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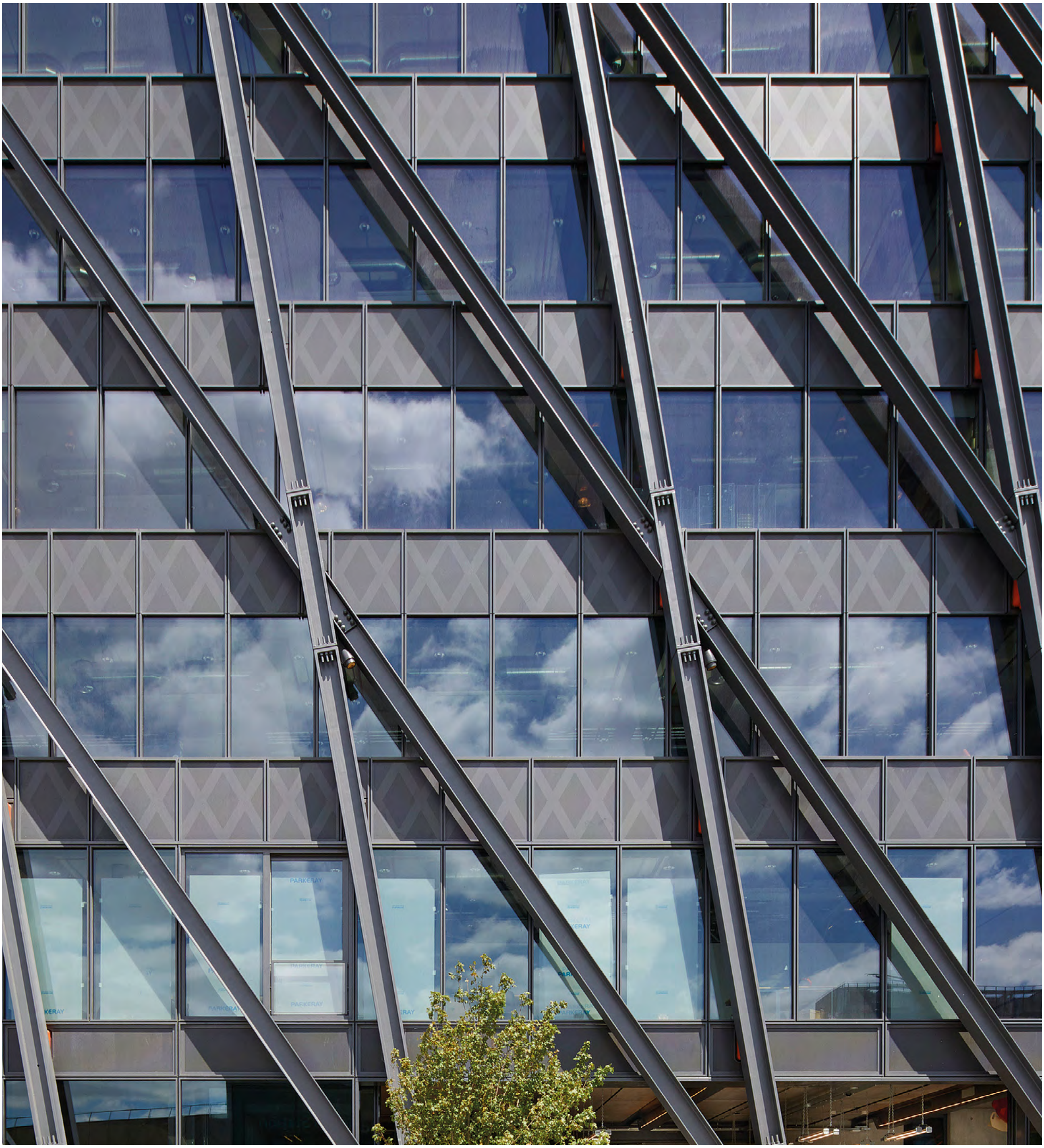
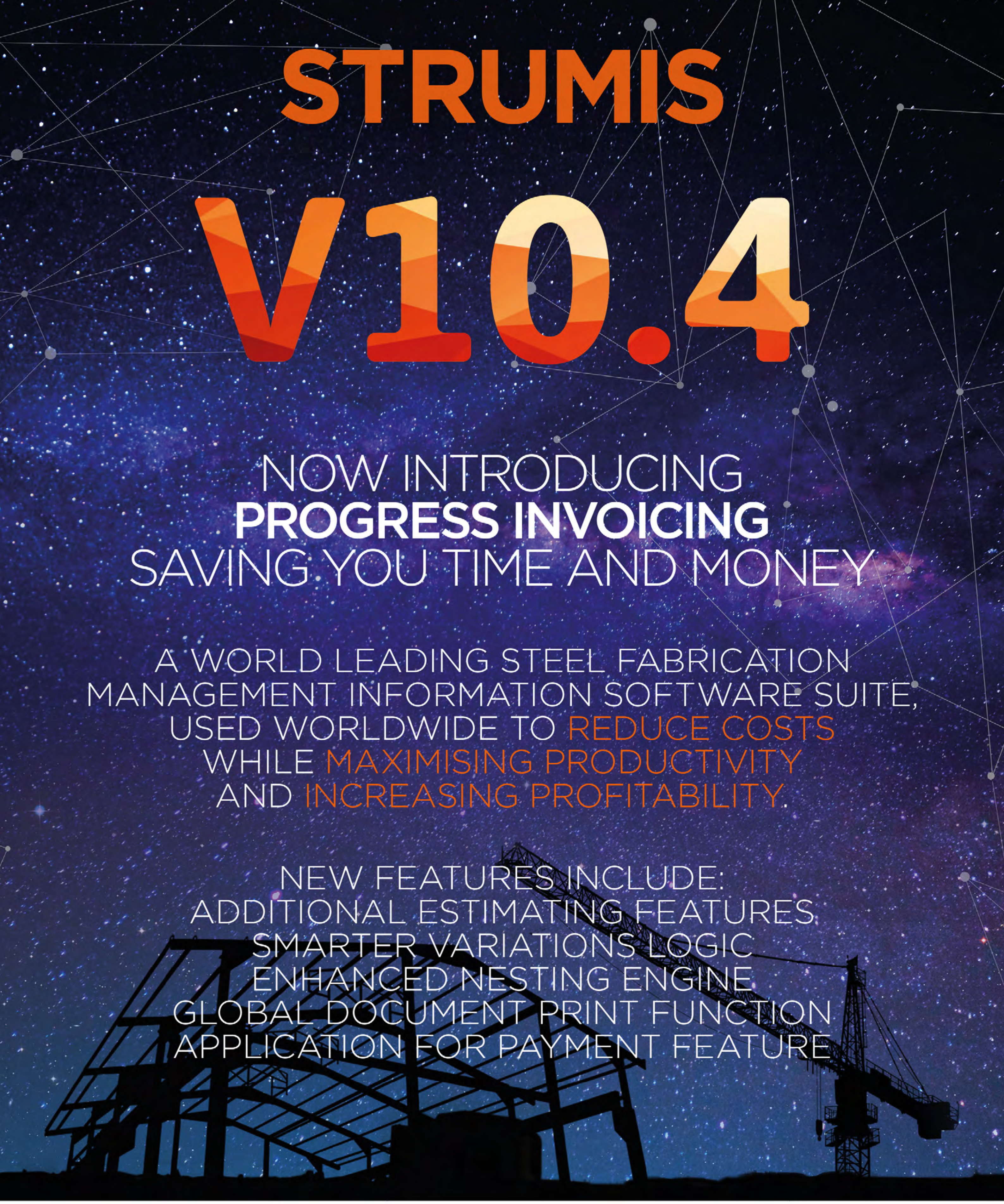
NSC

STRUCTURAL STEEL DESIGN AWARDS 2020

Vol 28 No 9 October 2020

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Cover Image
Brunel Building, London
Architect: Fletcher Priest Architects
Structural engineer: Arup
Steelwork contractor: Severfield
Main contractor: Lang O'Rourke
Client: Derwent London
Photo: © Jack Hobhouse

The images used in this month's project features were all taken before the coronavirus social distancing restrictions came into force. As such, some may show operatives in close proximity to each other.

NSC

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EDITOR
Nick Barrett Tel: 01323 422483
nick@newsteelconstruction.com

DEPUTY EDITOR
Martin Cooper Tel: 01892 538191
martin@newsteelconstruction.com

PRODUCTION EDITOR
Andrew Pilcher Tel: 01892 553147
admin@newsteelconstruction.com

PRODUCTION ASSISTANT
Alastair Lloyd Tel: 01892 553145
alastair@barrett-byrd.com

COMMERCIAL MANAGER
Fawad Minhas Tel: 01892 553149
fawad@newsteelconstruction.com

NSC IS PRODUCED BY BARRETT BYRD ASSOCIATES ON BEHALF OF THE BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION AND STEEL FOR LIFE IN ASSOCIATION WITH THE STEEL CONSTRUCTION INSTITUTE

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

Steel for Life Ltd
4 Whitehall Court, Westminster, London SW1A 2ES
Telephone 020 7839 8566
Website *www.steelforlife.org*
Email *steelforlife@steelconstruction.org*

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

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

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Judges overcome pandemic challenges

Nick Barrett - Editor

The UK's steel construction industry can justifiably take pride in its long track record of being willing and able to be early adopters of the latest technology, and are now at the forefront of the digital transformation in how buildings and other structures are designed and built.

The evidence is clear in all the projects that made the shortlist for the 52nd Structural Steel Design Awards, which the judges had the hard task of whittling down to the Award winners that feature in this issue of NSC. This year's SSDA judges can also take a pat on the back – self-administered for obvious reasons - for their willingness to take up new technology in the judging process itself, after COVID-19 restrictions meant their traditional visits to shortlisted projects to meet construction teams were not possible.

Visiting projects is an almost unique feature of the SSDA judging process in normal times, but as Chairman of the judges Chris Nash explains in his introduction to our special coverage of the Awards, this was the first time that the judges had to use Zoom and MS Teams to interact with construction teams, who, like the judges, rose to the challenge with enthusiasm.

Continuity in the judging panel helped a lot, as did the fact that they and construction teams have obviously become used to holding online meetings this year. Chris Nash is confident that despite the lack of face-to-face meetings the Award winners fully reflect the world-leading quality in constructional steelwork that our industry is so widely acknowledged for.

As is the case every year, the Award winners comprise a highly varied range of project sizes and types. The winners do not represent a curated group designed to show off steel; the judges are dauntingly severe in their view of what is worthy of an Award and in theory there could be no awards granted.

Buildability and speed of construction were key benefits of steel on the large commercial development known as the Scalpel at 52 Lime Street in London, which is inclined so as not to interfere with views of St Paul's Cathedral dome. Three bridges on the A14 Cambridge to Huntingdon Improvement Scheme, including a 750m long viaduct over the River Great Ouse, all illustrate the benefits of steel's offsite capabilities.

Retaining the existing Grade II-listed steel-framed structure and extending it with additional steelwork at Bath Schools of Art and Design chimes well with the carbon reduction policies which the steel sector has thrown its weight fully behind. The Award-winning Brunel Building in London's Paddington - adjacent to Brunel's iron-framed station shed - fittingly makes a feature of exposing its exoskeleton.

The Curragh Racecourse Development in County Kildare, Ireland, includes an Award-winning aerofoil roof, a bold architectural statement forming a dramatic centrepiece to a world-famous sporting venue. Steel's offsite benefits are again displayed at Cornwall's elegantly designed Tintagel Footbridge, linking both halves of the landmark castle for the first time in 500 years.

The other Commended projects, and in fact all of the SSDA Finalists, also provide compelling examples of the outstanding achievements of the UK and Ireland's steel construction designers and contractors. Even with a pandemic currently still raging, we can confidently look forward to next year's crop of outstanding structural steel achievements.

AWARDS

- 52 Lime Street, London
- A14 Cambridge to Huntingdon Improvement Scheme
- Bath Schools of Art and Design
- Brunel Building, London
- The Curragh Racecourse Redevelopment, Kildare
- Tintagel Footbridge, Cornwall

COMMENDATIONS

- One Bartholomew,Barts Square, London
- Centre Building, London School of Economics
- Mary Elmes Bridge, Cork City
- The Post Building, London
- The Standard Hotel, London
- Waterloo Station Roof Infill

MERITS

- The Gravity Bar, Guinness Storehouse, Dublin
- Scarborough Footbridge, York

NATIONAL FINALISTS

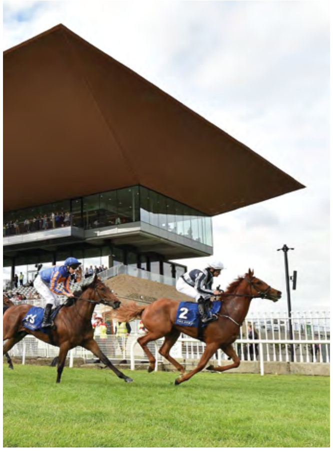
- The Balfour, Kirkwall, Orkney
- Barton Square, Intu Trafford Centre, Manchester
- Boeing GoldCare Aircraft Hangar, Gatwick Airport
- Bridgewater Place Wind Amelioration Scheme, Leeds
- One Bank Street, Canary Wharf
- Drake Circus The Barcode, Plymouth
- National Infrastructure Laboratory, University of Southampton
- The Wave, Coventry

STRUCTURAL STEEL DESIGN AWARDS 2020

Winners announced at 52nd Structural Steel Design Awards

Tintagel Footbridge, Cornwall

52 Lime Street, London



The Curragh Racecourse Redevelopment, Kildare

Six projects were Award winners at this year's Structural Steel Design Awards (SSDA).

The six winning projects at the 52nd annual SSDA were Tintagel Footbridge, Cornwall; 52 Lime Street, London; The Curragh Racecourse Redevelopment, Kildare; Bath Schools of Art and Design; A14 Cambridge to Huntingdon Improvement Scheme, and Brunel Building, London.

From an initial shortlist of 22 projects, all of this year's entries once again scored highly in terms of sustainability, cost-effectiveness, efficiency and innovation, with six schemes getting Commendations and two collecting Merits.

For the first time in its history, there was no gala awards ceremony for this year's SSDA and all winners were notified by email due to COVID-19 restrictions.

The unprecedented national lockdown also had an effect on how the SSDA judges came to their all-important decisions. In all previous years, at least two judges have visited each shortlisted scheme and met in-person the project team members. However, this was not possible in 2020 and so all project teams presented their schemes remotely.

Chairman of the Judges, Chris Nash said: "Keeping a sense of normality during a global pandemic has been difficult for everyone.

"As in previous years a preliminary selection was made on the basis of a close examination of the entry documents. The entrants of resultant shortlisted schemes were then invited to present their project by 'MS Teams' or 'Zoom' to at least two judges from different disciplines."

Commenting on the shortlisted projects, Mr Nash added: "This year there was a wide range of types of projects entered for the scheme. Scales of entry range from the largest prestige city office buildings, to smaller educational projects, and beautiful footbridges.

"The judges were particularly interested in projects that reflected a reuse of existing structures, and those that exemplified the logistics of overcoming time and spacial constraints, rather than just the beauty of the finished projects."

Trimble Solutions UK partnered the British Constructional Steelwork Association to deliver this year's awards.

Richard Fletcher, Regional Business Director, Trimble Buildings said: "As we look to construction to be at the forefront of assisting in the drive to return the economy back to pre-coronavirus levels, healthy, innovative and diverse structural steel and structural engineering industries will together form a significant part of that recovery.

"The entrants and winners of the SSDA in 2020 demonstrate that our industry is in a strong place."

Bath Schools of Art and Design

A14 Cambridge to Huntingdon Improvement Scheme

Brunel Building, London

Call for minimum UK content in HS2 constructional steelwork

The British Constructional Steelwork Association (BCSA) is calling on the UK Government to introduce a minimum UK content of 90% for the HS2 infrastructure project, following news that an early contract for 9,000 tonnes of structural steel has been awarded to French company, Eiffage Metal.

The basis for the BCSA's campaign for 90% UK content in the project is threefold: HS2 is a publicly funded infrastructure project, the largest in Europe, which should benefit British industry, the UK economy and create jobs; the constructional steel products used in the project are not specialist, and can be sourced by UK companies, whose production capacity far outstrips that demanded by the project; and there is a precedent for imposed targets for UK content in government projects, such as that in the Dogger Bank offshore windfarm

Dr David Moore, CEO of the BCSA, said: "HS2 presents a unique opportunity for the UK steel construction industry, and in particular the steelwork contractors, to showcase what they do best as well as kick-starting the UK economy.

"Unfortunately, although we're at an early stage in the project, so far it seems more likely that the project will contribute to the "levelling-up" of northern France than northern England.

"I have raised the concerns of BCSA members with the CEO of HS2 and government ministers, who have unfortunately only confirmed that early contracts have indeed been awarded to continental companies and that there isn't, and are no plans to introduce, a minimum UK content for the steelwork in the project.

"In order that HS2 fulfils its much-vaunted promise of delivering economic opportunity and prosperity for the British supply chain, it's vital that the government commits to utilising the expertise of UK contractors. That is why we're asking for 90% of the HS2 steelwork, used in the like of bridges, viaducts and stations, to be sourced locally."

BCSA's guide to steel's carbon credentials now available

Providing guidance and information to designers, to help them in their decision making as they strive to address the climate emergency, the British Constructional Steelwork Association (BCSA) and Steel for Life have produced a new publication, which is distributed with this issue of NSC and available online at: *www.steelconstruction.info*.

Entitled 'Steel Construction: Carbon Credentials' the publication highlights the many advantages of using structural steelwork and the environmental benefits that can be derived from choosing steel for buildings and other structures.

Within the publication an informative article on steelmaking describes how both of the main processes require significant amounts of recycled content for their production and sets out major manufacturer's plans for zero-carbon steelmaking by 2050.

The growing importance of embodied carbon in the drive towards a decarbonised world is discussed and the case is made for appropriate whole life carbon assessments. Steel has outstanding credentials on this key carbon score as it is typically reused or recycled, and it almost never adds to construction and demolition waste sent to landfill.

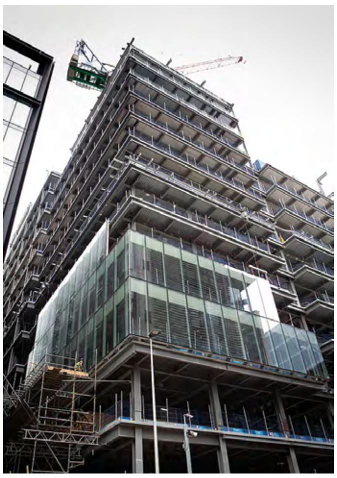
Operational carbon and thermal mass are explained in another article as well as how steel-framed buildings are capable of meeting the most stringent operational requirements in the drive towards net zero carbon emissions.

There are also features explaining steelwork's recyclability and sutability for reuse, steel's contribution to the circular economy, the BCSA's push for sustainable procurement, and project reports on four high-scoring BREEAM rated steel-framed buildings.

Glasgow's largest office block takes shape

Offering around 29,000m^2 of Grade A office space, 177 Bothwell Street is set to become Glasgow's largest and most ambitious office block.

The building forms the second part of the wider Bothwell Exchange development - the first part was 122 Waterloo Street – (see NSC Feb. 2017).



Situated on a plot previously occupied by the Albany Hotel, the building is a 14-storey steel-framed structure aiming to achieve a BREEAM 'Excellent' rating and featuring 2,276m^2 floorplates and a 743m^2 rooftop terrace that includes a 150m-long running track.

"Every HFD development has sustainability built into every aspect of the property. That starts with the physical methods and materials used during construction, but it equally applies to the finished product and the way the building is used," said Stephen Lewis, Managing Director for HFD Property Group.

The company's rationale extended to the choice of steel for the building's main frame.

"Speed of erection, the ability to achieve longer spans than concrete and therefore create a more open floor plate, together with the sustainability of steel as a recyclable product were the reasons for choosing the material," explained David Shearer, Managing Director for HFD Construction.

