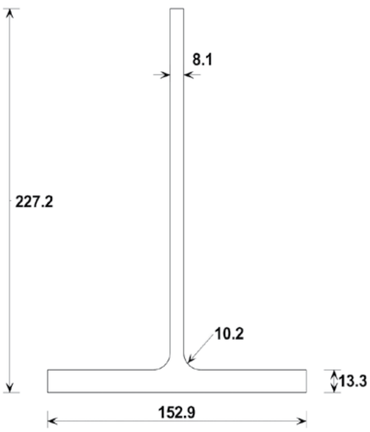


Figure 1: Tee section dimensions

Method 1 – BS 5950 reduced design stress

From look-up tables, d/t for the web = 28

From Table 11, the Class 3 limit is 18ε, and as $\varepsilon = 0.88$, the limit is 15.84. The section is therefore slender.

Clause 3.6.5 allows the use of a reduced design stress, p_{yr} given by:

$$p_{yr} = \left(\frac{15.84}{28}\right)^2 \times 355 = 114 \text{ N/mm}^2$$

Various section properties are needed from section tables:

minor axis radius of gyration, $r_{yy} = 32.3$ mm

buckling parameter, $u = 0.648$

monosymmetry index, $\psi = -0.746$ (negative as the flange is in tension)

▶28

▶26 elastic modulus, $Z = 111$ cm^3
plastic modulus, $S = 199$ cm^3
With some careful spreadsheet work:
$v = 1.05$
$w = 0.00449$ (includes the warping constant)
$\beta_w = 111/199 = 0.558$
$\lambda = 4000/32.3 = 123.8$
Then $\lambda_{LT} = 0.648 \times 1.05 \times 123.8 \times \sqrt{0.558} = 62.9$
The bending strength can then be calculated from B.2.1, with the result that
$p_b = 105$ N/mm^2
The buckling resistance moment $M_b = 105 \times 111 \times 10^{-3} = 11.7$ kNm

Method 2 – BS 5950 effective section method

Given that the section is slender, an effective section may be calculated. Clause 3.6.2.2 prescribes that the effective width of a class 4 slender outstand should be taken as equal to the class 3 limiting value (18ε, as above).

The overall depth of the effective section is therefore $18 \times 0.88 \times 8.1 = 128.3$ mm. The dimensions of the effective section are shown in Figure 2.

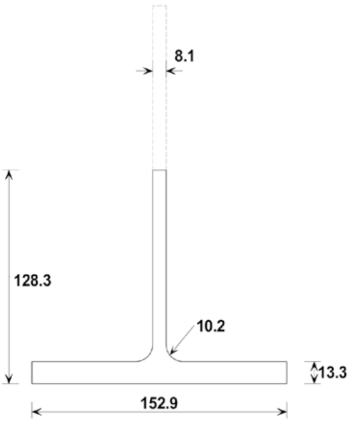


Figure 2: BS 5950 effective section

Calculations are required to determine the position of the neutral axis (accounting for the root radii if doing a 'proper' job!), and calculating the effective elastic modulus of the section. The effective modulus is calculated as 36.3 cm^3.

$$\beta_w = \frac{36.3}{199} = 0.18$$

Then $\lambda_{LT} = 0.648 \times 1.05 \times 123.8 \times \sqrt{0.18} = 35.7$
Following the same process from B.2.1, the bending strength,
$p_b = 339$ N/mm^2
The buckling resistance moment $M_b = 339 \times 36.3 \times 10^{-3} = 12.3$ kNm

Method 3 – BS EN reduced stress method

The ratio for local buckling is defined differently in the Eurocode, which species *c/t* as the dimensions of the outstand, not overall depth.

$$c/t = \frac{(227.2 - 13.3 - 10.2)}{8.1} = 25.2$$

The limiting value depends on the stress ratio between the stress at the tip of the web, and at the root radius (refer to Table 5.2 in BS EN 1993-1-1). To evaluate the limit, BS EN 1993-1-5 must be consulted to calculate the buckling factor, k_σ.

If the neutral axis is at 58.4 mm from the face of the flange (from section property tables), the stress ratio may be calculated from the dimensions shown in Figure 3.

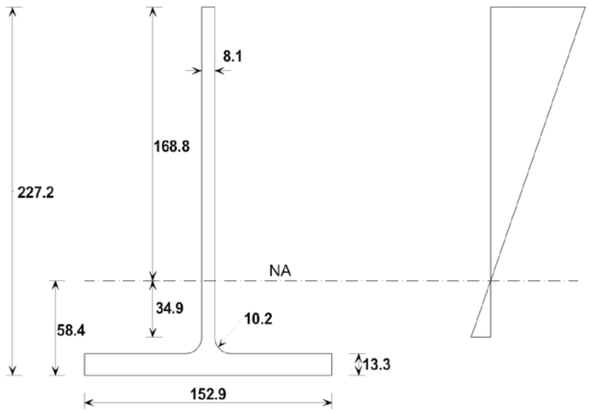


Figure 3: Elastic stresses in the web of the gross section

$$\psi = \frac{-34.9}{168.8} = -0.207$$

From Table 4.2 of BS EN 1993-1-5, then
$k_\sigma = 0.57 - 0.21\psi + 0.07\psi^2$
$k_\sigma = 0.57 - 0.21 \times (-0.207) + 0.07 \times (-0.207)^2 = 0.616$
Back in BS EN 1993-1-1 Table 5.2,
the limit is $21\sqrt{k_\sigma} = 21 \times 0.81 \times \sqrt{0.616} = 13.3$
25.2 > 13.3, so the section is class 4 (not surprisingly, given the BS 5950 classification)
To ensure the section remains class 3, the reduced design strength is given by $235 \Big/ \left(\frac{25.2}{21 \times \sqrt{0.616}}\right)^2 = 100.5$ N/mm^2

M_{cr} must be calculated, using the gross properties. *Ltbeam* is a convenient software to use. With a UDL causing compression on the web, M_{cr} = 67 kNm.

Verification then proceeds in the usual way, using the general case of clause 6.3.2.2. A tee section is taken to be an "other cross section" in Table 6.4. The intermediate values are therefore:

$\bar{\lambda}_{LT} = 0.41$
$\alpha_{LT} = 0.76$
$\varphi_{LT} = 0.66$
$\chi_{LT} = 0.84$
and finally M_{bRd} = 9.5 kNm

Method 4 – BS EN effective section method

Having found the section is class 4, the effective length of the web may be determined from BS EN 1993-1-5.

If k_σ = 0.616 then from clause 4.4(2)

$$\bar{\lambda}_p = \frac{\bar{b}/t}{28.4\varepsilon\sqrt{k_\sigma}} = \frac{25.2}{28.4 \times 0.81 \times \sqrt{0.616}} = 1.39$$

Because $\bar{\lambda}_p > 0.748$ then

$$\rho = \frac{\bar{\lambda}_p - 0.188}{\bar{\lambda}_p^{\,2}} = \frac{1.39 - 0.188}{1.39^2} = 0.622$$

The effective length of the web from the neutral axis is therefore 0.622 × 168.8 = 105 mm and the overall depth of the effective section is now 163.7 mm.

This change of section means that the original assumptions about *c/t* ratio, position of neutral axis etc are now invalid. The process must be repeated (by spreadsheet preferably!) until a final solution is found. A final solution is found when there is no further reduction needed to the web (i.e. all the reduced section is effective). This happens when ρ = 1 (no reduction), which, with reference to BS EN 1993-1-5, happens when $\bar{\lambda}_p$ =0.748

Probably, there would be a neat way to determine this point by calculation, but it is easy to complete a number of cycles to discover the point when the entire reduced section becomes effective. The final section, with an overall depth of 130 mm, is shown in Figure 4. The Eurocode effective section appears reassuringly similar to that according to BS 5950, in Figure 2.

Having found the final section, the section properties can be determined and the resistance determined in the normal way, as Method 3. The intermediate values are:

W_{el} = 37.3 cm³
$\bar{\lambda}_{LT}$ =0.44
$\alpha_{LT} = 0.76$
$\varphi_{LT} = 0.69$

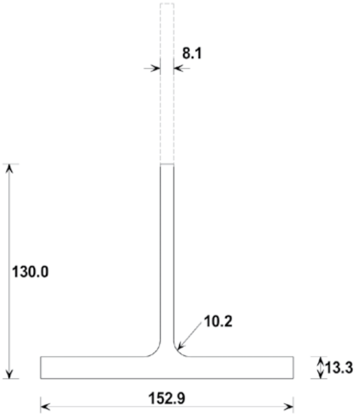


Figure 4: EN 1993 effective section

$\chi_{LT} = 0.82$
and finally M_{bRd} = 10.8 kNm

Summary

The various resistances are shown below:

BS 5950 reduced design strength	11.3 kNm
BS 5950 effective section	12.3 kNm
BS EN 1993-1-1 reduced design strength	9.5 kNm
BS EN 1993-1-1 effective section	10.8 kNm

Note that according to BS 5950, the maximum moment should be limited to M_b/m_{LT}, so the BS 5950 values above should be increased by $1/0.925$ to provide a proper comparison. The shape of the bending moment diagram – due to a UDL – is already included in the Eurocode resistances by virtue of the M_{cr} value.