"Our steelwork subcontractor has a renewably-powered fabrication plant, which was another important consideration."

Steelwork contractor BHC's investment in sustainability and renewables within its manufacturing facility has allowed the 4,100t of fabricated steelwork for the project to have 52% less associated carbon emissions, and it is the first building in Glasgow to have this added sustainability within the structure.

177 Bothwell Street is set for completion in the third quarter of 2021.

NEWS IN BRIEF

Steelwork contractor **Taziker** has appointed Steve Corcoran to the company and the Board as Chief Executive Officer. He has a distinguished career in the construction sector, operating at board level in both public and private businesses, including nine years as CEO of Speedy Hire. More recently he has been advising on a number of investment opportunities in the UK and Europe.

In an effort to reduce greenhouse gas emissions, all of **Tata Steel**'s operations in 26 countries have signed up to ResponsibleSteel the industry's first globally-present standards and certification scheme for sustainability.

The **British Constructional Steelwork Association** (BCSA) has published a new publication entitled *Design and Fabrication of Lifting Accessories*. The Guide (BCSA Publication No 64/20) is available in PDF format only and can be obtained from *www.steelconstruction.org* (Free for BCSA members and £20 for non-members).

Yorkshire-based **Caddick Construction** has been awarded the contract to build a £25M teaching facility on the Openshaw Campus of The Manchester College. The state-of-the-art venue forms part of an investment strategy that includes a brand-new campus in the city centre, responding to the increasing demand for training and skills in the region.

Kier has been appointed by Swansea University to deliver its Centre for Integrative Semiconductor Materials (CISM), a £30M building that will be a research and innovation hub to support the growth of the semiconductor industry in the UK. Situated on Swansea University's Bay Campus in its engineering quarter, the three-storey building will have a footprint covering 4,320m^2 and comprise of 850m^2 ISO Qualified clean rooms, laboratory research facilities and 20 offices.

Developer **St. Modwen Industrial & Logistics** has entered into a development agreement to create an 11.3-acre business park with Basingstoke and Deane Borough Council and leaseholder ITT. St. Modwen said it will create new employment space in response to strong occupier demand and has permission to deliver up to 18,500m^2 of industrial and logistics space.

PRESIDENT'S COLUMN

Governments around the World have made it clear that we all have a responsibility to reduce our carbon footprint. "The Structural Engineer" magazine has recently published several articles on the climate emergency which have focused solely on initial carbon and has largely ignored the wider issues associated with sustainability.

As engineers we don't just have a responsibility to the current generation, but to future generations and our choice of construction materials must reflect not only the initial carbon content, but the end of life carbon aspects too, and also the wider social and economic impacts. The UK steelwork industry is admired all over the world and it's imperative that part of the sustainability argument allows home grown steel producers to adapt their steelmaking methods to reduce the amount of embodied carbon they produce, such that artisan skills are not lost forever.

Decisions should be made on a whole life carbon basis including the circular economy principles, which means taking into account the value of the scrap that will be used to make the next generation of structural steel sections. The average initial carbon emissions for steel on the UK market together with its high strength-to-weight ratio results in steel having an initial carbon that is comparable to other construction materials. But steel has other benefits. If you take into account the end of life attributes of steel such as its reuse potential and its recyclability, it is far more carbon efficient than any other construction material. In my view, 'Module D' and the circular economy approach are not being used correctly in some parts of the article in "The Structural Engineer". The whole life benefits of steel including the recycling and reuse of steel at the end of its life should not be overlooked. Steel can be recycled repeatedly with no loss of properties. Steel is 100% recyclable, unlike other construction materials and the current recovery rates from demolition sites in the UK are 99% for structural steelwork and 96% for all steel construction products. More information on this whole life carbon approach can be found in the new *Steel Construction: Carbon Credentials* publication enclosed with this issue of NSC.

The other benefit of steel is its adaptability. Re-working the structural frame to redevelop and repurpose existing building is much easier with steel and can be done to suit the client's changing needs. I recall the redevelopment of the Royal Mail sorting office on Oxford Street, London made use of the existing steel frame to re-purpose the building into a highly desirable modern building.

Steelwork Contractor members of the BCSA are committed to sustainable and responsible procurement and many have signed up to BCSA's Sustainability Charter, which has for "Gold" membership twelve charter requirements. The Charter covers not only specific sustainability requirements, but also more corporate social responsibility aspects including the company's involvement in their local community, health and safety, personal development, an equal opportunities policy and ethical trading policy, among others. The scheme has been in operation since 2005. Again, the BCSA and its members are leading the way in a similar manner as they did with CE marking and BIM.

As a structural engineer and a steelwork contractor I very much welcome the challenge we have in tackling the climate emergency, but this must be done by considering the wider sustainability issues including the circular economy and the inclusion of recovery, reuse and recycling.

Mark Denham
BCSA President

Steel completes for first HS2 tunnel facility

HS2 has passed another major milestone at the high-speed rail project's first tunnel site, with the completion of structural work on the temporary precast factory which will produce wall lining sections for the 10-mile long Chiltern tunnels.

Working on behalf of Align, a joint venture between Bouygues Travaux Publics, Sir Robert McAlpine, and VolkerFitzpatrick, a total of 2,400t of structural steelwork at the south portal site, next to the M25, has been delivered and erected by Caunton Engineering.

Two giant tunnelling machines – named Florence and Cecilia - are due to launch next year. The 170m-long, 2,200 tonne machines will spend more than 3 years underground and use 112,000 concrete segments to line the tunnels, moving at a speed of 15.6m a day.

A second steel-framed precast plant will be used to cast sections for the nearby Colne Valley Viaduct. Once work is complete, the precast plants will be disassembled and the whole site will be landscaped with material excavated from the tunnels and trees planted in order to blend it in with the surrounding countryside.

HS2 Ltd's C1 Senior Project Manager, Mark Clapp said: "The precast plant will play a crucial role in delivering the Chiltern tunnels. By casting all 112,000 segments on site, we can significantly reduce the number of HGVs on local roads, reducing disruption for the local community.

Daniel Altier, the Align Project Director, said: "Caunton Engineering is delivering the structural steel for all the buildings at our south portal site, 15 in total. This includes two tunnel precast factories, the tunnel workshop and warehouse, and the viaduct precast factory."

Matthew Shimwell, Caunton's Managing Director said: "We are thrilled to be working with the Align team in helping to deliver this key part of infrastructure work. The project is an excellent example of how early engagement with the supply chain brings real value to a project."

Steel frame completed for Edinburgh indoor sports hall

The steel frame, consisting of 2,100t of structural steelwork, for the new Meadowbank Sports Centre in Edinburgh has been completed.

When it opens, the sports centre will feature indoor facilities including an athletics hall, dedicated gymnastic and martial arts halls, squash courts, multi-use sports halls, gym and fitness studios. Outside there will be an athletics track with a dedicated, purpose-built space for throws and two all-weather 3G pitches.

The new state-of-the-art centre will replace the now-demolished sports facilities built more than 50 years ago, which were used for the 1970 Commonwealth Games.

Working on behalf of Graham Construction, Walter Watson has fabricated, supplied and erected the project's steelwork.

Some of the largest steel elements include a series of 24m-long tubular trusses and 24m-long beams that support the first-floor sports hall. Creating the column-free space on this floor, the roof of the centre is supported by a 40m-long Toblerone-shaped truss.

Forming the facility's main entrance is a series of 19m-high tubular columns, chosen for their aesthetic appeal, as the steelwork will be left exposed in the completed sports centre.

Plans revealed for excellent London office refurb

Aiming to achieve a BREEAM 'Excellent' rating, Skanska has been awarded the contract for the redevelopment of Norfolk House in central London.

Due to complete in mid-2022, the job comprises the creation of a new eight-storey, commercial office building, including the reconstruction of two brick and Portland Stone façades.

The project also involves additional excavation to create a deeper basement. Internally, it will be finished to a Category A standard across all office floors. It will also include two reception entrances on St James' Square and Charles II Street.

Steve Holbrook, Managing Director, Skanska,

commented: "We are thrilled to be undertaking this project on behalf of our customer. I believe we won this job because of the vast knowledge and experience from our in-house experts that will enable us to meet our customer's specific requirements.

"Our innovative approach enables us to deliver better and more effective projects for customers and our work on Norfolk House will have this at its heart.

"When finished, this building will provide high-quality, sustainable office space in a prestigious London location."

Multi-use arena planned for Dundee waterfront

Ambitious plans have been released for a large multi-purpose arena in Dundee, which could also be adapted to host large video-gaming events.

Northern Lights Arena Europe (NLAE) has signed an 18-month agreement with Dundee City Council, allowing the company to progress initial design concepts.

The arena, which would be built near to the V&A Dundee building, would provide educational and employment opportunities for Dundee, giving Scotland's digital economy a boost.

The arena would have 4,000 seats, an e-sports academy for further and higher education, as well as indoor sporting events, retail and workspace areas.

NLAE is working on the project with Abertay University, Dundee & Angus College and Nottingham Trent University's creative technology faculty, Confetti.

As part of the project, Abertay intends to develop a new range of degree courses related to the global e-sports job market, with students gaining access to bespoke facilities within the arena complex.

Football pools building to become film studios

The iconic former Littlewoods Pools building in Liverpool could be relaunched as a film studio.

Developer Capital & Centric aims to appoint a consultant to draw up fixed costs for the 25,500m² scheme, before entering the detailed design phase with architecture studio Shedkm and launching a tender to appoint a main contractor in the autumn.

Under the plans, the Littlewoods building on Edge Lane would be transformed into a hub for the film and television industry. UK-based Twickenham Studios has already agreed to take 7,800m² of the scheme, and Capital & Centric is in talks with an unnamed education provider that would take the scheme to around 60-70% pre-let.

The property was ravaged by a fire in September 2018 and has continued to lay derelict, with plans shelved pending the resolution of insurance claims and other funding needs. Liverpool City Council owns the freehold of the building and Capital & Centric owns the long leasehold.

Built in 1938, the building was home to the Littlewoods Pools, the precursor to the National Lottery, and employed hundreds of people in Liverpool. It also played a key role in World War II, manufacturing a variety of items for the war effort, including five million parachutes.

Talent development programme launched to support strategic growth

Cleveland Bridge UK has launched a new talent development programme, which it claims will support its national growth strategy in UK bridge building.

The company said it has invested in a long-term programme to enable its engineering teams to keep ahead of the knowledge and skills demands of the industry, as it sees continued year-on-year growth in activity.

Cleveland Bridge's ongoing commitment to create a long-term sustainable workforce, is also supported by its membership of the 5% Club – made up of more than 250 UK companies to have pledged that five percent of the workforce will comprise apprentices and graduates within a five-year period.

The talent development programme, which consists of a series of initiatives to recognise, support and promote talent within the business, aims to develop its next generation of engineers and leaders through training events, documented development plans, and programmes for apprentices and graduates.

Several of the Cleveland Bridge UK's apprentices, who have completed their training, have successfully been promoted already, with each of them having passed their Functional Skills Level 2 English and maths exams.

Diary

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

Tuesday 13 October 2020
Corrosion protection of steel by hot-dip galvanizing
Webinar for SCI/BCSA Members only
This Guest webinar will be presented by the Galvanizers Association and will provide a detailed technical overview of hot-dip galvanizing as a method of corrosion protection of steel and will cover a range of topics.

Tue 20, Thu 22, Tue 27 and Thu 29 October 2020
Steel Building Design to EC3
Online course
This course is delivered over 4 sessions and focuses on orthodox construction, covering the primary design issues for practicing engineers. The course follows the process of determining actions, considering combinations of actions, frame analysis and the assessment of second order effects. The course will then demonstrate how the resistance of members are calculated, but also how they can be extracted immediately from resources such as the 'Blue Book'.

Tue 3, Thu 5, and Thu 12 November 2020
Light Gauge Steel Design Course
Online course
This course is delivered in 3 sessions and introduces the uses and applications of light gauge steel in construction, before explaining in detail the methods employed by Eurocode 3 for designing light gauge steel members in bending and compression and calculation of section properties. Specific design issues related to the different uses of light gauge steel are addressed.

Tuesday 10 November 2020
Analysis and design of structures against explosions
Webinar for SCI/BCSA Members only
This webinar is for SCI Members only. It will cover analysis and design of structures against explosions.

Tue 17, Thu 19 & Tue 24 November 2020
Steel Connection Design
Online course
This course is run over 3 sessions and is for designers and technicians wanting practical tuition in steel connection design. The course concentrates on the design of nominally-pinned connections, in accordance with BS EN 1993-1-8, considering vertical shear and tying. The Eurocode approach to the design of moment resisting connections will be discussed, anticipating that software will be used for the design of these connections.

AI: the future of iterative design

Craig Johnson, Regional Account Manager – Steel Division at Trimble, explores the future potential that Artificial Intelligence could bring to the world of BIM.

BIM is an area of constant development, with many in the industry continually looking for ways in which we can further push the efficiency and productivity benefits that technology can offer to detailing, engineering, fabrication and construction workflows. Parametric design, or data-driven design as it is also known, is perhaps one of the most recent developments, with an increasing number of detailers and engineers adopting this way of working.

By using parametric design tools in conjunction with modelling software, designers are able to input the required rules, parameters and design algorithm and have the computer then generate the design output. A natural progression of this is the idea of computer-driven design. Here, you can push technology further by inputting the required parameters and allowing the computer to automatically generate various different design iterations, in an effort to determine the most optimum and efficient design solution.

With an increasing number of people now adopting parametric design within their BIM workflows, allowing the software and technology to have more power while still remaining in control of the inputs and outputs, the question is: what's next?

While cloud-based software, such as Trimble Connect, is not necessarily new, it continues to be a great way of enabling a connected workflow, facilitating collaboration and communication between project teams. Essentially a huge, unlimited data storage facility, a project's BIM model can be stored in the cloud, along with all of its associated drawings, schedules and documentation, which people can access, review and individually work on. However, what happens once a project has been completed? Often, the majority of this valuable data remains in the cloud, un-used and un-utilised by its owner. Yet, the rise of Machine Learning and Artificial Intelligence (AI) could change this.

Put simply, AI is a form of machine-learning, whereby it takes existing data and information and uses this to develop its own intelligence system; to learn and think in a way similar to humans and provide its own solutions. Typically, the more data a machine is exposed to, the better it will become at detecting and internalising patterns in said data and understanding and providing insights.

Within the BIM and construction industry, AI has the potential to successfully harness and utilise the significant amount of past project data currently unused, in turn helping to further improve and enhance our productivity and efficiency levels.

While every building structure is itself unique, detailing and modelling tasks can often be repetitive by way of nature and design. For example, different steel beams and columns and their various connection solutions are often commonly occurring within a design project. It is these similarities in data that offer the potential for automation; with a company able to utilise their experience and known good design choices from past projects to help automate, design and optimise the new.

Take the task of detailing a complex steel connection as an example. Through the use of AI and machine-learning, it is possible that BIM software may (in the future) be able to detect similarities and patterns between a user's new model and their previously completed designs, automatically suggesting and recommending design solutions based on past projects. In this case, the optimum design could feature fewer welds, fewer bolts or even less steel, making it more cost-effective as well as easier to fabricate and assemble on site.

In addition to the time-savings that automated technology could deliver, both in terms of the initial detailing work and improved accuracy resulting in less rework, it could also contribute towards achieving the most optimum and efficient design. Imagine if AI technology was able to look at completed designs and categorise what worked well and what didn't; taking this existing data and using it to improve the new. Collaborative platforms could even then feed fabricator and construction information, such as costs and time, into this, resulting in new BIM designs that are driven by fabrication and construction, in addition to design. What was easy to fabricate? What was easy to install? What was most cost-effective? What was most successful?

Ultimately, however, the success of AI in complex environments, such as BIM, depends greatly on acceptance. In order for the industry to benefit from such technological advancements, there has to be a sense of trust – trust and confidence in the solutions that such automated and machine-learned software suggest. Only then can we truly reap the rewards of our technological advancements.

For more information, please visit *www.tekla.com/uk/*

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Structural Steel Design Awards 2020

Foreword

By Richard Fletcher, Regional Business Director, Trimble Buildings.

Although Trimble have been involved with the Structural Steel Design Awards for a relatively short time, we continue to be impressed with scale, scope and complexity of the projects submitted. The flexibility of steel shines through with the variety of the entrants and the use of advanced digitalisation that the structural steel industry has embraced as an enabler for the design, detail and manufacture of such impressive structures.

As we look to construction to be at the forefront of assisting in the drive to return the economy back to pre-coronavirus levels, healthy, innovative and diverse structural steel and structural engineering industries will together form a significant part of that recovery.

The entrants and winners of the SSDA in 2020 demonstrate that our industry is in a strong place and on behalf of Trimble I would like to congratulate the winning project teams.

The Judges

Christopher Nash is a senior Consultant Architect. He graduated in 1978 from Bristol University School of Architecture, and was at Grimshaw Architects from 1982, becoming a Director from 1992, Managing Partner from 1998 to 2008, and retiring from the Partnership in 2012. While at Grimshaw he was responsible for many of the practice's high profile buildings. These include - from his early years - the Financial Times Printing Works in London's Docklands and the British Pavilion for the Seville Expo 92, The Western Morning News headquarters in Plymouth, the RAC Regional Headquarters in Bristol and many other projects. Following the success of the Zurich Airport fifth expansion project, he returned to a smaller scale of work with the Cutty Sark Conservation Project. Chris continues to practise as a consultant in architectural practice management, architectural education and property development.

Richard Barrett was Managing Director of Barrett Steel Buildings for over 20 years prior to its sale in 2007 in a management buyout, and is a Director of steel stockholder Barrett Steel. Richard studied engineering at Cambridge University, graduating in 1978. At Barrett Steel Buildings, he developed the business into a leading specialist in the design and build of steel-framed buildings for structures such as distribution warehouses, retail parks, schools, offices and hospitals. He was President of the BCSA from 2007 to 2009, and was a member of BCSA's Council from 1994 to 2017.

Paul Hulme joined Robert Watson & Co as an apprentice draughtsman in 1981. In the following 36 years he held positions in all areas of the company, gaining appreciation of all aspects of the steelwork industry, most recently in the role of Project Director. Over the years Paul has been fortunate to be involved in many complex steel structures, both in UK and abroad. Most notable are Kansai and Hong Kong airports, Terminal 5 roof, London 2012 Olympic Stadium and Wimbledon Centre Court Redevelopment. Paul currently works as an independent consultant offering design and buildability advice to the construction industry. Paul is a Fellow of the Institution of Civil Engineering.

Sarah Pellereau is an Associate at Price & Myers with 19 years' experience. She has been involved in a number of award-winning schemes including leading a project shortlisted for the Stirling prize. As a Structural Engineer, she is rare in having graduated with a Part 1 in Architecture as well as a Masters in Engineering from the University of Leeds. She has a diverse portfolio of experiences in structural design but also has worked on-site with the CTRL alterations to St Pancras Station and tutored at Nottingham University.

Roger Plank is a structural engineer and, having recently retired as Professor of Architecture and Structural Engineering at the University of Sheffield, is currently a director of Vulcan Solutions Ltd offering software and consultancy services in fire engineering. He has collaborated extensively with the steel construction sector in the fields of fire engineering and sustainability, and is a Past President of the Institution of Structural Engineers.

Julia Ratcliffe is an independent Structural Engineering consultant and founded scale consulting in 2018 after twelve years working with Expedition Engineering and as a Director of the practice from 2011. In her career, she has worked for major consultancies in the UK and overseas as well as with international development organisations. Her design projects range from towers, bridges and cultural institutions to residential masterplans, refurbishments and private houses. She is a fellow of the Institution of Structural Engineers and a Professional Engineer, licensed in the state of Connecticut, USA, a Design Council CABE built environment expert and has served on award judging panels for RIBA London and the IStructE as well as the BCSA.

Bill Taylor is an architect in private practice. Having joined architects Michael and Patty Hopkins straight from Sheffield School of Architecture in 1982, he became their partner in 1988. He was a pivotal figure in the development and success of the practice both in the UK and overseas and was responsible for a large number of award-winning projects, many of which received a Structural Steel Design Award. Bill is a founding member of Tensinet, the pan European organization researching lightweight and tensile construction. In 2010 Bill left Michael and Patty to concentrate on his own projects and from 2012 has collaborated with architect Robin Snell and his practice. He has been a member of the RIBA National Awards Group and CABE Panels and is a Senior Assessor and Client Adviser for the RIBA competitions programme.

Oliver Tyler joined Wilkinson Eyre Architects (WEA) in 1991 becoming a Director in 1999. He has spent over 25 years in architectural practice and has extensive experience in leading and coordinating the design and construction of many high profile buildings and infrastructure projects. Oliver has led a number of prestigious projects at WEA including Stratford Regional Station in London for the Jubilee Line Extension; the Dyson Headquarters in Wiltshire, regional headquarters for Audi in west London, the Arena and Convention Centre in Liverpool, the UK's first urban cable car, the Emirates Air Line and most recently a new office building in Finsbury Circus. Oliver is currently leading a number of major infrastructure and commercial office schemes in the City of London, including Liverpool Street Station for Crossrail, the Bank Station capacity upgrade project and a 50-storey office tower on Leadenhall Street.

Introduction

By Christopher Nash RIBA – Chairman of the Judging panel.

Keeping a sense of normality during a global pandemic has been difficult for everyone. The SSDA judging process was this year constrained by the national lockdown, as our usual visits to see, understand and experience shortlisted projects 'in the flesh', and to meet the project teams in person were not possible. So, for the first time in the 52 years of the award scheme, we relied on technology to examine the entries online, and understand the shortlisted projects with entries presented by the project teams remotely.

Again, this year I was very pleased to moderate the discussions of our talented team of architects, engineering designers and experts from the steel fabrication industry. It was beneficial that our team of judges has remained constant as, without being able to actually meet in person, in our familiarity we could still rely on the opinions being argued robustly over the airwaves. As usual members of the panel brought their normal enthusiasm and enjoyment to the job, as well as fair-minded professional judgement.

This year there was a wide range of types of projects entered for the scheme. Scales of entry range from the largest prestige city office buildings, to smaller educational projects, and beautiful footbridges. The judges were particularly interested in projects that reflected a reuse of existing structures, and those that exemplified the logistics of overcoming time and spacial constraints, rather than just the beauty of the finished projects.

As in previous years a preliminary selection was made on the basis of a close examination of the entry documents. The entrants of resultant shortlisted schemes were then invited to present their project by 'MS Teams' or 'Zoom' to at least two judges from different disciplines. I want to thank and pay tribute here to the project teams for in every case working so well in getting together online and presenting such excellent and clear explanations of their projects and answering the judges' questions. Well done everyone for making the case for your entries so well!

The awards, commendations, merits and national finalists rewarded by the scheme reflect the achievements of the current steel construction industry. Everyone involved should be proud of what has been achieved. I believe that, notwithstanding the difficulties encountered this year, the Structural Steel Design Awards still reflect the quality of the achievement and look forward to a return to normal operations next year.

52 Lime Street, London

FACT FILE
Architect: Kohn Pedersen Fox
Structural engineer: Arup
Steelwork contractor: William Hare
Main contractor: Skanska
Client: WRBC Development UK Limited

Known as the Scalpel, 52 Lime Street is a dramatic, sleek and geometrical addition to the high-rise City of London landscape.

Designed by architects Kohn Pedersen Fox, 52 Lime Street has since its inception been dubbed the Scalpel, because of its dramatic architectural shape with asymmetric facets and a pointed attic roof structure.

Setting it apart from its neighbours in the City of London's cluster of high-rise buildings, the Scalpel features an inclined northern façade, which has a diagonal fold line running from top to bottom.

This façade is formed by a series of cranked plate girder columns, spaced at 6m centres. For the double-height ground floor these columns are vertical, but from the first floor they are cranked and slope inwards all the way to the building's pointed top.

Overall the structure has 42-storeys, including 36,966m^2 of internal office space spread over 35 floors. It is said to be a tall, yet sympathetic addition to the City, designed with particular regard to distant and local views.

The tower leans in such a way that it is invisible behind the dome of St Paul's Cathedral when approached from the west along Fleet Street, while the roofline falls away sharply to the south in recognition of the overall composition of the City cluster.

The structural frame consists of a composite design with steelwork supporting metal decking and a concrete slab. All of the floor beams are 670mm-deep fabricated plate girders with service holes to allow service integration within the structural void.

Commenting on the decision to use a steel framing solution Skanska Project Director Ian Perry says: "Using steelwork is the most efficient option for this type of construction project as buildability and speed of construction are vital on a city centre job."

The use of steelwork allowed the scheme to achieve a greater floor space, which was one of the client's specifications.

Unlike many commercial buildings, the Scalpel's main core is offset and positioned along the south elevation, which allows the structure to maximise its internal floor space with spans of up to 20m.

Having an offset core, coupled with an inclined north elevation, means that the loads on the building are eccentric from the main stability-giving core. To counteract

this, the north elevation, as well as the east and west façades, were designed as large perimeter moment frames to add stiffness to the building. The frames also allowed the steel erection to continue with a minimal temporary works needed, which significantly reduced cost during construction.

Cost also plays an important role in any construction project and the use of a BIM model on this scheme helped the team ensure the steel frame was as efficient as possible.

"We made a considerable weight saving as all of the beams have varying flanges and webs depending on the relevant loadings," explains Arup Project Engineer Steve McKechnie. "All of this was worked out automatically via the BIM model."

Steelwork contractor William Hare undertook and completed a complex construction sequence to complete the project. One of the main challenges was one of the final elements – the iconic triangular attic.

Positioned at the peak of the structure, the 10-storey triangular attic houses the plant and maintenance walkways. In order to make the erection of the attic structure as smooth as possible this portion of the building was trial erected in the fabrication yard, so the extremely complex fabrication and tight tolerances could be fully tested and proven.

Following the trial assembly, the structure was dismantled and transported to London in the largest possible pieces, in order to reduce the piece count and allow for erection on-site by tower cranes.

William Hare says the use of a complex pre-set strategy ensured the final position of the structure was within design tolerances. The attic was designed to be erected floor level by floor level, with each immediately stable upon erection. Designing the attic in this way was vital as there is no core at the top of the building to give stability and no internal floors to provide diaphragm action.

The triangular shape of The Scalpel and the prevailing south-westerly winds that regularly hit the structure's narrowest point, meant that a total of seven viscous dampers had to be installed within the north elevation of the steelwork.

Viscous dampers are hydraulic devices that dissipate the kinetic energy of the building and stop the build-up of uncomfortable side-to-side accelerations in a wind storm, improving the user experience and the durability of the building. It is said that by designing the viscous dampers into the stability system of the building they provide damping at a fraction of the cost and use less space than traditional 'Tuned Mass Dampers'.

In summary, the judges say taking its place within the cluster of prestigious tall buildings in London's financial centre, the distinct inclined outlines of 'The Scalpel' complement the surrounding profiles.

Ground-breaking savings in both costs and embodied carbon have been achieved by innovative solutions including integral damping and advanced digital design. Advanced use of BIM, along with full-scale trials enabled compact integration, maximising letting areas.

A14 Cambridge to Huntingdon Improvement Scheme

Two projects on a major £1.5bn road improvement scheme highlight why steel is the ideal material to form long bridges quickly and efficiently.

Highways England's £1.5bn A14 improvement scheme between Cambridge and Huntingdon is said to have relieved congestion, unlocked economic growth, improved safety and enhanced the local environment.

The old A14 was notoriously congested and suffered from numerous delays as it is used by almost 85,000 vehicles every day, far more than it was originally designed to accommodate.

The improvements include a new bypass to the south of Huntingdon, widened sections of both the existing A14 and A1 trunk roads, the creation of new local access roads, and improved junctions.

There are numerous bridge structures along the route of the scheme including the scheme's showpiece bridge; a 750m-long viaduct over the River Great Ouse, and two identical 1,050-tonne bridges to carry a major roundabout at Bar Hill Junction over the new A14. Weathering steel was used for all three structures to provide the required durability with minimal future maintenance.

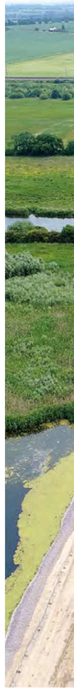
Commenting on the use of steel, A14 Integrated Delivery Team Construction Director Jim McNicholas says: "Prior to coming to site we carried out a value engineering exercise and from this we decided that any structure that was 40m or longer would be built with steel."

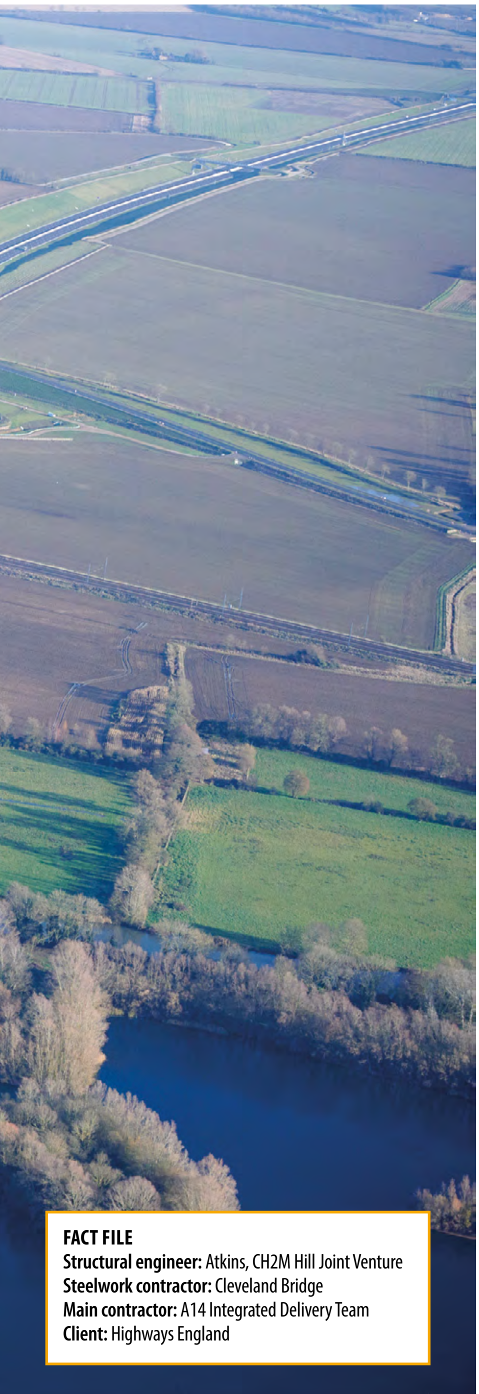
The River Great Ouse Viaduct required 6,000t of steel, comprising 76 separate main girders and 800 cross girders. The ladder deck bridge spans the river itself and a large area of floodplain on either side. Supported on 16 pairs of piers, most of the main girders are 40m-long, 2m-deep and weighed 50t. The section of bridge that crosses the river has a longer span requiring more complex girders, with larger, deeper haunches to carry the greater load.

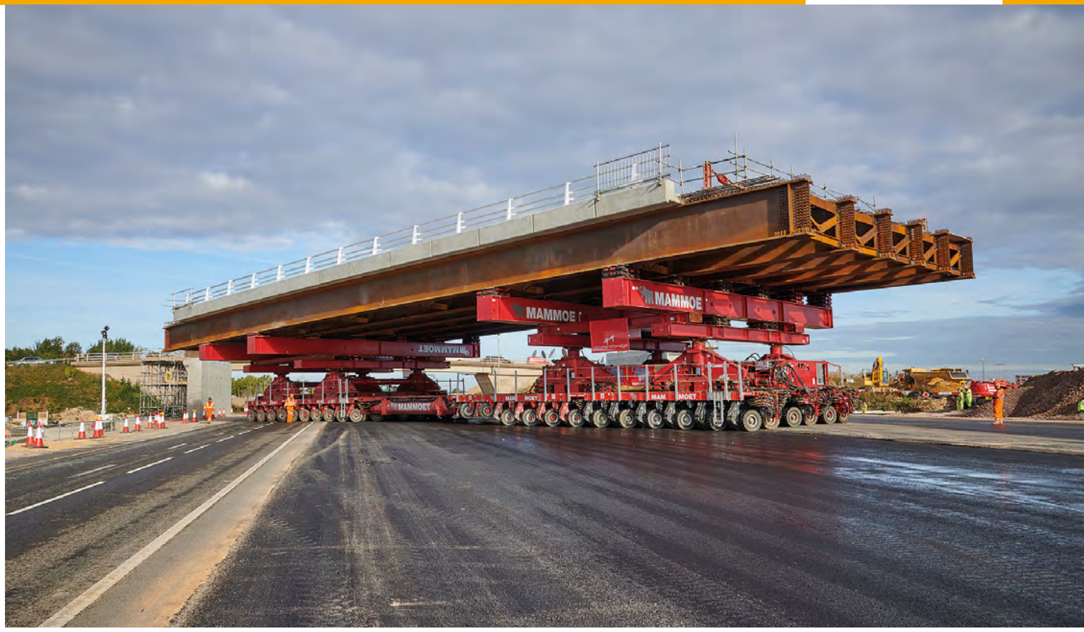
Due to the height of the haunch girders, they had to be transported lying on their side. This meant Cleveland Bridge had to devise a method of righting them and then lifting them into position once on site. A claw assembly was designed that clamped around the top flange and rotated the girder into an upright position as it was lifted. Once the girder was upright, a slight move in the position of the lifting shackles in the claw enabled the girder to be lifted into place.

In order to produce the cross girders more efficiently, a new welding procedure was devised that involved modifying the T & I machine with two welding heads on each arm, instead of the usual one, allowing twice the amount of weld metal to be placed per metre per minute.

A time-saving construction method adopted on this viaduct was the use of precast concrete slabs for the deck rather







than the more traditional insitu concrete deck slab. This meant that the concrete deck units could be installed simultaneously, while steelwork erection was still in progress further along the bridge. This construction sequence demanded close coordination and also meant that every piece of steelwork had to be fabricated to extremely tight tolerances to ensure a precise interface with the precast concrete slabs.

A temporary platform on the floodplain under the length of the bridge provided a solid base for cranes and lorries, but a different crane was offered to the one originally specified. By using a 600t-capacity crawler crane in place of a 300t-capacity crawler crane, the installation team could install all girders from one position at each 'bay', as well as being able to install all the heavy girders at the river span section. By minimising the crane movements, an installation rate of one bay per week could be maintained and even accelerated during periods of good weather.

The viaduct was completed on budget and ahead of schedule.

The installation of the twin bridges at Bar Hill Junction over the new A14 maximised the advantages of offsite steel fabrication and rapid assembly to improve programme times, reduce environmental impacts and minimise disruption to road users.

The multi-girder bridge decks, each measuring 47.5m in length comprise three pairs of braced main girders supporting GRP permanent formwork and an insitu concrete deck slab. Overall, each deck contains 330t of steel and 720t of concrete.

The original plan was to erect the bridges piece-by-piece using a crane. This would have involved closing the A14 for a number of weekends, causing significant disruption. However, a more cost-effective scheme was developed that allowed both bridges to be constructed offline prior to installation, and then installed using self-propelled modular transporters (SPMTs).

Following unforeseen programme delays, the site erection scheme was modified to reduce the time required on site even further. Instead of delivering the bridges as part-length paired-girders, they were delivered as 12 full-length single girders. This removed the need for main girder joints to be welded on site, which reduced the overall programme by three weeks. This also significantly reduced the number of deliveries to site from 18 to 12, minimising environmental impacts from transportation.

All steel components were fully trial assembled at the factory prior to delivery to ensure accurate fit-up. The girders were then delivered to a large temporary set-down area that was created close to the bridge site. Upon delivery, the single girders were placed onto specially constructed trestles and braced together. GRP permanent formwork and cantilever edge formwork were then added and the insitu concrete deck slab cast. The offline deck slab construction significantly reduced the overall construction programme.

Civil engineering works on site, including the construction of the concrete abutments, were undertaken in parallel with girder fabrication, so close collaboration was essential to ensure that both elements interfaced perfectly.

The A14 was closed to traffic at 9pm on a Friday to allow the sections of the existing A14 carriageway to be infilled and surfaced. The fully concreted bridge decks were then lifted from the trestles onto the SPMTs, and manoeuvred at less than 1mph onto and along the carriageway. The decks were positioned by the SPMTs and lowered precisely onto the concrete abutments.

Both bridges were installed during a single 11-hour period and the road was clear for reopening at noon on Sunday, an incredible 18 hours ahead of schedule

The judges were impressed with the innovative solutions the project team employed to minimise disruption, optimise the programme and ensure flawless execution on site.

FACT FILE
Structural engineer: Atkins, CH2M Hill Joint Venture
Steelwork contractor: Cleveland Bridge
Main contractor: A14 Integrated Delivery Team
Client: Highways England

Bath Schools of Art and Design

© Chris Wakefield

A retained steel frame has been combined with new steel elements to create a modern educational facility.

FACT FILE
Architect: Grimshaw Architects
Structural engineer: Mann Williams
Steelwork contractor: Littleton Steel
Main contractor: Willmott Dixon
Client: Bath Spa University

Opened in 1976 as Herman Miller's primary UK furniture factory and later purchased in 2016 by Bath Spa University, the Grade II-listed building has now been refurbished into a new home for Bath Schools of Art and Design.

According to Grimshaw Architects, the key ambition of the project's design was to retain as much of the existing steel-framed building as possible.

To this end, the steel façade frame has been kept as it supports a flexible modular system of glazed and solid panels, as well the primary structure of continuous secondary roof beams that create 20m-long internal spans.

Beyond the challenges of retaining and refurbishing the existing frame, a new steel structure raises the roof by 1m, supports a new roof deck for extensive plant equipment, supports a rooftop extension above the existing building and encloses two wings of flexible workshops and studios, as well as providing a substantial new mezzanine level.

Grimshaw Architects' Principal Ben Heath says the original Herman Miller factory building's listing directly references the distinctive bright yellow 'high-tech' steel frame, which provided one of the key architectural expressions.

"The conversion integrates a new steel structure, building upon this structural design aesthetic and principles of flexible workspace.

"The use of steel delivered the large uninterrupted flexible volumes which allow for its adaption over time. It also provides the aesthetic for the building at a number of scales from the structural frame and expressive structural connections right down to the steel brackets which support the services, lighting, signage and furniture."

Willmott Dixon Senior Building Manager Martin Dando agrees and adds: "The existing steel frame was listed for its architectural importance. The key challenge was erecting new steel frames within the existing steel to create the new facility without compromising the structural integrity or the original design philosophy.

"The compatibility of old and new was the driver for this. The new steel frames interact with the existing. Other types of superstructure could not achieve the same harmony the new steel provides."

The project's unique design has also become a mandate to teach differently. In the past, teaching practices adapted to suit the building, but this building informs teaching in a different way putting flexible creative enterprise at its heart.

To facilitate this, the new steel roof is raised by Vierendeel steel trusses, allowing a flexible network of 'plug & play' services to run at high level. This allows the spaces below to be reconfigured as required. The modular façade system also allows the elevation to be easily reconfigured to respond to changing internal requirements.

The mezzanine floor beams have additional web openings to allow for future servicing and both the mezzanine and rooftop pavilion are designed to allow the internal layout to be reconfigured to suit future needs. All structures are framed to be independent of the existing to allow for future removal or adaption without detriment to the original.

Within the building, reflective areas

encourage students to indulge in discourse outside of their usual disciplines. Communal open spaces encourage 'bumping into' of staff, students, professionals and visitors, providing unknown opportunities. While professionalised spaces such as the gallery, art shop, rooftop, a publicly accessible café and riverside landscape, are designed to actively engage enterprise activities and the local community.

With an emphasis on what the University calls 'thinking through making' the students and their creative practice are placed central to the design of the new campus. The design located the immense workshop facilities in the centre of the building to enable focused support from specialist technicians, and the ability for students to move seamlessly between materials and processes, whilst then allowing the mezzanine to be open and highly flexible.