Conclusions

Firstly, it is not easy to calculate the correct resistance. It took some time and the assistance of two colleagues at SCI to reach a consensus. The Eurocode approach has the benefit of software to calculate M_{cr}, but the easier solution (method 3, reduced design strength) is conservative. The less conservative method 4, effective section, is painful because of the loops required to calculate the effective section.

The second observation is that perhaps the guidance in BS 5950 could be clearer.

The final observation is that tees have their place - but preferably not as unrestrained members in bending.

New and revised codes & standards

From BSI Updates June 2019

BS EN PUBLICATIONS

BS EN ISO 2553:2019
Welding and allied processes. Symbolic representation on drawings. Welded joints
Supersedes BS EN ISO 2553:2013

BS EN ISO 8560:2019
Technical drawings. Construction drawings. Representation of modular sizes, lines and grids
Supersedes BS EN ISO 8560:1999

BS EN 10210-2:2019
Hot finished steel structural hollow sections. Tolerances, dimensions and sectional properties
Supersedes BS EN 10210-2:2006

BS EN 10219-2:2019
Cold formed welded steel structural hollow sections. Tolerances, dimensions and sectional properties
Supersedes BS EN 10219-2:2006

BS EN ISO 14731:2019
Welding coordination. Tasks and responsibilities
Supersedes BS EN ISO 14731:2006

BRITISH STANDARDS REVIEWED AND CONFIRMED

BS ISO 1891:2009
Fasteners. Terminology

BRITISH STANDARDS WITHDRAWN

BS EN ISO 2553:2013
Welding and allied processes. Symbolic representation on drawings. Welded joints
Superseded by BS EN ISO 2553:2019

BS EN ISO 8560:1999
Construction drawings. Representation of modular sizes, lines and grids
Superseded by BS EN ISO 8560:2019

BS EN 10210-2:2006
Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties
Superseded by BS EN 10210-2:2019

BS EN 10219-2:2006
Cold formed welded structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties
Superseded by BS EN 10219-2:2019

BS EN ISO 14731:2006
Welding coordination. Tasks and responsibilities
Superseded by BS EN ISO 14731:2019

NEW WORK STARTED

EN ISO 20349-2:2017/A1
Personal protective equipment. Footwear protecting against risk in foundries and welding. Requirements and test methods for protection against risks in welding and allied processes
Will supersede None

DRAFT BRITISH STANDARDS FOR PUBLIC COMMENT – ADOPTIONS

19/30375689 DC
BS EN ISO 8501-4 Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Initial surface conditions, preparation grades and flash rust grades in connection with water jetting
Comments for the above document were required by 2 July, 2019

CEN EUROPEAN STANDARDS

EN ISO 2553:2019
Welding and allied processes. Symbolic representation on drawings. Welded joints (ISO 2553:2019)

EN ISO 8560:2019
Technical drawings. Construction drawings. Representation of modular sizes, lines and grids (ISO 8560:2019)

EN 10210-2:2019
Hot finished steel structural hollow sections. Tolerances, dimensions and sectional properties

EN 10219-2:2019
Cold formed welded steel structural hollow sections. Tolerances, dimensions and sectional properties

ISO PUBLICATIONS

ISO/TR 12998:2019
Mechanical joining. Guidelines for fatigue testing of joints
Will be implemented as an identical British Standard

AD 432: Wind loads on building canopies

The purpose of this AD note is to direct designers' attention to PD 6688-1-4 as a source of design loads on building canopies and useful data and guidance relating to other topics.

A regular question for the SCI Advisory team relates to wind loading on canopies attached to buildings. A canopy may typically be provided over the entrance to a building, but questions arise as there are no coefficients provided in BS EN 1991-1-4.

Designers should refer to PD 6688-1-4, section 3.5, which provides force coefficients for canopies attached to the lower half of a building. Canopies attached to the upper half of a building should be assessed using the rules for free standing canopies fully blocked at one edge (the back or the side, depending on the wind direction). The forward reference in PD 6688-1-4 section 3.5 is incorrect – it should direct designers to section 7.3 of the Eurocode for loads on canopies.