The new raised roof structure spans above the existing beams, moving the load of the roof closer to the columns. This maximised the capacity of the existing structure so the roof could support increased insulation, PV's and rooflights.

The new Vierendeel trusses were fabricated offsite in two parts, and craned into position, before being bolted together. The majority of the structural steel relies on bolted connections, with long term benefits to deconstruction, and protecting the integrity of the existing listed structure.

To this end the new rooftop extension is supported on steel columns and cantilevered trusses that thread between the existing steel beams, as an independent structure, with half the columns making use of existing pad foundations that were provided to allow for a future extension. The new rooftop plant deck structure also follows this same ethos.

More than retaining significant embodied carbon within the building, a key outcome for the project was to ensure that the energy performance was brought up to modern standards and beyond, safeguarding its long-term future.

The entire envelope was upgraded to provide dramatically improved thermal performance through new double glazing, additional insulation and much improved air-tightness. The new roof provides over 100 rooflights, reducing the reliance on artificial daylighting, and PV's providing over 10% of the building's energy consumption.

In summary, the judges say this project involved a major re-purposing of a Grade II-listed industrial building, thus validating key concepts of the original 1970s design - adaptability and sustainability. Structural additions were separated from the existing, requiring careful installation and the façade sensitively upgraded to improve performance. The result is a building of exceptional quality ideally suited to its new use.

All images on this page © Paul Raftery

Brunel Building, London

Exposed steelwork has created a stand-out commercial building in Paddington named in honour of a famous engineer.

Named in honour of Isambard Kingdom Brunel, who built the adjacent station for his Great Western Railway, the Brunel Building would undoubtedly have delighted the famous engineer with its exposed engineered steelwork and multiple connections, which sits perfectly next to his giant iron-framed station shed.

"As well as offering recognition to Brunel, as his first-ever bridge was once located on the northern boundary of our site, the steel design has enabled us to express the structure in a contemporary way and create the desired clear internal spans," says Fletcher Priest Architects' Senior Project Architect Chris Radley.

The architectural brief was to create a landmark building which provided high-quality, innovative, people-centred workspace and which would re-engage the site with the canal.

Within the structure, services are exposed to maximise flexibility and workspace volume. This logic is continued externally with an exoskeleton positioned outside the façade.

The exoskeleton structure extends beyond roof level to create glazed, wind-sheltered gardens on the 15th and 17th floor levels. It also shades the large expanses of glazing, affording scenic panoramic views across the west London skyline.

This approach brought many benefits to the building, including tall, open column-free workspaces, 25 per cent solar shading and a dynamic appearance. This celebration of steelwork is said to extend to the artwork commissioned for the building, most notably James Capper's maritime-inspired steel 'Tread Pads' which are suspended above the reception by slender Macalloy rods.

Despite the bespoke nature of the building, a regular 6m floor beam spacing was used with precast lattice slabs set down into the web zone of the supporting steel plate girders. The services and structure are seamlessly integrated, thus enabling a more efficient use of the available structural depth and maximising floor-to-ceiling heights.

A semi-unitised curtain-wall cladding system with an insulated strong-back

FACT FILE
Architect: Fletcher Priest Architects
Structural engineer: Arup
Steelwork contractor: Severfield
Main contractor: Laing O'Rourke
Client: Derwent London

© Jack Hobhouse

© Dirk Lindner

system provided a considerable amount of repetition together with flexibility where required.

The building's adaptability and high architectural quality should also allow the structural design life to be met and exceeded. A detailed whole-life carbon assessment of operational energy and embodied carbon associated with construction was conducted. It forecast a 71 per cent operational energy improvement over a typical Econ19 office fit-out and a 7.5 per cent reduction against a typical UK new-build CAT A office building.

For the steelwork design, floor beams span directly from core wall out to the exoskeleton. One consequence of this is that the location of the floor beams on each level varies so to meet the exoskeleton support. This means that beam location varies slightly on each floor and thus beam spans and service opening locations also vary on each floor. The project team used digital workflows to optimise and communicate plate thicknesses, weld sizes, connection designs, pre-cambers, movements, and fabrication and installation information.

For example, close collaboration between all parties allowed the various stiffness factors, tolerances and construction sequence impacts to be considered and individual pre-camber values agreed for each beam in the building.

This also provided a challenge for the contractor & MEP sub-contractors which they solved, in part, by projecting the MEP sub-contractor information onto the relevant ceilings while the operatives installed the required equipment and service runs.

Where floor beams pass through the façade, they are haunched so that the head of the glazing can be raised, increasing daylight penetration. At the core end, they are haunched to allow air distribution ducts to pass beneath.

This notch was unstiffened at the request of the architect, and justified using plastic design – including non-linear finite element modelling. The beams meet the external structure with a thermally broken connection encased in an insulated stub collar, which is removable to allow for future inspections.

All in all, the exoskeleton defines the character of the building, as it is a visual focal point, and contributes to the external shading, with the inclined columns and braces carrying the gravity loads at the perimeter of the building and bridging over constraints below ground level.

The project team say the realised project could only have been achieved with a steel frame. It allowed long spans and integral MEP service runs to be achieved. The exoskeleton and floor beams are plate girders and thus a high level of optimisation could be achieved by varying individual plate thicknesses and beam pre-cambers while still maintaining the same design intent. Visible, legible connections could be achieved in steelwork which formed part of the design aesthetic of the project.

In summary, the judges say this project shows how a proactive client working with a talented team can produce a commercial office building of the highest integrity.

Expressed structural steelwork in the external frame and floor structures is dramatic and dynamic; all is detailed with great care and attention. A roof garden overlooking Paddington station and the canal basin provide a welcome extension to the public domain.

The Curragh Racecourse Redevelopment, Kildare

A grandstand with a dramatic cantilevering roof is the centrepiece of a wider racecourse redevelopment masterplan.

FACT FILE
Architect: Grimshaw Architects
Structural engineer: AECOM
Steelwork contractor: Kiernan Structural Steel Ltd
Main contractor: John Sisk & Son
Client: The Curragh Racecourse Ltd

The Curragh is one of the world's most famous racecourses and said to be the spiritual home of flat racing in Ireland.

To maintain its competitive position as one of the top racing venues, a redevelopment of the site has been undertaken to meet anticipated future demands.

At the heart of the masterplan is a new grandstand, whose design had to respond to the site's unique context in an elegant, yet unobtrusive style. In its formal expression, the new grandstand is comprised of stacked horizontal forms, crowned with a dramatic soaring cantilever roof that recognises the planar landscape in which it is set.

According to project architect Grimshaw, the dramatic 7,200m² cantilever roof design was key to creating the architectural vision, with the envelope surfaces tuned to mask the depth of the structure and create a gravity-defying illusion with cantilever spans ranging from 27m in the central area to 45m in the double-cantilevered corners.

The roof structure, supported on the exposed precast concrete grandstand frame below, consists of a regular arrangement of steel cantilever trusses tapering into open plated sections at the tips to create the razor-sharp leading edge as well as simplifying fabrication. Additional spine trusses follow the diagonal hip line of the roof corners, creating a two-way lattice frame with optimised planar geometry.

AECOM Project Engineer Michael Orr says the main challenge for the Curragh Racecourse was the design of the steelwork forming the doubly cantilevered roof and specifically the detail design and fabrication of the complex three-dimensional nodes supporting the dramatic overhangs.

"The nodes, and their interfaces with the exposed concrete structure below, required intensive collaboration between AECOM's designers and the steel fabricators to resist the high concentrations of load from the two-way spanning structure, and to ensure all tolerances and pre-setting requirements could be achieved. This allowed the sharp leading edge of the roof to be perfectly aligned after de-propping."

The roof design also allowed the MEP plant to be concealed within the roof space with no detriment to the overall form. The result is a total steelwork mass of approximately 115 kg/m² for the majority

© Gareth Byrne

© Matt Browne/Sportsfile

of the roof area.

Integrating the structural solution with the building envelope was also key to the success of realising the team's mutual vision. For the long-span double-clad roof AECOM's structural engineers and façade engineers worked hand-in-hand to deliver a holistic design solution, minimising the overall quantities of structural steelwork by ensuring all steel surfaces were fully coordinated with the cladding fixing requirements. This included integrating with the MEP, lighting and rainwater collection systems without compromising the structural or visual integrity.

"Structural steelwork was used as it was the only cost-effective solution that could meet the demands of the design, in terms of achieving structural performance and creating the architectural drama of the slender cantilevered roof," adds Mr Orr.

The benefits of steel also extended to the use of modular truss components. These were used where possible and maximised the benefits of offsite fabrication, allowing for flexibility in the construction sequence, meaning that the adjacent racecourse could remain operational during the construction works; both for training and a full summer race season; and provided good site tolerance for the installation of the roof finishes to create the seamless continuity of the envelope.

Meanwhile, the copper colour of the roof is said to reference the rural, Irish vernacular and agricultural heritage of Kildare, while the contemporary panelled roof structure, comprised of aluminium sinusoidal panels, provides a striking yet empathetic appearance amidst the rolling countryside. Drawing on a palette of neutral tones, the range of material finishes to the buildings consciously link to the local flora, geology and the traditional rural architectural of its setting.

The Racecourse is designed around the movement and flow between the parade rings, the betting and hospitality areas, and the racetrack, with each of the public spaces designed to have a distinctive atmosphere and identity that celebrate the spectacle of racing. The design creates flexible spaces that can be utilised by the racecourse throughout the year to generate revenue outside of racing.

There was a desire to adopt a genuinely positive approach to sustainability, and the focus was on lean design and the intelligent use of materials including cement replacements, recycled steel, and the adoption of rainwater attenuation and rainwater harvesting as part of a sustainable drainage system. Natural ventilation utilises the exposed thermal mass of the frame internally and is supplemented by smart sensors, actuators and efficient systems design to minimise the building's energy use.

The structure supports high performance glazing systems to maximise daylight to the main public spaces. A fully integrated access and maintenance strategy was developed with the design team to ensure all aspects of the building fabric can be accessed and maintained as required. The use of high-performance protective coatings and finishes ensured a durable and robust product.

The judges say, a blade-like aerofoil roof is now the dramatic centrepiece to this open landscape and world-famous sporting venue. Behind this bold architectural statement lies a highly-accomplished level of detailed design, precise fabrication, and accurate construction to the most demanding of tolerance requirements. A great team effort.

Tintagel Footbridge, Cornwall

The two halves of Tintagel Castle have been reconnected for the first time in more than 500 years by a new steel footbridge.

Managed by English Heritage, Tintagel Castle is one of the UK's most important historic sites and draws more than 200,000 visitors a year and up to 3,000 a day in the peak summer season.

Perched on two rocky outcrops along the north coast of Cornwall, Tintagel Castle is a spectacular site, divided by a steep gorge. The main part of the castle is predominantly positioned on a headland, which was once linked to the mainland and its gatehouse by a narrow strip of land that was lost to erosion sometime during the 15th or 16th Century.

Subsequently, visitors crossed a wooden bridge at the foot of the void and climbed a series of vertiginous steps onto the island. This restricted access caused significant congestion in the summer months and ruined the experience for many visitors.

The opening of the new footbridge has alleviated this problem and restored the original link, allowing visitors once again to walk in the footsteps of the site's medieval inhabitants.

English Heritage's Chief Executive Kate Mavor says: "Tintagel Castle has been made whole again. Once more, people will cross from one side of the castle to the other and their footsteps will echo those from hundreds of years ago.

"As a charity, English Heritage's core purpose is to care for historic sites like Tintagel Castle and to inspire people to visit them. Our new bridge does both – protecting the castle's archaeology and bringing its story to life in a brilliant, imaginative way."

In order to achieve the client's vision, the design had a number of considerations and challenges to overcome, not least the site, which is inaccessible for many vehicles and large deliveries of materials.

Project Architect William Matthews says: "The design of the footbridge is relatively simple – two 33m-long cantilevers which reach out from each abutment and don't quite meet in the middle.

"The central gap serves two functions; technically it allows each bridge half to expand and contract with variations in temperature; and poetically it creates a threshold between the mainland and the island. A series of 16m-long rock anchors tie the bridge halves into each cliff face."

© Jim Holden

The palette of materials is said to be equally simple. Painted mild steel has been used for the main chords, duplex stainless steel for the cross bracing, deck trays and balustrading; Delabole slate laid on edge for the deck finish, and untreated English oak for the handrail.

Each material was selected for its durability as the site is in an extremely harsh marine environment. Architecturally, the aim was to create a bridge which was resolutely contemporary in its design and fabrication, but also timeless and complementary to its setting.

The steel element was chosen as a lightweight solution and one that could be fabricated offsite into deliverable pieces. Getting the steel elements to site was just one of the challenges that needed to be overcome, as the gatehouse can only be accessed by one narrow lane. A multi-axle vehicle was used to deliver the steelwork and navigate the winding road.

Lifting the steel into place was another significant challenge, with no room or access for a crane in the gorge, which is more than 60m-deep. A cable crane was installed, more commonly used in mountainous regions such as the Alps, to supply materials and even personnel to otherwise inaccessible locations.

The cable crane had a 5t lifting capacity, could pick-up steel elements from a small holding area on the headland and

FACT FILE
Lead Architect: Ney & Partners
Co Architect: William Matthews Associates
Steelwork contractor: Underhill Engineering Limited
Main contractor: American Bridge UK
Client: English Heritage

subsequently fed the construction of the bridge's two cantilevers.

None of the bridge's steel elements exceeded the cable crane's capacity, while the largest two pieces, each 10m-long × 4.5m-deep - installed at either end of the cantilevers, where the structure meets the abutments - where within a size that was transportable on the access route.

All of the steel elements were fabricated by Underhill Engineering into fully assembled and erectable pieces, that included top and bottom chords, bracings and cross members.

A total of six pieces were needed for each of the cantilevers. As the bridge is in a very aggressive environment with plenty of wind-borne sea salt around, mild steel was chosen for the parts which can be easily repainted and stainless steel, which is more resistant to corrosion, for the areas where painting would be more difficult.

The connection points between each individual steel assemblage (two on each piece) are also fabricated from stainless steel and were welded to the main cord members during the fabrication stage.

The connections consist of finger joints that interlock with opposite members on the adjoining section, similar to a woodwork dovetail joint. Once the individual sections were lifted and manoeuvred into place during the erection programme, the connections were then bolted up.

Underhill's fabrication process required some precise engineering and each section was trial erected with its neighbouring piece to ensure the two cantilevers could be seamlessly installed on-site.

Construction started in September 2018 and was completed in August 2019.

Summing up, the judges say it is a highly crafted and timeless structure: daring in its concept yet modest and sympathetic to its historic and natural context. Every steel component has been carefully detailed for constructability and durability, elevating the graceful aesthetic.

The project is a triumph: a credit to English Heritage's vision and the entire team which employed mostly local fabricators, supported by alpine construction specialists.

One Bartholomew, Barts Square, London

A modern steel-framed and flexible commercial building acts as an anchor-point for a wider central London mixed-use development.

© Sheppard Robson

FACT FILE
Architect: Sheppard Robson
Structural engineer: Waterman
Steelwork contractor: William Hare
Main contractor: Mace
Client: Helical

Forming the latest element of the Bart's Square scheme, a new mixed-use development in Farringdon, central London, One Bartholomew is a 12-storey structure offering approximately 20,000m² of Grade A office space with a BREEAM 'Excellent' rating.

According to architect Sheppard Robson, the building is a simple but finely detailed form that marks the step change between the edge of the Smithfield conversation area and the larger developments of the City.

It is distinctly modern in both form and materiality, with metal screens, and floor-to-ceiling glazing to reflect and embrace the scale of the capital's modern environment. The design has allowed the building to integrate into the extensive public area improvements, which turn Bartholomew Close into a pedestrian-friendly zone, enlivened by a café and restaurant on the ground floor.

Flexibility is at the heart of the building's steel-framed design as the structure is highly adaptable to the anticipated changing requirements of its users with generous floor-to-ceiling heights, alongside an efficient and adaptable floorplate.

William Hare erected 2,350t of steel for the scheme. The steel frame gains its stability from a reinforced concrete core and the diaphragm action of the floor slabs.

The structure was built with full traceability across every steel member and to a Eurocode design, which ensured that the European Standards for resistance, durability and fire resistance were met.

William Hare and structural engineer Waterman, together with the fire engineer, derived a value engineered fire and corrosion protection solution. This resulted in the building having a mix of fire protected members using intumescent paint, concrete encasement and fire boarding, meeting the financial constraints and end user requirements.

Typically, the floors are a composite design, with Holorib slabs supported by plate girders that span up to a maximum length of 17m.

Some of the project's largest steelwork elements are at ground floor, where a series of deep cantilever transfer beams extends the façade to the boundary and above the basement perimeter piles.

These deep beams required extensive work to ensure they could be lifted into position, while the design had to make sure the splice connections did not interfere with the large service holes.

In summary, the judges say the project showcases how steel can deliver a highly flexible long-span commercial building within an urban context. The 9m corner cantilever of the upper floors over the entrance enhances the presence of the building in the public realm. The progressive procurement approach meant that the fabricators were appointed early, supporting the design team to maximise efficiency of design and fabrication.

Centre Building, London School of Economics

Exposed external bracing, with expressed connection details, bookend the frames of the largest and highest building on the LSE's campus.

Built in two sections, with a six-storey and 13-storey element, and interlinked by an atrium, the Centre Building project replaces four previous buildings that were demolished on the London School of Economics (LSE) campus.

The original brief called for world-class architecture to match the LSE's international academic reputation. The design went further by creating a new public square, which has become a new focal point for the school. Expression of the superstructure both internally and externally is central to the architectural identity of the building within this new public setting.

The overall superstructure system of steel beams and columns, concrete cores and precast concrete floor slabs facilitates simple and flexible floorplates, which can be easily adapted to suit LSE's current and future academic needs.

At either end of each block, exposed SHS bracings bookend the project and form a highly visible steelwork element. This exoskeleton bracing, which sits approximately 300mm outside of the building envelope, is not just an aesthetic element. It also serves a structural purpose, sharing the stability with two concrete cores.

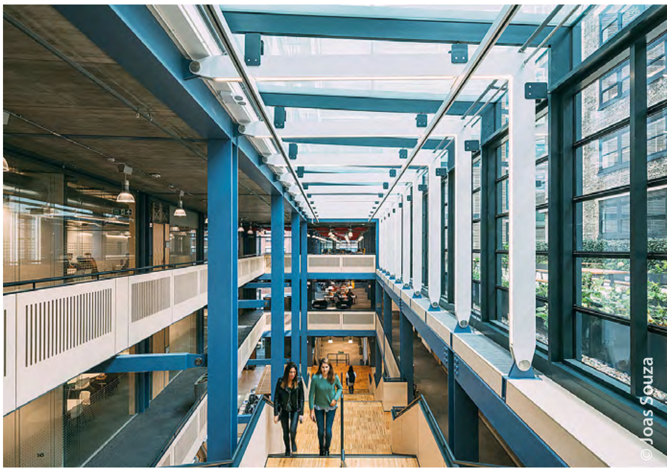
The project achieved a BREEAM 'Outstanding' rating due in part to initiatives that included a 35% reduction in embodied carbon, which was achieved by reducing the amount of concrete and aluminium used in the foundations and façade fins respectively, and by incorporating more recycled and low-carbon materials.

One of the highlights of the scheme is exposed steelwork, both internal and external, which give the building a distinct and contemporary appearance, a design that required several bespoke steelwork elements in order to fulfil the project's architectural vision.

As exposed steelwork plays such an important role within the design, the fabrication process had to rise to the challenge. Close collaboration between steelwork contractor and the design team ensured that the structural and aesthetic intent was captured and realised in the final structure. For the project, Billington Structures provided over 1,000t of bespoke fire-protected structural steelwork.

This expressed structural steelwork created many challenges. Shear forces and torsional moments applied to the RHS beams, in conjunction with the desire to avoid site welding, led to a bespoke hidden connection design. Many of the steel members have an internal bolted connection, hidden from view and accessed via a pre-formed aperture in each box section beam.

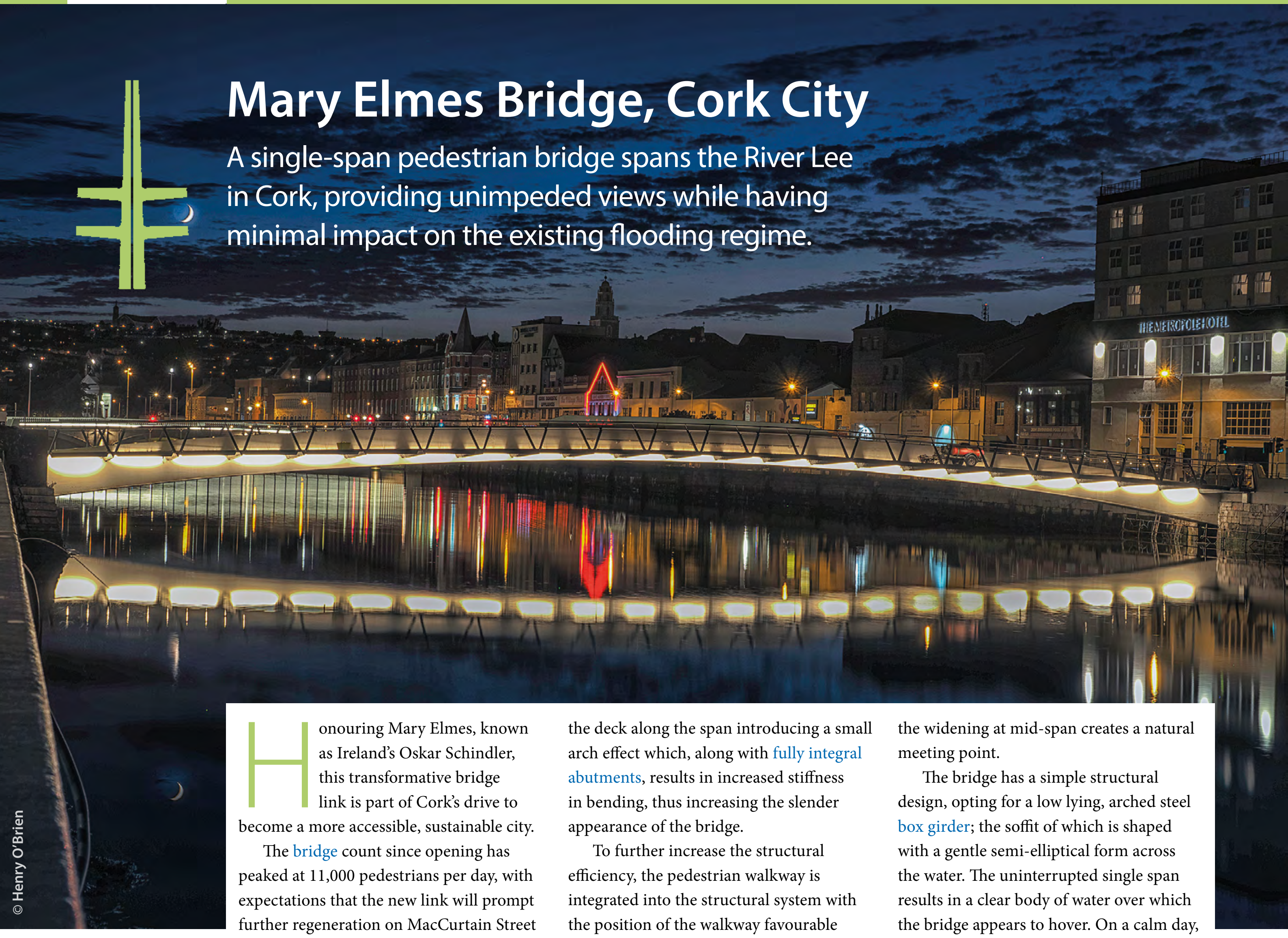

© Mark Gorton, RSHP


© Joas Souza

Another part of the architectural intent was to provide a slimmed down floor construction, in order to maximise available space. This was achieved by using RHS or plated floor beams, featuring bottom plates to support the building's long span precast floor units, which sit within the depth of the beams.

Summing up, the judges say carefully crafted, exposed steel frame building, worked into an extremely constrained university campus site. Close collaboration between the design team and steel fabricator has produced a high-quality appearance to the steelwork with careful attention paid to the connection details and paint finish.

FACT FILE
Architect: Rogers Stirk Harbour + Partners
Structural engineer: AKT II
Steelwork contractor: Billington Structures Ltd
Main contractor: Mace
Client: London School of Economics



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Mary Elmes Bridge, Cork City

A single-span pedestrian bridge spans the River Lee in Cork, providing unimpeded views while having minimal impact on the existing flooding regime.

FACT FILE
Architect: WilkinsonEyre
Structural engineer: Arup
Main contractor: Keating
Client: Cork City Council

Honouring Mary Elmes, known as Ireland's Oskar Schindler, this transformative bridge link is part of Cork's drive to become a more accessible, sustainable city.

The bridge count since opening has peaked at 11,000 pedestrians per day, with expectations that the new link will prompt further regeneration on MacCurtain Street to the north and Merchant's Quay to the south.

Consequently, Mary Elmes Bridge is a key element of Cork reshaping its vision for the future as a more sustainable, commuter-friendly city, integrating with other projects, such as the Cork City Centre Movement Strategy and Cork Cycle Network.

Designed by WilkinsonEyre Architects and Arup, and constructed by Keating, the structure has a 66m-long span between quays.

The design features a central spine beam that transitions from below to above the deck along the span introducing a small arch effect which, along with fully integral abutments, results in increased stiffness in bending, thus increasing the slender appearance of the bridge.

To further increase the structural efficiency, the pedestrian walkway is integrated into the structural system with the position of the walkway favourable relative to the position of the neutral axis of the main spine beam at both midspan and at supports.

Meanwhile, combining the shallow slender arch with transparent mesh parapets allowed the design team to deliver an understated but visually appealing design with uninterrupted views of the river and cityscape.

The design team's vision to integrate the walking platform with structure and embedded benches on either side of the central beam has resulted in the bridge becoming part of the urban realm, while the widening at mid-span creates a natural meeting point.

The bridge has a simple structural design, opting for a low lying, arched steel box girder; the soffit of which is shaped with a gentle semi-elliptical form across the water. The uninterrupted single span results in a clear body of water over which the bridge appears to hover. On a calm day, the waters of the river reflect the bridge and complete the elliptical form.

The primary arched box girder of the bridge is fabricated from high-grade steel plate and coated with a protective paint treatment in an off-white colour. This provides a finish which is extremely durable and suitable for the marine environment. Framed stainless steel tension mesh infill panels are fixed back to the parapet posts, providing safe, but relatively transparent, guide rails that allow for unobstructed views up and down the river. The parapet posts are painted dark grey to help contrast their distinctive v-shaped silhouette against the backdrop of the main arched girder.

The bridge was fabricated offsite in nine sections before assemblage at a shipyard downriver from its eventual home. In May 2019, the completed structure was transported up the River Lee on a custom-made barge. It was then lifted into position by cranes located on each quay during an overnight road closure in a tandem lift of 160 tonnes.

Summing up, the judges say the elegant and deceptively simple design of this bridge has turned a new pedestrian and cycle city centre river crossing into something of a destination in its own right.

© Arup

The Post Building, London

Reusing much of the original steel frame of a former 1960s Royal Mail sorting office, a modern mixed-use development has been created

Located on London's Oxford Street, a former Royal Mail sorting office has been redeveloped into a new mixed-use scheme by incorporating large retained steel elements within a new steel frame.

Unlike many city centre schemes, this project's demolition programme included retaining a large portion of the original 1960s-built steel-framed building.

A horseshoe-shaped zone in the middle of the site containing ground, first and second floor levels was left in place. These floors were originally used for mail sorting duties, while the building's upper four floors, now demolished, accommodated administrative offices and a plant level.

Keeping some of the original steel frame also fitted into the overall design aesthetic, which features exposed steel beams and columns creating a modern 'white collar factory' office building.

Retaining a large steel frame required steelwork contractor BHC to use more than 200t of temporary steel propping and bracing, as the frame's original stability system had been demolished. The stability system was completely remodelled to remove the existing cores from the key corner floor areas and create a new one in the central part of the site.

Once the steel core was erected, the retained steelwork was connected to this new stability-giving element and this then allowed the temporary props and bracing to be dismantled.

"A number of factors came into play when we chose a steel core instead of a concrete one. The site's basement and raft foundations have both been reused and this lighter steel option helped avoid the need for new piles," says Arup Project Engineer Tim Bennett.

"The former post office underground railway runs directly beneath the site and so it was also important not to add unnecessary loads."

Having stabilised the retained steelwork BHC then set about reconfiguring the large steel beams in readiness for the insertion of new steel mezzanine levels.

The original grid pattern for the Post Building's ground floors was 12m × 20m to suit post office vehicle movements. Consequently, a series of deep transfer beams was originally installed to support these spans. These transfer beams had the effect of concentrating the original building loads into heavily-loaded, widely-spaced points on the raft foundation.

As these long spans were no longer necessary, new columns were added to reduce the spans and spread the increased overall building mass more evenly on the existing foundations.

The now redundant transfer beams have been slimmed down from 2.0m-deep to 600mm-deep members to allow mezzanine floors to be inserted and maximize the available headroom within the existing floor-to-floor heights.

An entirely new steel frame was then erected around the retained portion completing the lower three floors and filling up the entire site's footprint.

In summary, the judges say this is a great example of a steel-framed building being adapted to give a new life for a different use. The existing steel frame was retained wherever possible to produce impressive and unusually generous commercial spaces. Maximising the reuse of the existing structure resulted in a build with a much smaller carbon footprint.

FACT FILE
Architect:
Allford Hall Monaghan Morris
Structural engineer:
Arup
Steelwork contractor:
BHC Ltd
Main contractor:
Laing O'Rourke
Client:
Brockton Capital LLP and Oxford Properties Group

The Standard Hotel, London

FACT FILE
Architect: Orms
Structural engineer: Heyne Tillett Steel
Main contractor: McLaren Construction
Client: Crosstree Real Estate Partners LLP

A former Camden Council office building has been transformed into a contemporary, boutique hotel, with sustainability and low carbon at the heart of its conversion.

A 1970s concrete-framed former council office has, after extensive research and the addition of new upper floors, been reinvented as a boutique hotel.

Matt Mason, Partner and Head of Development at Crosstree Real Estate Partners says: "We are extremely proud of the results of the collaboration with The Standard and the entire design team, and feel we have delivered an iconic new hotel development for London. It is an excellent example of the merits of working with and improving existing unloved buildings to create something that successfully marries the past with the contemporary."

Before construction work began, structural engineer Heyne Tillett Steel (HTS) tested the capacity of the structure, foundations and ground to reveal their spare capacity. Once complete, they were confident that the concrete frame and under-reamed piles could be pushed to allow the conversion of the building and a three-story extension added to the structure. Approximately 94% of the primary structure, including extensive basement and piling, was able to be retained, minimising the waste and carbon release associated with demolition.

To support the required three additional floors that start at level nine, new supporting steel perimeter columns from the first-floor transfer slab was the preferred option. This was the simplest structure – with a direct load path – and reused the existing foundation capacity. Adding the three storeys, a 30% increase to the weight of the building, only required discrete strengthening to four existing columns.

The new floor slabs are 150mm-deep concrete-filled Comflor 80 decks, which are supported by, and act compositely with, the steel beams. In order to limit beam depths, Universal Column sections were selected for most spans.

The steel beams are supported by steel columns with sway frames above eighth floor providing stability to the extension. Perimeter steel columns installed through the existing building from the first floor continue through the additional floors to the uppermost 11th level.

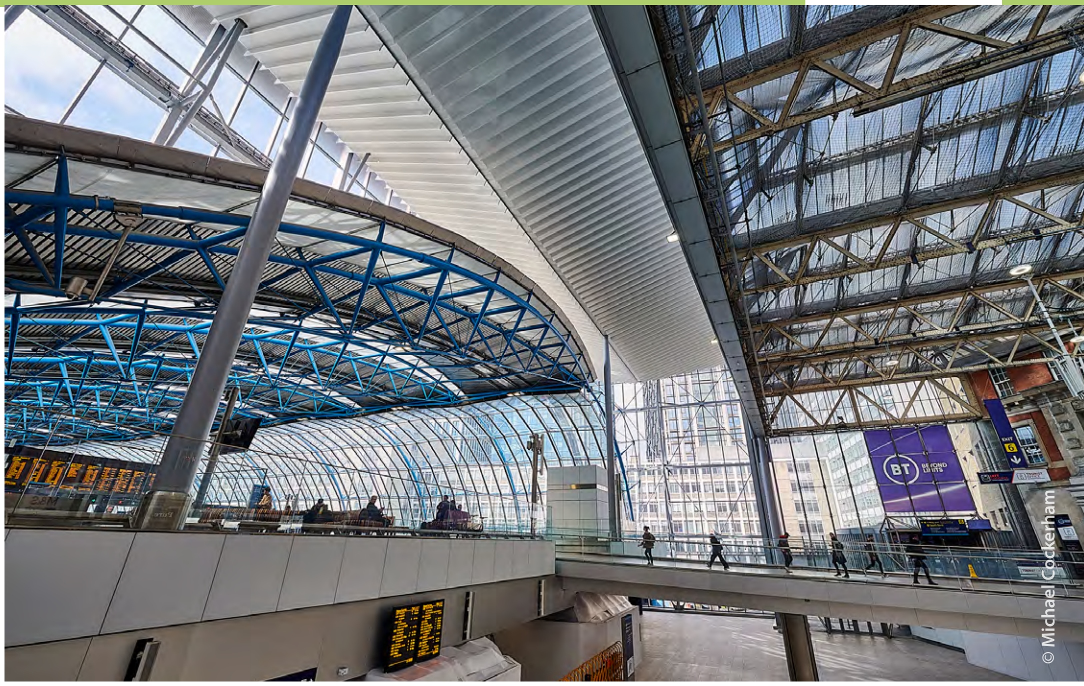
HTS says the use of steel enabled the new floors to be lightweight and shallow in depth, while also adhering to tight hotel vibration criteria and the long span existing office column grid below. The low weight meant less strengthening was required for the existing superstructure and foundations.

The additional three storeys are said to deliver maximum site density, reducing the need for future demolition and redevelopment. The existing façade is constructed of highly durable load bearing precast concrete units which were restored and thermally improved, reducing capital costs and providing significant embodied carbon savings both at completion and when measured as part of a retrospective Whole Life Cycle Assessment.

The judges say, through forensic analysis of the existing building and highly intelligent design responses, this project showcases the role of structural steel in repurposing and enlarging this existing building, maximizing the retention of embodied carbon and creating a new landmark at the end of one of the capital's principal arteries.

Waterloo Station Roof Infill

A roof structure, requiring a high degree of complex design work, bridges the gap between two existing structures at the UK's busiest station to form a new covered concourse.



© Michael Cockerham

London's Waterloo Station has been transformed by the Wessex Capacity Alliance's (WCA) programme of works, which included the rebuilding of the station's former international terminal (WIT), allowing its platforms to be brought back into use with modern facilities, new track, signalling and a layout to cope with thousands of domestic passengers.

As part of this programme, an infill roof structure has been delivered, bridging the gap between the three-pin arch roof of the Grimshaw designed WIT terminal, and the trussed 1920s steel roofs forming the main station concourse.

The infill roof is a rectangular steel-framed box, 52m long by 18m wide and 26m-high at the western end, tapering along one side to accommodate the shape of the former Eurostar structure and over-sailing the two station roofs. Aside from the fact that the roof is supported at the eastern end by Waterloo's 1840s-built masonry walls, the new structure is self-supporting.

According to the project team, the greatest challenge was developing a suitable foundation system to support the new structure. The footprint of the roof sits directly above four London Underground lines, in addition to two large escalator boxes and various access tunnels.

As a consequence, piled foundations were not an option, and structural concepts focused on opportunities to reuse existing support structures using load-balancing approaches wherever possible, supplemented by localised assessment or strengthening if necessary. A steel-framed solution became the only viable design for the project.

"The entire roof structure including glazing is only 400t," says Wessex Capacity Alliance Engineering Manager, Chris Kitching. "But however light this may be, we still needed to work out where the loads could be transferred to and if we could free-up any capacity from the existing structures."

The roof requires two 508mm-diameter circular hollow section (CHS) columns to support it in the middle.

"Using circular columns means the steelwork is less harsh on the eye and importantly they have been located so they do not hinder the important views in the station concourse," adds Mr Kitching.

As well as providing additional support to the roof, the CHS columns allow the structure to have a central area with a 26m clear span. However, as no new foundations can be installed in the central area, the CHS members are founded directly on top of the WIT platform slab.

Because of its propped cantilever design, the existing slab is subject to movement of up to plus or minus 35mm, so the columns are placed on bearings. The bearings accommodate these movements, which would otherwise crack the roof's glazing. Forming the main span of the roof is a 4.2m-deep × 52m-long spine truss, weighing 27t.

The central spine truss supports eight pairs of gullwing trusses sitting perpendicular to the main structure, forming overhangs on either side. Each wing measures approximately 8.3m-long × 4m-deep.

The judges say, the major challenges for this infill roof included foundation conditions requiring the use of existing supports and restricted site access. The solution is a steel frame sympathetically designed to reflect the detailing of the existing structure, and ingeniously erected in a live station, facilitating a huge increase in station capacity.

FACT FILE
Architect: AECOM
Structural engineer: Mott MacDonald
Steelwork contractor: Bourne Group Ltd
Main contractor: Wessex Capacity Alliance
Client: Network Rail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The Gravity Bar, Guinness Storehouse, Dublin

Strengthened Edwardian steel columns along with the construction of a new rooftop structure, have helped enlarge one of Dublin's most popular attractions.

One of Ireland's most famous and visited tourist attractions, the Gravity Bar that sits atop the Guinness Storehouse, has undergone an expansion in order to accommodate an ever-increasing number of visitors.

In 2018, more than 1.7M tourists visited the Guinness Storehouse, to see how the famous Porter beer is brewed and learn about its history. At the end of their tour, all adults are given a complimentary pint that can be supped in the rooftop Gravity Bar, which is a disc-shaped glazed structure offering 360-degree views over Dublin.

Opened in 2000, the Gravity Bar needed more space and the solution was to build a rooftop extension, which consists of a new steel-framed structure, that links to the existing bar and more than doubles the available floor space. The extension is a disc-shaped structure, connected to the existing bar via new semi-circular structure.

For the construction of the new gravity bar, a crash deck was erected by the main contractor, positioned 1m below the bottom level of the steelwork. This gave the steel erectors a working platform from which to work.

The main steel frame is supported on four CHS columns, which were supported from the existing structure. Before these new columns were installed, the existing Edwardian steel columns below were strengthened with stiffener plates.

The floor of the new bar structure is formed from a grillage of box girder beams and UB section infills.

All UB infills and several of the box girders were detailed with service penetrations to co-ordinate exactly with the M&E requirements. The downpipe from the roof was also integrated inside the CHS perimeter columns in several locations where required.

The perimeter of the building is formed from a curved PFC section, which was erected in discrete lengths and welded, with the welds ground flush, to produce one continuous member around the full bar.

In summary, the judges say this popular bar sits above Dublin's most visited tourist attraction and the works were carried out with the building remaining operational throughout. The challenging installation forms an extension to an existing rooftop structure that sits above the 1904 'Protected' building. The new bar is supported on four steel columns that connect through the roof to the strengthened, historic structure, below.

FACT FILE
Architect: RKD
Structural engineer: Arup
Steelwork contractor: Steel & Roofing Systems
Main contractor: P.J. Hegarty & Sons
Client: Diageo

Scarborough Footbridge, York

Reminiscent of Viking longboats, a new weathering steel pedestrian and cycle bridge has improved access between York railway station and the city centre.