It should be noted that when using the data provided in the PD, the reference height is the height of the building, not the height of the canopy. This is because gusts on the upper parts of the building can be directed down the building face onto the canopy.

The overall force coefficients tabulated in the PD in the downward direction are considerably larger than those in the Eurocode, particularly for shallow angle canopies attached at a relatively low level – so it is particularly important that the PD is consulted.

More generally, PD 6688-1-4 is a valuable resource with helpful guidance on such topics as non-simultaneous loads on faces, assessment of dominant openings, re-entrant corners and inset faces.

Contact: **Richard Henderson**
Tel: **01344 636555**
Email: **advisory@steel-sci.com**

BUILDING WITH STEEL

Reprinted from Volume 5 No. 4
June 1969

British Steel in Bahrain

View of completed grandstand

Erection of longitudinal guides between columns.

by D. K. Doran, BSc(Eng), DIC, MICE,
Manager, Structural Design Department,
George Wimpey & Co. Ltd

The foundation stone for Isa new town was laid in December 1963 by the Ruler of Bahrain and its Dependencies, His Highness Sheikh Isa bin Shulman Al-Khalifa. The town, named after the Ruler, will eventually accommodate 15,000 people in territory won from the desert.

The plan for Isa Town includes as one of its essential amenities a comprehensive sports complex with a stadium in which there is accommodation for 11,000 spectators including 5,000 seated under cover in a modern grandstand recently completed.

The roof structure 416ft 8in × 57ft 6in was designed in B.S.15 mild steel and checked using an IBM 360 computer. The structure was fabricated in the UK and shipped piece small to Bahrain. All site connections were simple bolted joints and erection of the 145 tons of steelwork was achieved with unskilled local labour and one specialist supervisor.

The steelwork was assembled into girders, etc on the ground and then lifted into position using a LIMA machine with a 100ft jib. Good alignment of the canopy fascia was obtained by adjustment to turnbuckles in the 4in diameter ties at the rear of the stand.

The roof framing is essentially a 45ft cantilever supported on tapered box stanchions formed of $\frac{3}{8}$in thick welded plates and an anchor span of 12ft 6in. To combat corrosion all work was hot dip galvanized (to B.S.729) using a 2oz per sq ft coating.

Protection of the steelwork was completed, after using a degreasing agent, by the application of calcium plumbate, followed by two undercoats and a gloss finish paint. The terracing is constructed of precast concrete units which are supported on in situ concrete crosswalls at 16ft 8in centres.

Alternate crosswalls support the box stanchions.

Design wind pressures for the open backed stand were derived from the Swiss Code of Practice and confirmed by wind tunnel tests.

The roof covering and blue covered under lining were in plastic coated steel sheet fixed to the purlins by self tapping stainless steel screws.

The architect for this project was E. V. Collins, ARIBA, and the author was the engineer.

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

Lorraine MacKinder, Marketing and Membership Administrator,
The British Constructional Steelwork Association Limited, Unit 4 Hayfield Business Park, Field Lane, Auckley, Doncaster DN9 3FL
Tel: 020 7747 8121 Email: *lorraine.mackinder@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
- **BIM** BIM Level 2 assessed
- **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	BIM	SCM	Guide Contract Value (1)
A & J Stead Ltd	01653 693742			●	●					●	●			●	●		3			Up to £400,000
A C Bacon Engineering Ltd	01953 850611			●	●	●	●				●			●			2			Up to £3,000,000
Access Design & Engineering	01642 245151					●				●	●			●	●	✔	4			Up to £4,000,000
Adey Steel Ltd	01509 556677	●		●	●	●	●	●	●	●	●			●	●	✔	3	✔	Silver	Up to £4,000,000
Adstone Construction Ltd	01905 794561			●	●	●	●									✔	2	✔	Gold	Up to £3,000,000
Advanced Fabrications Poyle Ltd	01753 653617				●	●	●	●		●	●			●	●	✔	2			Up to £800,000
AJ Engineering & Construction Services Ltd	01309 671919			●	●		●		●	●	●			●	●	✔	4		Silver	Up to £3,000,000
Angle Ring Company Ltd	0121 557 7241												●			✔	4			Up to £1,400,000*
Apex Steel Structures Ltd	01268 660828					●	●			●	●			●	●		2			Up to £3,000,000
Arminhall Engineering Ltd	01799 524510	●			●	●		●		●	●			●	●	✔	2			Up to £800,000
Arromax Structures Ltd	01623 747466	●		●	●	●	●	●	●	●	●	●		●	●		2			Up to £800,000
ASME Engineering Ltd	020 8966 7150				●	●	●	●		●	●			●	●	✔	4		Gold	Up to £4,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●	●	●			●	●			●	●	✔	2			Up to £1,400,000
Austin-Divall Fabrications Ltd	01903 721950				●	●	●	●		●	●			●	●	✔	2			Up to £1,400,000
B D Structures Ltd	01942 817770			●	●	●	●				●	●		●	●	✔	2	✔	Silver	Up to £1,400,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✔	4			Up to £1,400,000
Barnshaw Section Benders Ltd	0121 557 8261												●			✔	4			Up to £1,400,000
BHC Ltd	01555 840006	●	●	●	●	●	●	●			●	●		●	●	✔	4	✔	Silver	Above £6,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	Gold	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●		4			Up to £3,000,000
Bourne Group Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●		●	●	●	✔	4			Up to £6,000,000
Builders Beams Ltd	01227 863770			●	●	●	●			●	●			●	●	✔	2	✔		Up to £2,000,000
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●				●	●	✔	4		Silver	Up to £4,000,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●		●	●	●		●	●	✔	4	✔	Gold	Above £6,000,000
Cementation Fabrications	0300 105 0135	●			●		●	●			●		●		●	✔	3		Gold	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●		●	●	●			✔	4		Gold	Above £6,000,000
CMF Ltd	020 8844 0940				●		●	●		●	●				●	✔	4			Up to £6,000,000
Cook Fabrications Ltd	01303 893011			●	●		●			●	●			●	●		2			Up to £1,400,000
Coventry Construction Ltd	024 7646 4484			●	●	●	●		●	●	●			●	●	✔	4			Up to £1,400,000
D H Structures Ltd	01785 246269			●	●		●				●						2			Up to £40,000
D Hughes Welding & Fabrication Ltd	01248 421104				●	●	●	●		●	●		●	●	●	✔	4			Up to £800,000
Duggan Steel	00 353 29 70072	●	●	●	●	●	●	●	●		●				●	✔	4			Up to £6,000,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●	●	●	●	●			●	●	✔	3			Up to £3,000,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●	●	●	●	●	●		●	●	✔	4	✔	Gold	Up to £6,000,000
EvadX Ltd	01745 336413			●	●	●	●	●	●	●	●	●			●	✔	3		Gold	Up to £3,000,000
Four Bay Structures Ltd	01603 758141			●	●	●	●	●	●	●	●			●	●		2			Up to £1,400,000
Four-Tees Engineers Ltd	01489 885899	●			●		●	●	●	●	●		●	●	●	✔	3		Member	Up to £2,000,000
Fox Bros Engineering Ltd	00 353 53 942 1677			●	●	●	●	●		●	●				●		2			Up to £2,000,000
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●				●	●	✔	2			Up to £1,400,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
G.R. Carr (Essex) Ltd	01286 535501	●		●	●			●			●			●	●	✔	4			Up to £800,000
H Young Structures Ltd	01953 601881			●	●	●	●	●						●	●	✔	2		● (green)	Up to £2,000,000
Had Fab Ltd	01875 611711				●				●	●	●				●	✔	4			Up to £3,000,000
Hambleton Steel Ltd	01748 810598		●	●	●	●	●	●			●	●		●		✔	4		● (grey)	Up to £6,000,000
Harry Marsh (Engineers) Ltd	0191 510 9797			●	●	●	●			●	●				●	✔	2			Up to £1,400,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●	✔	2			Up to £3,000,000