Spanning the River Ouse in York, Scarborough Footbridge provides a new pedestrian and cycle link between the city centre and main railway station.

The scheme comprised the replacement of the existing narrow lattice u-frame superstructure and steep step access with a widened architectural weathering steel pedestrian bridge with step-free approaches.

The overall structure and approach parapets are said to be reminiscent of Viking longships, providing a fitting aesthetic appearance for the centre of York, which was once the main stronghold of the Norsemen's British possessions.

The bridge comprises two 22m-long main river spans, which are formed of prefabricated box girders with integral curved parapets and cantilevered deck plates. Meanwhile, two 10m-long side spans cross over the existing river footpath and are formed of prefabricated u-troughs with integral parapets and deck plates to match the main river spans.

Stability of the cantilevered main spans was achieved with mechanical uplift bearings. Tensioned straining wires run through integral eyelets on the parapets, which are anchored into masonry clad anchor blocks at either end of the structure.

The approach ramps and stairs at either end of the structure are flanked by bespoke fabricated painted steel curved parapet panels with a stainless steel top rail and integrated handrail lighting. The steelwork elements of the scheme are said to complement the masonry blocks and stone cladding to provide a mix of modern and historic elements to enhance the local conservation area.

The architectural and outline structural design was developed by Network Rail on behalf of City of York. AmcoGiffen were appointed as main contractor for the scheme and they selected AECOM as lead designers to develop the project through detailed design.

Early engagement and implementation of a 'safety by design' philosophy led to the project team developing the outline reference scheme to deliver a safe, economical and innovative solution, which greatly enhanced buildability and minimised risks, not only during construction, but with future inspection and maintenance operations in mind.

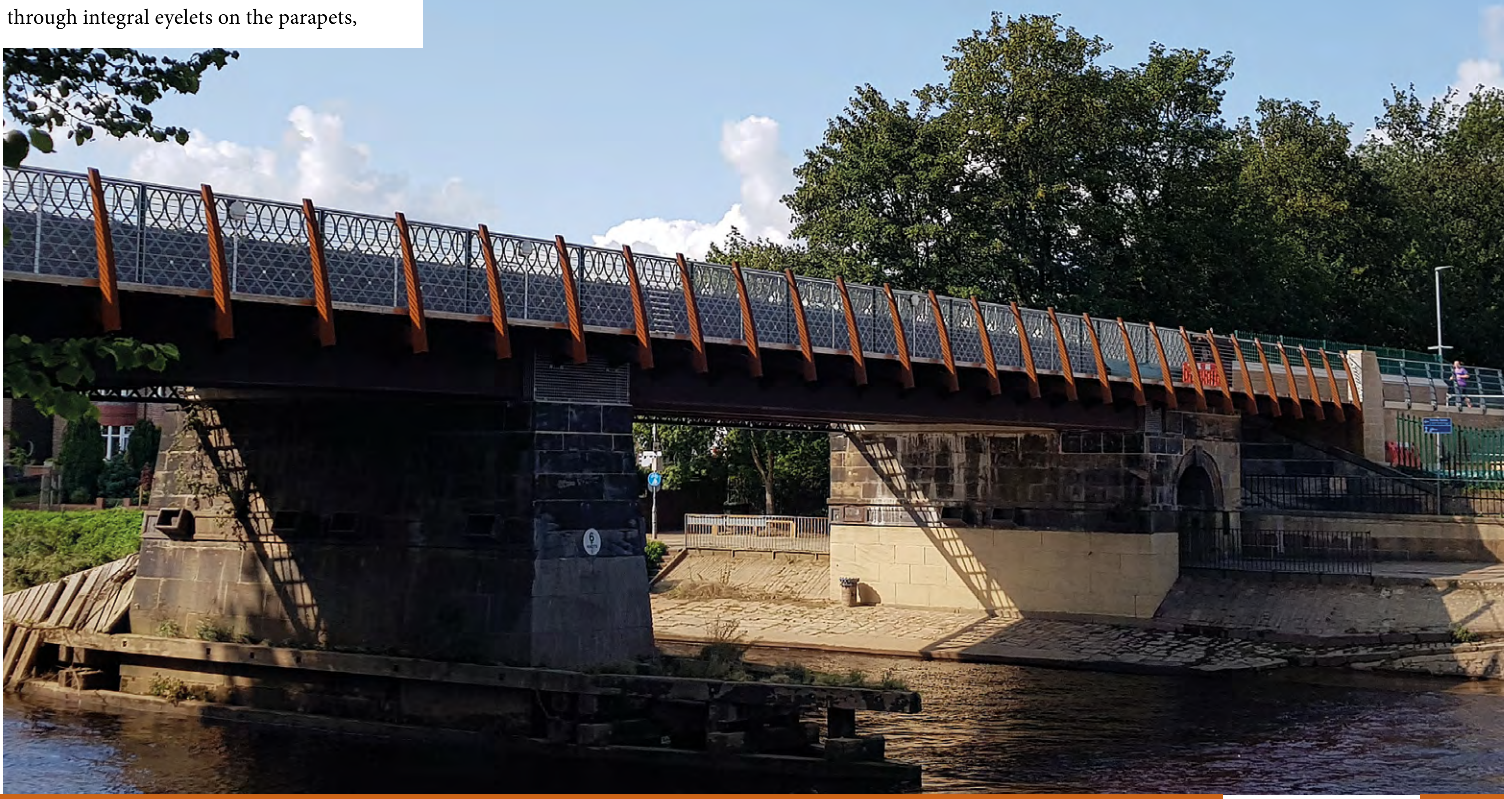
AECOM Regional Director, Transportation, Peter Robinson says: "To minimise weight and maximise prefabrication, steel was the obvious choice for the scheme.

"Steelwork was also beneficial as it helped form a lightweight, aesthetic structure that required minimal work at height over water and therefore caused minimal disruption to the operational railway."

The main spans were modified to a fully prefabricated box girder with integral parapet posts and a cantilevered deck plate to simplify construction, limit lifting operations, remove joints and potential hidden critical elements, reduce time spent working at height over the river and improve durability.

The judges say, the project used its location, adjacent to Scarborough Rail Bridge, to enable delivery and installation of large preassembled units using the railway. The bridge wholly fulfils the brief, promoting sustainable transport for all users through the city.

FACT FILE
Architect:
Network Rail
Structural engineer:
AECOM
Main contractor:
AmcoGiffen
Client:
City of York Council



The Balfour, Kirkwall, Orkney

A steel-framed design helped NHS Orkney realise its wish to have a unique hospital that attended to the Islands' needs.

Known as The Balfour, it provides a state-of-the-art clinical environment for the delivery of essential health care services, significantly reducing the number of people travelling to the Scottish Mainland for routine care.

In a challenging and exposed location, the building is designed with protection and shielding from the elements in mind, leading to a complex design and shape with two inner circular courtyards. The curve of the building also protects the main entrance space and inpatient accommodation while referencing the ancient architectural form of Skara Brae.

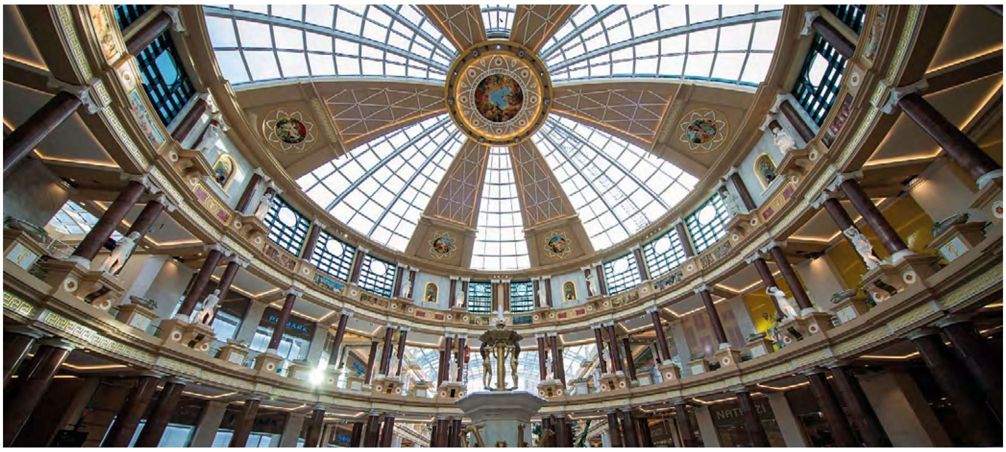
The steel frame, prefabricated on the mainland, allowed speedy completion and reduced vulnerability of the construction programme to extreme weather conditions, and an integrated BIM model facilitated complex service integration.

FACT FILE
Architect: Keppie Design
Structural engineer: AECOM
Steelwork contractor: BHC Ltd
Main contractor: Robertson
Client: NHS Orkney

Barton Square, Intu Trafford Centre, Manchester

Opened in 1998 the Trafford Centre is the third largest retail development in the UK. Developed by the Peel Group and now owned by Intu Properties.

The scope of the refurbishment of Barton Square, carried out by Vinci Construction, includes the addition of two 36m-wide glazed barrel vault roofs over the main malls, providing a more user-friendly experience for shoppers, and a 32m-diameter central dome that creates a stunning focal point towering above an ornate water feature. The upper levels of the centre have additional steelwork framing and stairs along with four smaller roof structures to extend the available retail space.



The critical interface between the steelwork and the glazing system called for strict tolerances to be achieved, and construction was carried out outside normal trading hours to allow the centre to remain open throughout.

FACT FILE
Architect:
Corstorphine + Wright, Leach Rhodes Walker
Structural engineers:
Cameron Darroch Associates, Mott MacDonald
Steelwork contractor: S H Structures Ltd
Main contractor: VINCI Construction UK
Client: intu Properties plc

Boeing GoldCare Aircraft Hangar, Gatwick Airport

The Boeing Company has commissioned a brand-new maintenance hangar at Gatwick Airport to provide servicing facilities for its current and future fleet of aircraft. The total structural steel used in the building amounted to more than 3,000t.

The hangar provides a 15,000m² dual-bay facility and 3,000m² of support offices, storage and plant space.

Deep steel trusses, spanning up to 75m, create the vast column-free space required and are supported on lattice columns. Braced elevation columns form a primary stability system, which enabled efficient construction with few temporary supports.

Rooflights, to reduce reliance on artificial light, and 900m² of photovoltaic (PV) solar panels on the roof contributed to achieving a BREEAM 'Excellent' rating for the hangar, while design development saved an estimated 635t of steel. This in addition to savings in temporary works and foundations equated to a carbon reduction of 1,045t.

FACT FILE
Architect: D5 Architects LLP
Structural engineer: Mott MacDonald
Main contractor: John Sisk & Son
Client: Boeing United Kingdom Limited

Bridgewater Place Wind Amelioration Scheme, Leeds

Bridgewater Place is a landmark structure and at 112m high it is the tallest building in Leeds. Topped out in 2005 the building's shape accelerates winds in the immediate vicinity to the extent that pedestrians experienced severe difficulties walking nearby, with adjacent roads and main entrances to the building having to be closed for safety reasons.

As the prevailing westerly wind reaches the building it is deflected downward to ground level, this is known as 'downwash'. The wind mitigation measures comprising a series of perforated metal wind baffles, canopies and screens ameliorate the 'downwash', improving the environment for pedestrians, road users and the occupants of Bridgewater Place.

Influenced by aeronautical design, the baffles are portal structures supported on circular hollow section columns, designed to resist vehicle collision loads. These columns support a steel truss comprising horizontally curved circular hollow section booms and tapering vertical fabricated fin members arranged as a ladder frame.

FACT FILE
Architects: Chetwoods Architects
Structural engineer: Buro Happold
Steelwork contractor: S H Structures Ltd
Main contractor: Lendlease
Client: CPPI Bridgewater Place LP

One Bank Street, Canary Wharf

Located on the prestigious Canary Wharf estate in east London, One Bank Street is a striking 27-storey commercial building offering 60,000m² of high-quality office space, including three levels of trading floors.

Structurally, the typical lower trading floors are trapezoidal and approximately 80m × 65m on plan. At level four, the structure steps in to create a large terrace along the entire western elevation.

From level four to 19 the building is tapered on the west side with a series of inclined columns. Above level 19, the structure takes on a more traditional prismatic shape and the floors are 65m × 55m on plan.

Designed to achieve a BREEAM 'Outstanding' rating, the steel-framed structure sits atop a triple 16m-deep basement and gains its stability from a large centrally-positioned core. Sustainability was a key design element of One Bank Street which includes measures to save 352t of carbon annually.

FACT FILE
Architect: Kohn Pedersen Fox
Structural engineer: Arup
Steelwork contractor: William Hare
Main contractor: Canary Wharf Contractors
Client: Canary Wharf Group

Drake Circus The Barcode, Plymouth

Located on the site of the former Bretonside bus station in the centre of Plymouth, the Drake Circus Leisure Complex, otherwise known as The Barcode due to its striking façade, forms part of the ongoing transformation of the city centre. The structure, measuring 130m by 50m in plan, forms a real landmark and houses a 12-screen cinema stacked above 13 restaurants, a large indoor golf leisure facility, a sky-bar with views overlooking the harbour and several levels of car parking.

With a structural grid changing up the building to suit efficient layouts for the auditoriums, retail units and car parking, and a planning height restriction, the 5,505t steel frame is necessarily complex with offset bracing, transfer structures and shallow composite beams.

FACT FILE
Architect: Corstorphine + Wright
Structural engineer: Evolve Consulting Engineers
Steelwork contractor: BHC Ltd
Main contractor: McLaren Construction Group
Client: British Land

National Infrastructure Laboratory, University of Southampton


© fotohaus

FACT FILE
Architect: Grimshaw Architects
Structural engineer: Buro Happold
Main contractor: Wates Construction Limited
Client: University of Southampton

The National Infrastructure Laboratory is a £48M facility that accommodates over 100 academics. Part of a larger campus development, it has five major laboratories and three floors of offices, while key features include a 3m-radius geotechnical centrifuge and a 1m-thick floor supporting large testing equipment.

Flexibility was a key driver of the design and this was addressed with column-free office spaces and a larger informal teaching area. These clear span zones were created by two 24m-long storey-deep steel trusses with cantilever transfer beams at level two.

The trusses, which also form a full height atrium, are key structural and architectural features as they are fully exposed and can be seen when entering the building.

Other notable steel elements include a double-height braced steel frame enclosing the large testing laboratory. This steel frame also supports a high-level gantry crane.

The Wave, Coventry

Located next to the 70m-high Grade II-listed Christchurch Spire, one of Coventry's most recognisable historical landmarks, the Wave provides a high-quality destination, accessible to all and acts as a catalyst for further regeneration of the city centre.

The £36M project was commissioned by Coventry City Council and houses multiple water slides, a lazy river, wave pool, day spa, 25m-long swimming pool, 120 station gym, dance studio and squash courts.

Solutions in both concrete and steel were explored, but steelwork was chosen as the best option on the basis of cost and the ability to meet a tight programme on a congested site.

As well as a facetted curved perimeter, the lower floor levels are formed with a steel frame containing exposed bespoke plate girder beams with cellular holes.

The deep cellular beams provide the necessary stiffness to support pool tanks and control the dynamic response of the gym, while the holes accommodate the many services required for the building.

FACT FILE
Architect: FaulknerBrowns Architects
Structural engineer: Engenuiti
Steelwork contractor: Billington Structures Ltd
Main contractor: Buckingham Group Contracting Ltd
Client: CV Life


© Buckingham Group Contracting Ltd

Design of beam-column splice connections according to Eurocode 3

Ricardo Pimentel of the SCI discusses the design of beam-column splice connections considering second-order effects due to combined flexural and lateral torsional buckling according to Eurocode 3.

Introduction

Buckling phenomena cause additional internal forces within members due to local second order effects (P-δ). Recent NSC articles [1], [2], [3] introduced these effects, giving theoretical background and practical applications. Reference [3] provides a detailed worked example of the assessment of the second order bending moment on columns due to strut action for column splices designed under pure compression. Members subjected to major axis bending that are susceptible to lateral torsional buckling are also subjected to second order effects, because the major axis bending induces a horizontal deflection (minor axis - δ_h), vertical deflection (major axis - δ_v) and a cross-sectional rotation (θ) as illustrated in Figure 1. Such deformations will increase as the applied bending moment increases. When the bending moment is close to the so-called elastic critical moment, the deformation increases rapidly and failure occurs.

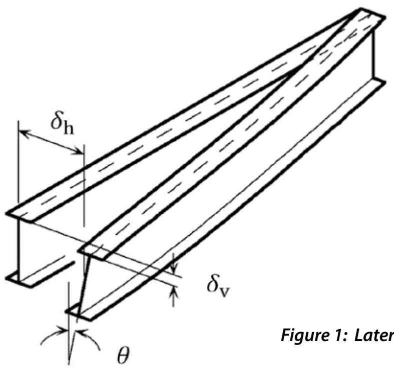


Figure 1: Lateral torsional buckling mode shape

Addressing second order effects

Whilst for a strut an equivalent initial bow imperfection can be back-calculated relatively easily and amplified to account for the second order effect, the problem for lateral torsional buckling phenomena offers a much more complex challenge. Although the effects of the vertical displacement and rotation have an impact on the lateral torsional buckling resistance of the member, the consideration of an equivalent horizontal out of plane bow imperfection offers a good approximation to establish the initial member imperfection. EN 1993-1-1 clause 5.3.4 (3) supports this approach. A precise analysis including the amplification of the initial member imperfection is complex and usually undertaken by numerical analysis with advanced finite element model tools. A reasonable approximation can be achieved by manual methods, as demonstrated in this article. The process described is useful when designing splice connections in unrestrained beams.

Lateral torsional buckling failure criteria

The design buckling resistances for buckling phenomena according to Eurocode philosophy are calibrated based on an elastic cross section failure, where all imperfections (such as residual stresses, lack of straightness, etc.) are accounted for by an equivalent imperfection factor α. Second order local effects are implicitly considered by the Eurocode design method (section 6.3). Reference [1] explains this concept for a strut. Using the same principles for an element subjected to lateral torsional buckling, the buckling failure can be understood as a critical stress, for which two components can be identified: (i) component due to major axis bending (σ_{M_y}); (ii) component due to the second order bending moment under minor axis bending ($\sigma_{M_{z,P\delta,LTB}}$).

Out of plane bending moment due to lateral torsional buckling

If the buckling failure is considered as an elastic cross section failure (with a material yield strength of f_y), the following condition can be established:

$$f_y = \sigma_{M_y} + \sigma_{M_{z,P\delta,LTB}}$$

According to Eurocode nomenclature, the buckling resistance can be established as the product of the reduction factor for buckling phenomenon χ multiplied by the design characteristic resistance. As the characteristic resistance is directly proportional to the material resistance, the stress at lateral torsional buckling failure can be established as $\chi_{LT}\cdot f_y$ (described as the critical buckling stress). The stress $\sigma_{M_{z,P\delta,LTB}}$ can be defined based on cross section properties and the second order bending moment $M_{z,P\delta,LTB}$, which leads to:

$$f_y = \chi_{LT}\cdot f_y + \frac{M_{z,P\delta,LTB}}{W_{el,z}}$$

Dividing the previous equation by the critical buckling stress, it can be demonstrated that:

$$\frac{f_y}{\chi_{LT}\cdot f_y} = \frac{\chi_{LT}}{\chi_{LT}\cdot f_y}\cdot f_y + \frac{M_{z,P\delta,LTB}}{\chi_{LT}\cdot f_y\cdot W_{el,z}} \leftrightarrow M_{z,P\delta,LTB} = \left(\frac{1}{\chi_{LT}} - 1\right)\cdot\chi_{LT}\cdot M_{z,el,Rk}$$

Where $M_{z,el,Rk}$ is the out of place elastic bending resistance of the cross section.