Intersteels Ltd	01322 337766	●			●	●	●	●		●				●	●	✔	3			Up to £2,000,000
J & A Plant Ltd	01942 713511				●	●									●		4			Up to £40,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●				●	●		●			4			Up to £6,000,000*
Kiernan Structural Steel Ltd	00 353 43 334 1445	●		●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	● (orange)	Up to £6,000,000
Kloeckner Metals UK Westok	0113 205 5270												●			✔	4			Up to £6,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●					✔	2		● (grey)	Up to £6,000,000
Legge Steel (Fabrications) Ltd	01592 205320			●	●		●		●	●	●			●	●		3			Up to £800,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●				●	✔	4		● (green)	Up to £2,000,000
M J Patch Structures Ltd	01275 333431				●					●	●				●	✔	3			Up to £1,400,000
M&S Engineering Ltd	01461 40111				●				●	●	●			●	●		3			Up to £2,000,000
Mackay Steelwork & Cladding Ltd	01862 843910			●	●		●			●	●			●	●	✔	4			Up to £1,400,000
Maldon Marine Ltd	01621 859000				●	●			●	●				●		✔	3			Up to £1,400,000
Mifflin Construction Ltd	01568 613311			●	●	●	●				●						3			Up to £3,000,000
Millar Callaghan Engineering Services Ltd	01294 217711									●				●	●	✔	4			Up to £1,400,000
Murphy International Ltd	00 353 45 431384	●			●		●	●	●		●				●	✔	4			Up to £1,400,000
Newbridge Engineering Ltd	01429 866722	●	●	●	●	●	●	●	●		●	●		●	●	✔	4		● (grey)	Up to £2,000,000
North Lincs Structures	01724 855512			●	●					●	●				●		2			Up to £400,000
Nusteel Structures Ltd	01303 268112						●	●	●	●				●		✔	4		● (orange)	Up to £3,000,000
Overdale Construction Services Ltd	01656 729229			●	●		●	●							●		2			Up to £400,000
Painter Brothers Ltd	01432 374400	●			●				●	●	●				●	✔	3			Up to £6,000,000*
Peter Marshall (Steel Stairs) Ltd	0113 307 6730									●					●	✔	2			Up to £800,000*
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●		3			Up to £1,400,000
Robinson Structures Ltd	01332 574711			●	●	●	●				●			●	●	✔	3			Up to £6,000,000
S H Structures Ltd	01977 681931	●			●	●	●	●	●	●	●	●			●	✔	4	✔	● (orange)	Up to £2,000,000
SAH Engineering Ltd	01582 584220			●	●	●				●	●			●	●		2			Up to £800,000
SDM Fabrication Ltd	01354 660895	●	●	●	●	●	●				●			●	●	✔	4			Up to £2,000,000
Severfield plc	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	● (orange)	Above £6,000,000
SGC Steel Fabrication	01704 531286				●					●				●	●	✔	2			Up to £200,000
Shaun Hodgson Engineering Ltd	01553 766499	●		●	●		●			●	●			●	●	✔	3			Up to £800,000
Shipley Structures Ltd	01400 251480			●	●	●	●		●	●	●			●	●		2			Up to £3,000,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●	●	●	●			●				●		2	✔		Up to £1,400,000
South Durham Structures Ltd	01388 777350			●	●	●				●	●	●			●		2			Up to £1,400,000
Southern Fabrications (Sussex) Ltd	01243 649000				●	●				●	●			●	●	✔	2			Up to £1,400,000
Steel & Roofing Systems	00 353 56 444 1855			●	●	●	●				●	●		●	●	✔	4			Up to £3,000,000
Structural Fabrications Ltd	01332 747400	●			●	●		●	●	●	●			●	●	✔	3		● (grey)	Up to £1,400,000
Taunton Fabrications Ltd	01823 324266				●	●				●	●			●	●	✔	2		● (grey)	Up to £2,000,000
Taziker Industrial Ltd	01204 468080	●		●	●		●			●	●		●	●	●	✔	3			Above £6,000,000
Temple Mill Fabrications Ltd	01623 741720			●	●	●	●			●	●			●	●	✔	2			Up to £400,000
Traditional Structures Ltd	01922 414172			●	●	●	●	●	●		●			●	●	✔	3	✔	● (grey)	Up to £2,000,000
TSI Structures Ltd	01603 720031			●	●	●	●	●			●			●			2	✔		Up to £2,000,000
Underhill Engineering Ltd	01752 752483				●		●	●	●	●	●			●	●	✔	4	✔		Up to £3,000,000
W I G Engineering Ltd	01869 320515				●					●					●	✔	2			Up to £400,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✔	4			Above £6,000,000
Westbury Park Engineering Ltd	01373 825500	●		●	●	●	●	●	●	●	●				●	✔	4		● (green)	Up to £800,000
William Haley Engineering Ltd	01278 760591				●	●	●									✔	4		● (orange)	Up to £4,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	● (orange)	Above £6,000,000
WT Fabrications (NE) Ltd	01642 691191			●	●	●	●				●			●	●	✔	4			Up to £40,000
Company name	**Tel**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**Q**	**R**	**S**	**QM**	**FPC**	**BIM**	**SCM**	**Guide Contract Value (1)**

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:

- **FB** Footbridges
- **CF** Complex footbridges
- **SG** 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** Ancillary 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
- **BIM** BIM Level 2 compliant
- **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	FB	CF	SG	PG	TW	BA	CM	MB	RF	AS	QM	FPC	BIM	NHSS 19A	NHSS 20	SCM	Guide Contract Value [1]
AJ Engineering & Construction Services Ltd	01309 671919	●			●	●	●	●	●	●	●	✓	4				Silver	Up to £3,000,000
Bourne Group Ltd	01202 746666	●			●	●				●	●	✓	4	✓		✓	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	●	●	✓	4			✓		Up to £6,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●	●	●	●		●	●	✓	4			✓	Silver	Up to £4,000,000
Cementation Fabrications	0300 105 0135	●		●	●	●	●				●	✓	3			✓	Gold	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Above £6,000,000
D Hughes Welding & Fabrication Ltd	01248 421104	●		●		●			●	●	●	✓	4			✓		Up to £800,000
Donyal Engineering Ltd	01207 270909	●		●						●	●	✓	3			✓	Silver	Up to £1,400,000
ECS Engineering Services Ltd	01773 860001	●			●	●	●		●		●	✓	3					Up to £3,000,000
Four-Tees Engineers Ltd	01489 885899	●			●	●	●		●	●		✓	3			✓	Member	Up to £2,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●				●				●	●	✓	4	✓		✓	Gold	Up to £6,000,000
M Hasson & Sons Ltd	028 2957 1281	●	●	●	●	●	●	●	●	●	●	✓	4			✓	Member	Up to £2,000,000
Millar Callaghan Engineering Services Ltd	01294 217711	●						●		●	●	✓	4			✓		Up to £1,400,000
Murphy International Ltd	00 353 45 431384	●	●	●	●	●	●				●	✓	4			✓		Up to £1,400,000
Nusteel Structures Ltd	01303 268112	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Up to £4,000,000
S H Structures Ltd	01977 681931	●	●	●	●	●	●	●	●	●	●	✓	4	✓		✓	Gold	Up to £2,000,000
Severfield (UK) Ltd	01204 699999	●	●	●	●	●	●	●	●	●	●	✓	4	✓	✓	✓	Gold	Above £6,000,000
Shaun Hodgson Engineering Ltd	01553 766499									●	●	✓	3			✓		Up to £800,000
Structural Fabrications Ltd	01332 747400	●		●	●	●	●			●	●	✓	3				Silver	Up to £1,400,000
Taziker Industrial Ltd	01204 468080	●		●	●	●	●	●	●	●	●	✓	3		✓	✓		Above £6,000,000
Underhill Engineering Ltd	01752 752483	●	●	●	●	●				●	●	✓	4	✓		✓		Up to £3,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	✓	4	✓	✓	✓	Gold	Above £6,000,000
Non-BCSA member																		
Allerton Steel Ltd	01609 774471	●	●	●	●	●	●	●		●	●	✓	4			✓	Silver	Up to £4,000,000
Centregreat Engineering Ltd	029 2046 5683	●		●	●	●	●	●	●	●	●	✓	4					Up to £2,000,000
Cimolai SpA	01223 836299	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓		Above £6,000,000
CTS Bridges Ltd	01484 606416	●	●	●	●	●	●	●	●	●	●	✓	4			✓	Member	Up to £1,400,000
Ekspan Ltd	0114 261 1126	●				●			●	●	●	✓	2					Up to £400,000
Francis & Lewis International Ltd	01452 722200									●	●	✓	4			✓	Gold	Up to £2,000,000
Harrisons Engineering (Lancashire) Ltd	01254 823993	●		●	●	●	●	●	●	●	●	✓	3		✓			Up to £1,400,000
Hollandia Infra BV	00 31 180 540 540	●	●	●	●	●	●	●	●	●	●	✓	4					Above £6,000,000*
HS Carlsteel Engineering Ltd	020 8312 1879									●	●	✓	3			✓		Up to £200,000
IHC Engineering (UK) Ltd	01773 861734	●									●	✓	3			✓		Up to £400,000
In-Spec Manufacturing Ltd	01642 210716									●	●	✓	4			✓		Up to £400,000
Lanarkshire Welding Company Ltd	01698 264271	●		●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Up to £2,000,000
Total Steelwork & Fabrication Ltd	01925 234320	●		●		●				●	●	✓	3			✓		Up to £3,000,000
Victor Buyck Steel Construction	00 32 9 376 2211	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	Silver	Above £6,000,000