According to the Eurocode definition, χ_{LT} is the ratio between the buckling bending resistance and the characteristic bending resistance of the cross section. As the buckling bending resistance ($M_{b,Rd}$) should be always less than the applied bending moment ($M_{y,Ed}$), it can be approximately (and conservatively) assumed that:

$$\chi_{LT} = \frac{M_{b,Rd}\cdot\gamma_{M1}}{M_{y,el,Rk}} \approx \chi_{LT} = \frac{M_{y,Ed}\cdot\gamma_{M1}}{M_{y,el,Rk}}$$

Where γ_{M1} is that partial factor for buckling phenomenon according to the UK NA to BS EN 1993-1-1 [4].

This leads to:

$$M_{z,P\delta,LTB} = \left(\frac{1}{\chi_{LT}} - 1\right)\cdot\frac{M_{z,el,Rk}}{M_{z,el,Rk}}\cdot M_{y,Ed}\cdot\gamma_{M1} \qquad \text{Eq (1)}$$

The complexity of the procedure is related to the calculation of χ_{LT}. For cases where section 6.3.2.3 (2) of EN 1993-1-1 is applied, $M_{z,P\delta,LTB}$ should be multiplied by "f".

Splices of elements under compression

Splices subjected to axial compression should be designed for the following forces:

1. N_{Ed} – Applied axial force;
2. $M_{i,P\delta,FB}$ – Second order bending moment due to strut action (flexural buckling) about the axis "i".

It should be clear that a member only experiences flexural buckling under one of its axes. The design bending moments $M_{i,P\delta,FB}$ should be only considered about the weak axis for flexural buckling (i.e. the axis which shows the higher slenderness – reflected in a higher value of $\bar{\lambda}$ - according to EN 1993-1-1 section 6.3.1.2).

The second order bending moment due to strut action can be calculated as follows:

$$M_{i,P\delta,FB} = N_{Ed}\cdot e_{P\delta,i} = N_{Ed}\cdot e_{0,i}\cdot k_{amp,i}\cdot\gamma_{M1} \qquad \text{Eq. (2)}$$

Where:

N_{Ed} is the applied axial load;

$e_{0,i}$ is the initial bow imperfection about axis "i" equal to $\frac{W_{el,i}}{A}\,\alpha\,(\bar{\lambda}_i - 0.20)$;

▶38

▶37

$e_{P\delta,i}$ is the bow imperfection accounting for the second order effects;

$k_{amp,i}$ is the amplification factor equal to $\frac{N_{cr,i}}{N_{cr,i} - N_{Ed}}$;

$W_{el,i}$ is the elastic modulus of the cross section about axis "i";

A is the cross-section area;

α is the equivalent imperfection factor according to EN 1993-1-1 section 6.3.1.2;

$\bar{\lambda}_i$ is the non-dimensional slenderness according to EN 1993-1-1 section 6.3.1.2 about axis "i";

$N_{cr,i}$ is the elastic critical buckling load for flexural buckling under the axis "i": $N_{cr,1} = \frac{\pi^2 EI_i}{L_{crit,i}}$, where I_i is the second moment of area about axis "i" and $L_{crit,i}$ is the buckling length about axis "i";

N_{Ed} is the applied axial load on the column.

Splices of elements under bending

Splices within unrestrained segments subjected to major axis bending should be designed for the following forces:

1. $M_{Ed,y}$ – Applied bending moment under the major axis;
2. $M_{Ed,z}$ – Applied bending moment under the minor axis;
3. $M_{z,P\delta,LTB}$ – Second order bending moment due to lateral torsional buckling.

Beam-column splices

Beam-column splices can be exposed to the following design forces:

1. N_{Ed} – Applied axial force;
2. $M_{Ed,y}$ – Applied bending moment about the major axis;
3. $M_{Ed,z}$ – Applied bending moment about the minor axis;
4. $M_{i,P\delta,FB}$ – Second order bending moment due to strut action (flexural buckling) about the axis "i";
5. $M_{z,P\delta,LTB}$ – Second order bending moment due to lateral torsional buckling;
6. $M_{i,P\delta,Amp}$ – Moments due to the amplification of the applied bending moments due to the strut action about the axis "i".

As for elements under compression, the design bending moments $M_{i,P\delta,FB}$ should be only considered about one of the cross-sectional axes for flexural buckling. Beam-columns experience an additional bending moment $M_{i,P\delta,Amp}$ which is related to the amplification of the applied bending moments due to the presence of axial load. The second order bending moments due to the presence of axial force can be calculated considering the amplification factor about the axis "i" as follows:

$$M_{i,P\delta,Amp} = M_{Ed,i} \cdot \left[\frac{N_{cr,i}}{N_{cr,i} - N_{Ed}} - 1 \right] \qquad \text{Eq. (3)}$$

The minor axis bending moment $M_{z,P\delta,Amp}$ should be always considered. The effects of $M_{y,P\delta,Amp}$ and $M_{z,P\delta,Amp}$ should not be considered together: designers should consider two independent combination of action where $M_{y,P\delta,Amp}$ or $M_{z,P\delta,Amp}$ are considered. This is because the second order effects will only develop about one of the member axes, i.e. either LTB will govern and the beam will deform sideways, or a major axis second order bending moment will be generated.

The procedure described above comprises segments under a uniform bending moment profile along the segment. To assess other bending moment profiles, designers may consider the value of $C_{m,i}$ from EN 1993-1-1 Table B.3. For such cases, the values of $M_{i,P\delta,Amp}$ obtained from equation 3 may be multiplied by the values of $C_{m,i}$.

As a summary, the design forces for a beam-column splice can be established by the following equations:

$$N_{Ed,splice} = N_{Ed} \qquad \text{Eq. (4)}$$

$$M_{Ed,y,splice} = M_{Ed,y} + [M_{y,P\delta,FB}] + \{M_{y,P\delta,Amp}\} \qquad \text{Eq. (5)}$$

$$M_{Ed,z,splice} = M_{Ed,z} + [M_{z,P\delta,FB}] + \{M_{z,P\delta,LTB}\} + M_{z,P\delta,Amp} \qquad \text{Eq. (6)}$$

Pairs of effects within the square and round brackets should not be considered simultaneously. Designers should consider them individually and assess which combination of forces gives the most onerous design condition.

Second order bending moment distribution along an unrestrained segment

The bending moment diagrams calculated according to equations 1, 2 and 3 represent a maximum value at mid span of an unrestrained segment. The second order bending moments follow a sinusoidal shape between points of inflexion (points between which the effective length is measured) of: $M_{i,P\delta}(x) = M_{i,P\delta,max} \cdot \sin(\pi \cdot x / l)$, where "$x$" is the position from a point of inflexion and "l" is the length between points of inflexion (for a pinned column, this is the column length).

Comparison with BS 5950 approach

Previous UK practice design addressed second order effects for columns, beams and beam-column splices according to BS 5950 [6]. Further guidance was given by SCI AD notes 243 [7] and AD 244 [8].

The second order out of plane bending moment is addressed by BS 5950 Annex B.3. While BS 5950 established the second order bending moment based on a relationship between yield strength and bending strength for lateral torsional buckling, the Eurocode nomenclature establishes it based on the parameter χ_{LT}. The parameter χ_{LT} can also be understood as a relationship between the allowable buckling stress and the yield strength. Therefore, $1 / \chi_{LT}$ represents the same relationship as proposed by BS 5950. The factor m_{LT}, which considers the bending moment diagram shape along the segment, is accounted for while calculating χ_{LT} according to EN 1993-1-1 6.3.2 (within the elastic critical bending moment - M_{cr}). Both BS 5950 and Eurocode 3 approach have the same background.

Strut action is defined by Annex C.3 of BS 5950. Both BS 5950 and EN 1993-1-1 approaches to address flexural buckling are based on an elastic cross section failure due to the combined stresses of axial load and second order bending moments due to the strut action. If the same buckling resistances are assumed, and considering the elastic section modulus, the simplified method from Annex C.3 of BS 5950 tends to give conservative values in comparison with equation 2. A similar answer for the strut moment is obtained if the applied load is close to the buckling resistance.

Second order effects for members subjected to combined axial load and bending are defined by Annex I.5 of BS 5950. The expression $1/(p_{Ei}/f_c - 1)$ gives the same answer as $[(N_{cr,i}/(N_{cr,i} - N_{Ed}) - 1]$ if the same buckling resistances are assumed. The values of m_y and m_x according to BS 5950-1 Annex I.5 (which should be defined according to BS 5950-1 4.8.3.3.4) are similar to the values defined by EN 1993-1-1 Table B.3.

Calculation example

Consider a UB 533 × 165 × 66 beam-column element with an unrestrained segment of 5 m length subjected to an axial load of 150 kN and a linear bending moment diagram between 165 kNm and 82.5 kNm. A splice connection is located at 1/3 (1.67m) of the unrestrained segment length, closer to the point of maximum bending moment. The bending moment at the splice location is therefore 137.5 kNm. The calculation of the second order design forces to design the splice connection is summarized in the table below. Member resistances are taken from the Blue Book.

Conclusions

1. Lateral torsional buckling failure can be considered by means of an equivalent initial horizontal bow imperfection under the minor axis of the profile, which must then be amplified;
2. Considering the member lateral torsional buckling capacity, it is possible to estimate the cross-section forces at failure;
3. The failure criteria for lateral torsional buckling is assumed to be elastic failure of the cross section considering major axis bending and the second order bending moment due to lateral torsional buckling; strut action effects also need to be accounted for in beam-columns;
4. EN 1993-1-1 approaches for beam and beam-column splices follow the same principles as BS 5950.

References

1 Pimentel, R., Stability and second order of steel structures: Part 1: fundamental behaviour; New Steel Construction; vol 27 No 3 March 2019;
2 Pimentel, R., Stability and second order of steel structures: Part 2: design according to Eurocode 3; New Steel Construction; vol 27 No 4 April 2019;
3 Eurocode 3 - Design of steel structures - Part 1-1: General rules and rules for buildings; BSI, 2014;
4 NA BS EN 1993-1-1+A1 UK National Annex to Eurocode 3 - Eurocode 3 - Design of steel structures - Part 1-1: General rules and rules for buildings; BSI, 2014;
5 Henderson, R., Bearing splice in a column; New Steel Construction; vol 28 No 3 March 2020;
6 BS 5950, Structural use of steelwork in building: Part 1: Code of practice for design - Rolled and welded sections, BSI, 2000;
7 SCI Advisory Desk Notes: AD 243: Splices within unrestrained lengths;
8 SCI Advisory Desk Notes: AD 244: Second order moments

Section properties and resistances, critical loads (S355); UB 533 × 165 × 66	Eurocode buckling Resistances	EN 1993-1-1 P-δ effects	Critical design effects for splice design
$A = 83.7$ cm^2	$N_{b,rd,y} = 2890$ kN	$k_{amp,y} = 1.005$	$N_{Ed,splice} = N_{Ed} = 150$ kN
$W_{el,y} = 1340$ cm^3	$N_{b,rd,z} = 598$ kN	$k_{amp,z} = 1.267$	$M_{Ed,y,splice} = M_{Ed,y} = 137.5$ kNm
$W_{el,z} = 104$ cm^3	$M_{b,rd} = 225$ kNm	$\bar{\lambda}_z = 2.04$	$M_{Ed,z,splice} = M_{z,P\delta,FB} + M_{z,P\delta,LTB}$ $M_{Ed,z,splice} = 1.3 + 16.2 = \pm 17.5$ kNm
$W_{pl,y} = 1560$ cm^3	Note: $C_1 \approx 1.35$	$e_{0,z} = 7.8$ mm ($\alpha = 0.34$)	The set of design actions presented above give the most onerous design scenario according to equations 5 and 6.
$W_{pl,z} = 166$ cm^3		$e_{P\delta,z} = 9.9$ mm	
$I_y = 35000$ cm^4		$M_{z,P\delta,FB,max} = 1.5$ kNm	
$I_y = 859$ cm^4		$M_{z,P\delta,FB}$ (@ 1.67 m) = 1.3 kNm	
$M_{y,pl,Rd} = 554$ kNm		$M_{z,P\delta,LTB,max} = 18.7$ kNm	Note: the value of χ_{LT} was calculated as $M_{b,rd} / M_{y,rd} = 225/554 = 0.41$
$M_{z,pl,Rd} = 59$ kNm		$M_{z,P\delta,LTB}$ (@ 1.67 m) = 16.2 kNm	
$M_{y,el,Rd} = 474$ kNm		$M_{y,P\delta,Amp,max} = 0.86$ kNm	
$M_{z,el,Rd} = 36.9$ kNm		$M_{y,P\delta,Amp}$ (@ 1.67 m) = 0.74 kNm	
$N_{cr,y} = 29017$ kN		($C_{m,y}$ is assumed as 1 considering the low value of $M_{y,P\delta,Amp,max}$)	
$N_{cr,z} = 712$ kN			

Design forces and bending moments for splice design

New and revised codes & standards

From BSI Updates September 2020

BS EN PUBLICATIONS

BS EN ISO 23387:2020

Building information modelling (BIM). Data templates for construction objects used in the life cycle of built assets. Concepts and principles
no current standard is superseded

UPDATED BRITISH STANDARDS

BS EN 15804:2012+A2:2019

Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products

BRITISH STANDARDS REVIEWED AND CONFIRMED

BS EN ISO 1891-2:2014

Fasteners. Terminology. Vocabulary and definitions for coatings

BS EN ISO 2320:2015

Fasteners. Prevailing torque steel nuts. Functional properties

BS 476-6:1989+A1:2009

Fire tests on building materials and structures. Method of test for fire propagation for products

DRAFTS FOR PUBLIC COMMENT

BS EN 1990

Eurocode, Basis of structural and geotechnical design.
Visit http://standardsdevelopment.bsigroup.com/projects/2019-00635 to view the draft details.

BS EN 1993-1-1

Eurocode 3, Design of steel structures, General rules and rules for buildings.
Visit http://standardsdevelopment.bsigroup.com/projects/2020-00560 to view the draft details

Comments for the above documents are required by 26 October, 2020.
Anyone wishing to submit comments will need to register/login to access the Standards Development Site.

20/30420690 DC

BS EN ISO 9016 Destructive tests on welds in metallic materials. Impact tests. Test specimen location, notch orientation and examination
Comments for the above document were required by 7 September, 2020

20/30420694 DC

BS EN ISO 4136 Destructive tests on welds in metallic materials. Transverse tensile test
Comments for the above document were required by 13 September, 2020

20/30420698 DC

BS EN ISO 17639 Destructive tests on welds in metallic materials. Macroscopic and microscopic examination of welds
Comments for the above document were required by 14 September, 2020

ISO PUBLICATIONS

ISO 11463:2020

Corrosion of metals and alloys. Guidelines for the evaluation of pitting corrosion
Will be implemented as an identical British Standard

AD 450: Resistance of composite slabs to concentrated loads

EN 1994-1-1[1] clause 9.4.3 is entitled *effective width of composite slabs under concentrated point and line loads*. It has been the cause of much confusion, as explained below. We are now confident about our interpretation of this clause, and in particular the limits of 7.5 kN and 5.0 kN/m² quoted in its part 5).

The purpose of EN 1994-1-1 9.4.3

For design purposes composite slabs are, not unreasonably, assumed to be one-way spanning. Span is in the direction of the ribs, which add significantly to the depth of the slab and make its stiffness in this direction considerably greater than its transverse stiffness. A question that then arises is what width of slab can be assumed to be active in supporting a concentrated load?

A typical composite slab might span 3.5 m, and could be anything from 6 m to 12 m or more 'wide' (i.e. transverse to the assumed spanning direction). Clause 9.4.3 tells the designer how much of this width can be assumed to carry a concentrated load, acting as a beam. Figure 1 below is taken from EN 1994-1-1:

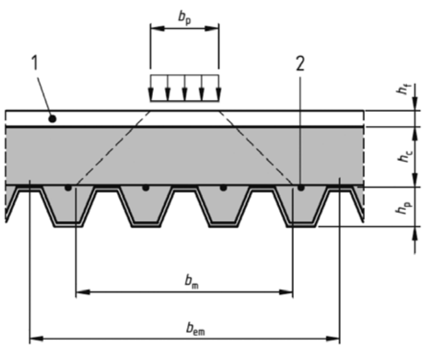


Figure 1: Widths associated with a concentrated load (1 indicates topping)

A load with a physical width b_p distributes at 45 degrees through the depth of slab (and any finishes) above the decking. It then distributes further, to a total width b_{em}, which is the width of slab assumed to carry the load (acting as a beam). The total width b_{em} is a function of the span type (internal or end), the load position within the span, and what physical behaviour is being verified (bending moment and longitudinal shear, or vertical shear resistance). Reference should be made to EN 1994-1-1 equations 9.2, 9.3 and 9.4.

The need for the limits given in 9.4.3 (5)

In 5) of this clause it is noted that 'nominal transverse reinforcement may be used without calculation' (i.e. assumed to be adequate) provided the following maxima are not exceeded for the 'characteristic imposed loads':

- Concentrated load 7.5 kN
- Distributed load 5.0 kN/m²

It is worth noting that, although EN 1994 1-1 clearly states these are limits for imposed loads, given the purpose of this clause other types of point and line loads should also be included in the verification.

It has long been assumed by many – including ourselves in P359 – that the inclusion of a 'squared' in the second of these limits was a 'typo', given that clause 9.4.3 concerns itself with point and line loads (not distributed loads). The wording in ECCS publication 087 (dated 1995) Design Manual for Composite Slabs[2] seemed to confirm this assumption. Some software has also, conservatively, misinterpreted this clause – for example using the defined contact area of a point load to determine a value per metre squared, to check against the second criterion.

The key to understanding what 5) is about is to consider the context. As noted above, it falls within a section of EN 1994-1-1 concerned with calculating the effective width of slab that may be assumed to support a concentrated load. That part of the width b_{em} that goes beyond b_m is a function of the transverse slab stiffnesses, and the definitions of b_{em} given in EN 1994-1-1 are for a typical slab. A slab that was subject to a very high concentrated load might not be typical – it could be designed to be appropriately strong and stiff in the direction of the ribs (its assumed span direction), but might then be relatively more flexible than 'typical' in the transverse direction (for which no explicit design is normally carried out). That relative flexibility would result in the concentrated load being carried over a narrower strip of slab.

So the intent of checking against the two limits defined in 5) is to ensure that the slab is not subject to excessive concentrated loads, so that it remains 'typical'. To do this the designer should consider all the loads on a given area of slab (between the supporting beams on all four sides), be they UDL, point loads or line loads, and check that:

- The heaviest concentrated load does not exceed 7.5 kN
- The sum of all the loads divided by the area of slab does not exceed 5.0 kN/m²

Unless both of these criteria are satisfied the slab should be designed considering the effects of transverse bending moments under the concentrated loads, with appropriate transverse reinforcement provided (see below). Alternatively, the effective width could be limited to b_m, so that no transverse distribution is assumed (or transverse slab stiffness needed). This option was explicitly stated in the ENV (so-called pre-standard) version of Eurocode 4[3].

It is important to recognise that these are 'rule of thumb' limits, so particularly unusual situations are worthy of more detailed analysis. For example, a combination of small UDL combined with a significant line load (the sum of which satisfied the 5.0 kN/m² limit), would result in very different behaviour from a large UDL combined with a small line load (also less than 5.0 kN/m²). The former situation would place greater demands on the ability of the slab to distribute load effects transversely. To avoid such situations a third limit that line loads should not exceed 5.0 kN/m was proposed in ECCS 087[2]. An alternative line load limit is given in Reference [5].

The fact that the UDL limit of 5.0 kN/m² does not allow significant concentrated loads to be supported in addition to the uniformly distributed loads typically present, is an indication that composite slabs are not well suited to carrying large concentrated loads.

Designing the slab for transverse bending

As noted above, if the stated load limits are exceeded then the slab must be designed explicitly for transverse bending, and appropriate transverse reinforcement provided. Whereas EN 1994-1-1 9.4.3(6) simply gives a general reference to EN 1992-1-1[4] for guidance, Reference [5] proposes a simple way of determining the transverse bending moment that can then be used in the standard design of a reinforced concrete beam strip that passes under the load.