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
Control Energy Costs Ltd	01737 556631
Gene Mathers	0115 974 7831
Griffiths & Armour	0151 236 5656
Highways England Company Ltd	08457 504030

Company name	Tel
Inspire Insurance Services	02476 998924
Kier Construction Ltd	01767 640111
McGee Group (Holdings) Ltd	020 8998 1101
Sandberg LLP	020 7565 7000

Company name	Tel
Structural & Weld Testing Services Ltd	01795 420264
SUM Ltd	0113 242 7390

Industry Members

Industry Members are those principal companies involved in the direct supply to all or some Steelwork Contractor Members of components, materials or products. Industry 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	BIM
AJN Steelstock Ltd	01638 555500								●		M		
Albion Sections Ltd	0121 553 1877	●									M		
Arcelor Mittal Distribution - Scunthorpe	01724 810810								●		D/I		
Ayrshire Metals Ltd	01327 300990	●									M		✓
BAPP Group Ltd	01226 383824									●	M		
Barrett Steel Services Limited	01274 682281								●		M		
Behringer Ltd	01296 668259					●					N/A		
British Steel Ltd	01724 404040				●						M		
British Steel Distribution	01642 405040								●		D/I		
BW Industries Ltd	01262 400088	●									M		
Cellbeam Ltd	01937 840600	●									M		
Cleveland Steel & Tubes Ltd	01845 577789								●		M		
Composite Metal Flooring Ltd	01495 761080	●									M		
Composite Profiles UK Ltd	01202 659237	●									D/I		
Cooper & Turner Ltd	0114 256 0057									●	M		
Cutmaster Machines (UK) Ltd	01226 707865					●					N/A		
Daver Steels Ltd	0114 261 1999	●									M		
Daver Steels (Bar & Cable Systems) Ltd	01709 880550	●									M		
Dent Steel Services (Yorkshire) Ltd	01274 607070								●		M		
Duggan Profiles & Steel Service Centre Ltd	00 353 56 7722485	●							●		M		
easi-edge Ltd	01777 870901							●			N/A	Gold	
Fabsec Ltd	01937 840641	●									N/A		
Farrat Isolevel	0161 924 1600	●									N/A		
Ficep (UK) Ltd	01924 223530					●					N/A		
FLI Structures	01452 722200	●									M	Gold	
Forward Protective Coatings Ltd	01623 748323						●				N/A		
Hadley Industries Plc	0121 555 1342	●									M	Silver	
Hempel UK Ltd	01633 874024						●				N/A		
Highland Metals Ltd	01343 548855						●				N/A		
Hi-Span Ltd	01953 603081	●									M	Member	

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM	BIM
International Paint Ltd	0191 469 6111						●				N/A	Gold	
Jack Tighe Ltd	01302 880360						●				N/A		
Jamestown Manufacturing Ltd	00 353 45 434288	●									M		
John Parker & Son Ltd	01227 783200								●	●	D/I		
Joseph Ash Galvanizing	01246 854650						●				N/A		
Jotun Paints (Europe) Ltd	01724 400000						●				N/A		
Kaltenbach Ltd	01234 213201					●					N/A		
Kingspan Structural Products	01944 712000	●									M	Gold	
Kloeckner Metals UK	0113 254 0711								●		D/I		
Lincoln Electric (UK) Ltd	0114 287 2401					●					N/A		
Lindapter International	01274 521444									●	M		
MSW UK Ltd	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 Architectural Coatings UK & Ireland	01924 354233						●				N/A		
Prodeck-Fixing Ltd	01278 780586	●									D/I		
Rainham Steel Co Ltd	01708 522311								●		D/I		
SDS/2 Ltd	07734 293573		●								N/A		
Sherwin-Williams Protective & Marine Coatings	01204 521771						●				N/A	Silver	
Structural Metal Decks Ltd	01202 718898	●									M		
StruMIS Ltd	01332 545800		●								N/A		
Stud-Deck Services Ltd	01335 390069	●									D/I		
Tata Steel – Tubes	01536 402121				●						M		
Tata Steel – ComFlor	01244 892199	●									M		
Tension Control Bolts Ltd	01978 661122						●			●	M		
Trimble Solutions (UK) Ltd	0113 887 9790		●								N/A		
voestalpine Metsec plc	0121 601 6000	●									M	Gold	
Wedge Group Galvanizing Ltd	01909 486384						●				N/A		
Wightman Stewart (WJ) Ltd	01422 823801					●					N/A		