By analogy with the load width b_m, the load length a_m is assumed to be given by:

$$a_m = a_p + 2(h_f + h_c)$$

Where h_f and h_c are the thickness of any finishes and depth of concrete above the deck, respectively, and a_p is the contact length of the load.

The transverse bending moment due to the load Q_{Ed}, per metre length (in the direction of the slab span) is then given by:

$$M_{Ed} = \frac{Q_{Ed}\,(b_{em}-b_m)}{8 \cdot a_m}$$

As a footnote it is worth remembering that software tends to consider one metre wide strips of slab – there is no facility to input the width of slab. Some post-processing of outputs in order to verify compliance with this clause may therefore be necessary.

References:

[1] BS EN 1994-1-1:2005, Eurocode 4 - Design of composite steel and concrete structures - Part 1-1: General rules and rules for buildings, BSI, 2005.

[2] ECCS 087 – Design Manual for Composite Slabs; Technical Committee 7 - Cold Formed Thin Walled Sheet Steel; Technical Working Group 7.6 - Composite Slabs, 1995.

[3] DD ENV 1994-1-1:1994, Eurocode 4. Design of composite steel and concrete structures. General rules and rules for buildings (together with United Kingdom National Application Document), BSI, 1994.

[4] BS EN 1992-1-1:2004+A1:2014, Eurocode 2: Design of concrete structures. General rules and rules for buildings, BSI 2004.

[5] Johnson, R. P, Wang, Y. C., Composite Structures of Steel and Concrete, Fourth edition, 2019; Wiley Blackwell.

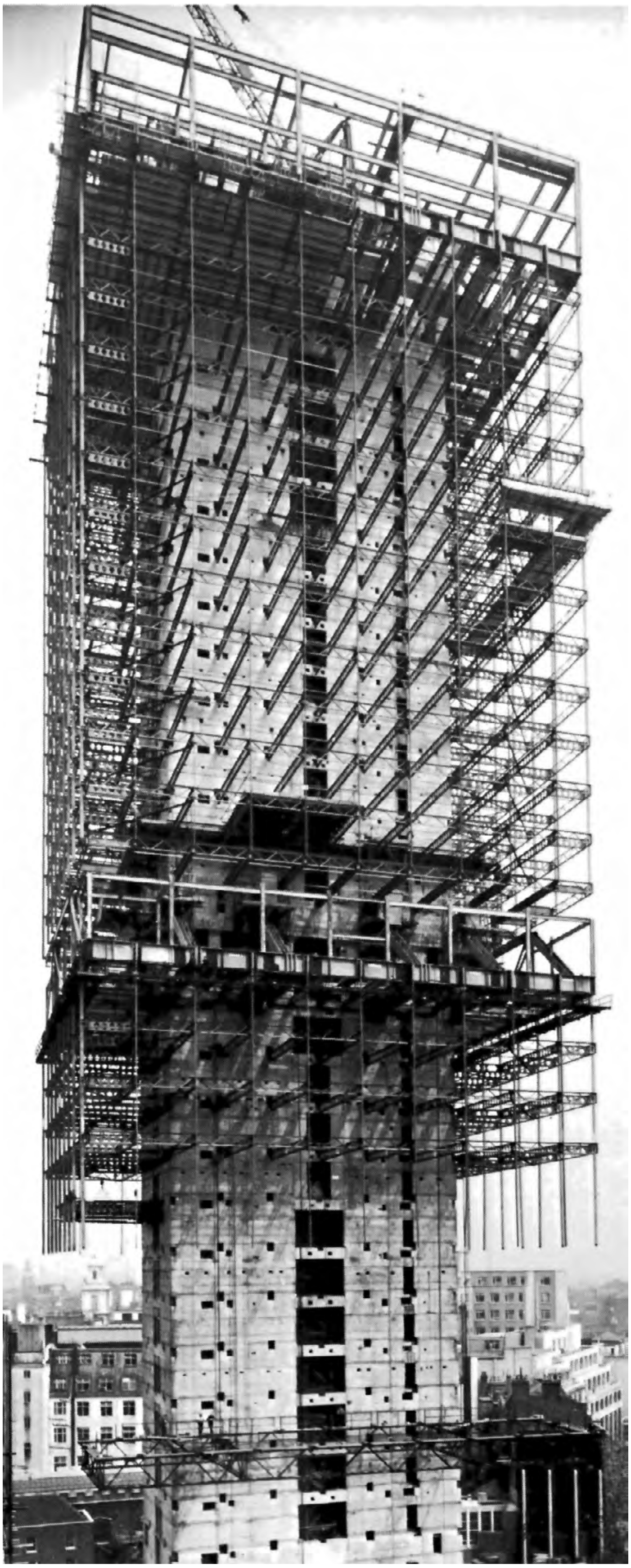
Contact: **Graham Couchman**
Tel: **01344 636555**
Email: **advisory@steelconstruction.org**

Structural Steel Design Awards 1970

As in 1969, the British Steel Corporation in conjunction with the British Constructional Steelwork Association has presented awards for structural steelwork design. Certain changes were made to the rules governing the competition compared with last year, one result of which was to enable the judges to make a Special Award to that entry which in their opinion is '... the outstanding structure of the year on the basis of originality of design and of steel application.' This has been gained by the Commercial Union Head Office illustrated here during construction.

The objectives are the same as last year and are '... to recognize the high standards of design attainable in the use of structural steel and its potential in terms of efficiency, economy and aesthetics.'

As can be seen, these criteria have been met by the structures receiving awards and their diversity again underlines that for modern concepts of design steel provides the designer with the greatest scope for the expression of his skills.



Special Award

Commercial Union Head Office

	for Commercial Union Assurance Co. Ltd
ARCHITECTS	Gollins Melvin Ward & Partners
STRUCTURAL ENGINEERS	Scott Wilson Kirkpatrick & Partners
STEELWORK CONTRACTOR	Dawnays Ltd
MAIN CONTRACTOR	Taylor Woodrow Construction Ltd

FROM **Building with Steel** NOVEMBER 1970

BOAC Hangar 01 for Jumbo Jet Aircraft

	for British Overseas Airways Corporation
ARCHITECTS	Norman Royce, Topping, Hurley and Stewart
STRUCTURAL ENGINEERS	Z S Makowski & Associates
STEELWORK CONTRACTOR	Dawnays Ltd
SUBCONTRACTORS FOR THE ROOF	Stewarts & Lloyds Ltd (now [1970] Tubes Division, BSC)
MAIN CONTRACTOR	Holland & Hannen & Cubitts (Southern) Ltd

Private house, 81 Swains Lane, London N6

	for John Winter
ARCHITECTS	John Winter & Associates
STRUCTURAL ENGINEERS	Herbert Heller
STEELWORK CONTRACTOR	F Monk & Sons Ltd

Royal Commonwealth Pool, Edinburgh

	for Edinburgh Corporation
ARCHITECT	Robert Matthew, Johnson-Marshall & Partners (In association with A. Steele, City Architect)
STRUCTURAL ENGINEERS	Ove Arup & Partners
STEELWORK CONTRACTOR	Redpath Dorman Long Ltd (now [1970] Constructional Engineering Division, BSC)
MAIN CONTRACTOR	James Laidlaw & Sons Ltd

Cargo Agents' Building, Heathrow Airport, London

	for British Airports Authority
ARCHITECTS	Yorke Rosenberg Mardall
STRUCTURAL ENGINEERS	The Director of Engineering, British Airports Authority
STEELWORK CONTRACTOR	Boulton & Paul (Steel Construction) Ltd
MAIN CONTRACTOR	Costain Construction Ltd

Mersey Tunnel Approach Viaducts at Birkenhead

	for The County Borough of Birkenhead
DESIGN OFFICE	Brian Colquhoun & Partners
STEELWORK CONTRACTOR	United Steel Structural Co Ltd (now [1970] Constructional Engineering Division BSC)
MAIN CONTRACTOR	Marples Ridgway Ltd

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 C Bacon Engineering Ltd	01953 850611			●	●	●	●				●			●			2			Up to £3,000,000
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*
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
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
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●				●	●	✔	4		Gold	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 £400,000
Duggan Steel	00 353 29 70072	●	●	●	●	●	●	●	●		●				●	✔	4			Up to £6,000,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●	●	●	●	●			●	●	✔	4		Gold	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
G.R. Carr (Essex) Ltd	01286 535501	●		●	●			●			●			●	●	✔	4			Up to £800,000
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)
H Young Structures Ltd	01953 601881			●	●	●	●	●						●	●	✔	4	✔	●	Up to £3,000,000
Had Fab Ltd	01875 611711				●				●	●	●				●	✔	4			Up to £3,000,000
Hambleton Steel Ltd	01748 810598		●	●	●	●	●	●			●	●		●		✔	4		●	Up to £6,000,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●	✔	2			Up to £3,000,000
Intersteels Ltd	01322 337766	●			●	●	●	●	●	●			●	●	●	✔	3			Up to £3,000,000
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	✔	●	Above £6,000,000
Kloeckner Metals UK Westok	0113 205 5270												●			✔	4			Up to £6,000,000
LA Metalworks Ltd	01707 256290				●	●				●	●			●	●	✔	2			Up to £2,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●					✔	2		●	Up to £6,000,000
Legge Steel (Fabrications) Ltd	01592 205320			●	●		●		●	●	●			●	●		3			Up to £800,000
Littleton Steel Ltd	01275 333431				●					●	●				●	✔	3			Up to £1,400,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●				●	✔	4		●	Up to £3,000,000
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
Murphy International Ltd	00 353 45 431384	●			●		●	●	●		●				●	✔	4			Up to £1,400,000
Newbridge Engineering Ltd	01429 866722	●	●	●	●	●	●	●			●	●				✔	4		●	Up to £2,000,000
North Lincs Structures	01724 855512			●	●					●	●				●		2			Up to £800,000
Nusteel Structures Ltd	01303 268112						●	●	●	●				●		✔	4		●	Up to £6,000,000
Painter Brothers Ltd	01432 374400	●			●				●	●	●				●	✔	3			Up to £6,000,000*
Peter Marshall (Steel Stairs) Ltd	0113 307 6730									●					●	✔	2			Up to £1,400,000*
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●		3			Up to £1,400,000
Robinson Structures Ltd	01332 574711			●	●	●	●				●				●	✔	3			Up to £2,000,000
S H Structures Ltd	01977 681931	●		●	●	●	●	●	●	●	●	●			●	✔	4	✔	●	Up to £3,000,000
SAH Luton Ltd	01582 805741			●	●	●				●	●			●	●		2			Up to £800,000
SDM Fabrication Ltd	01354 660895	●	●	●	●	●	●				●			●	●	✔	4			Up to £2,000,000
Severfield plc	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	●	Above £6,000,000
SGC Steel Fabrication	01704 531286				●					●				●	●	✔	2			Up to £200,000
Shaun Hodgson Engineering Ltd	01553 766499	●		●	●		●			●	●			●	●	✔	3			Up to £1,400,000
Shipley Structures Ltd	01400 251480			●	●	●	●		●	●	●			●	●		2			Up to £3,000,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●	●	●	●			●				●		2	✔		Up to £2,000,000
South Durham Structures Ltd	01388 777350			●	●	●				●					●		2			Up to £800,000
Southern Fabrications (Sussex) Ltd	01243 649000				●	●				●	●			●	●	✔	2			Up to £1,400,000
Steel & Roofing Systems	00 353 56 444 1855	●		●	●	●	●				●	●		●	●	✔	4			Up to £4,000,000
Structural Fabrications Ltd	01332 747400	●			●	●	●	●	●	●	●			●	●	✔	3		●	Up to £1,400,000
Taunton Fabrications Ltd	01823 324266				●					●	●				●	✔	2		●	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	✔	●	Up to £2,000,000
TSI Structures Ltd	01603 720031			●	●	●	●	●			●			●			2	✔		Up to £2,000,000
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		●	Up to £800,000
William Haley Engineering Ltd	01278 760591				●	●	●									✔	4		●	Up to £6,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	●	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
SRF Site-based bridge refurbishment

FRF Factory-based bridge refurbishment
AS Ancilliary structures in steel associated with bridges, footbridges or sign gantries (eg grillages, purpose-made temporary works)

QM Quality management certification to ISO 9001

FPC Factory Production Control certification to BS EN 1090-1
1 – Execution Class 1 2 – Execution Class 2
3 – Execution Class 3 4 – Execution Class 4

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	SRF	FRF	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
Billington Structures Ltd	01226 340666	●		●	●	●	●					●	✓	4	✓	✓	✓	Gold	Above £6,000,000
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			✓	Gold	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 £400,000
Donyal Engineering Ltd	01207 270909	●		●						●	●	●	✓	3			✓	Silver	Up to £1,400,000
ECS Engineering Services Ltd	01773 860001	●			●	●	●		●			●	✓	3				Gold	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	Above £6,000,000
M Hasson & Sons Ltd	028 2957 1281	●	●	●	●	●	●	●	●	●		●	✓	4			✓	Member	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
Nusteel Structures Ltd	01303 268112	●	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Up to £6,000,000
S H Structures Ltd	01977 681931	●	●	●	●	●	●	●	●	●	●	●	✓	4	✓		✓	Gold	Up to £3,000,000
Severfield (UK) Ltd	01204 699999	●	●	●	●	●	●	●	●	●	●	●	✓	4	✓	✓	✓	Gold	Above £6,000,000
Shaun Hodgson Engineering Ltd	01553 766499											●	✓	3					Up to £1,400,000
Structural Fabrications Ltd	01332 747400	●		●	●	●	●			●	●	●	✓	3				Silver	Up to £1,400,000
Taziker Industrial Ltd	01204 468080	●		●	●	●	●	●	●		●	●	✓	3		✓	✓		Above £6,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●		●	✓	4	✓	✓	✓	Gold	Above £6,000,000
Non-BCSA member																			
Allerton Steel Ltd	01609 774471	●		●	●	●	●	●			●	●		4	✓				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
Eiffage Metal	00 33 388 946 856	●	●		●		●	●	●			●	✓	4					Above £6,000,000
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 £800,000
Kelly's Welders & Blacksmiths Ltd	01383 512 517											●	✓	2			✓		Up to £200,000
Lanarkshire Welding Company Ltd	01698 264271	●	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Up to £3,000,000
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
Gene Mathers	0115 974 7831
Griffiths & Armour	0151 236 5656
Highways England Company Ltd	08457 504030
Inspire Insurance Services	02476 998924
Sandberg LLP	020 7565 7000
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.

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
NHSS National Highway Sector Scheme

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

SfL Steel for Life Sponsor

Structural components

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
Albion Sections Ltd	0121 553 1877	✓	M	4			
BW Industries Ltd	01262 400088	✓	M	3			
Cellbeam Ltd	01937 840600	✓	M	4	20		
Composite Profiles UK Ltd	01202 659237		D/I				
Construction Metal Forming Ltd	01495 761080	✓	M	3			
Daver Steels Ltd	0114 261 1999	✓	M	3			
Fabsec Ltd	01937 840641		N/A				
Farrat Isolevel	0161 924 1600	✓	N/A				
FLI Structures	01452 722200	✓	M	4	20	🟠	
Hadley Industries Plc	0121 555 1342	✓	M	4		⚪	
Hi-Span Ltd	01953 603081	✓	M	4		🟢	
Jamestown Manufacturing Ltd	**00 353 45 434288**	✓	**M**	**4**	**20**		**Headline**
Kingspan Structural Products	01944 712000	✓	M	4		🟠	
Lionweld Group	01642 233238	✓	M	4			
MSW UK Ltd	0115 946 2316		D/I				
Prodeck-Fixing Ltd	01278 780586	✓	D/I				
Structural Metal Decks Ltd	01202 718898	✓	M	2			
Stud-Deck Services Ltd	01335 390069		D/I				
Tata Steel – ComFlor	**01244 892199**		**M**				**Silver**
voestalpine Metsec plc	**0121 601 6000**	✓	**M**	**4**		🟠	**Gold**

Computer software

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
Idea Statica UK Ltd	02035 799397		N/A				
StruMIS Ltd	01332 545800		N/A				
Trimble Solutions (UK) Ltd	**0113 887 9790**		**N/A**				**Silver**

Steel producers

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
British Steel Ltd	01724 404040	✓	M				
Tata Steel – Tubes	**01536 402121**	✓	**M**				**Silver**

Manufacturing equipment

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
Behringer Ltd	01296 668259		N/A				
Cutmaster Machines (UK) Ltd	**07799 740191**		**N/A**				**Bronze**
Ficep (UK) Ltd	**01924 223530**		**N/A**				**Gold**
Kaltenbach Ltd	**01234 213201**		**N/A**				**Silver**
Lincoln Electric (UK) Ltd	0114 287 2401	✓	N/A				
Peddinghaus Corporation UK Ltd	**01952 200377**		**N/A**				**Gold**
Wightman Stewart (WJ) Ltd	01422 823801		N/A				

Protective systems

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
Forward Protective Coatings Ltd	01623 748323	✓	N/A				
Hempel UK Ltd	**01633 874024**	✓	**N/A**				**Bronze**
Highland Metals Ltd	01343 548855	✓	N/A				
International Paint Ltd	0191 469 6111	✓	N/A				
Jack Tighe Ltd	**01302 880360**	✓	**N/A**		**19A**		**Silver**
Joseph Ash Galvanizing	**01246 854650**	✓	**N/A**				**Bronze**
Jotun Paints (Europe) Ltd	01724 400000	✓	N/A				
PPG Architectural Coatings UK & Ireland	01924 354233	✓	N/A				
Sherwin-Williams Protective & Marine Coatings	**01204 521771**	✓	**N/A**			⚪	**Bronze**
Vale Protective Coatings Ltd	01949 869784		N/A				
Wedge Group Galvanizing Ltd	**01909 486384**	✓	**N/A**				**Gold**

Safety systems

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
easi-edge Ltd	01777 870901	✓	N/A			🟠	

Steel stockholders

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
AJN Steelstock Ltd	**01638 555500**	✓	**M**	**4**			**Bronze**
Arcelor Mittal Distribution - Scunthorpe	01724 810810	✓	D/I	4	3B		
Barrett Steel Services Limited	**01274 682281**	✓	**M**	**4**	**3B**		**Headline**
British Steel Distribution	01642 405040	✓	D/I	4			
Cleveland Steel & Tubes Ltd	**01845 577789**	✓	**M**	**3**			**Gold**
Dent Steel Services (Yorkshire) Ltd	01274 607070	✓	M	4	3B		
Dillinger Hutte U.K. Limited	01724 231176	✓	D/I	4			
Duggan Profiles & Steel Service Centre Ltd	00 353 567722485	✓	M	4			
Kloeckner Metals UK	0113 254 0711	✓	D/I	4	3B		
Murray Plate Group Ltd	0161 866 0266	✓	D/I	4	3B		
NationalTube Stockholders Ltd	**01845 577440**	✓	**D/I**		**3B**		**Gold**
Rainham Steel Co Ltd	01708 522311	✓	D/I	4	3B		

Structural fasteners

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
BAPP Group Ltd	01226 383824	✓	M		3		
Cooper & Turner Ltd	0114 256 0057	✓	M		3		
Henry Venables Products Ltd T/A Blind Bolt	01299 272955		M				
Lindapter International	01274 521444	✓	M				
Tension Control Bolts Ltd	**01978 661122**	✓	**M**		**3**		**Bronze**

Welding equipment and consumables

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
Air Products PLC	01270 614167		N/A				

The Katana 100E

Supercharged Sawing from Ficep

- Process profiles with up to 60° mitring cuts in both directions
- Hydraulic horizontal and vertical hold-down clamps ensure profile stability while processing
- Magnetic unloading system automatically quickly transfers small processed parts and trim cuts to the specially designed unloading table
- Automatic synchronised brush cleans chips away from the blade
- Designed for quick and easy blade replacements

The latest advancement in automatic steel band sawing technology brings remarkable processing speeds and quality operation to structural steel processors.

The Katana 100E is available as a stand-alone saw, as part of a complete automatic sawing line or as a combined solution with one of the Ficep drilling lines. All options come with a dedicated CNC control unit to enable operator efficiency and improve productivity.