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NSC

STRUCTURAL STEEL DESIGN AWARDS 2016

October 2016
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Cover Image
Harlech Castle Footbridge
Concept designer: Mott MacDonald
Structural Engineer:
David Dexter Associates
Steelwork Contractor: S H Structures Ltd
Main Contractor: RL Davies & Son Ltd
Client: Cadw

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Award entries on rising trend

Nick Barrett - Editor

Living in interesting times as we do, it is good to see the Structural Steel Design Awards come around again with a range of first class projects that demonstrate advances in design, innovation and fabrication.

Much has changed in the year since the last awards, with UK steelmaking undergoing a restructure and the referendum to exit the EU in June. The structural steelwork sector has come through the year in fine shape, experiencing no issues around the supply of high quality raw steel and a study by KPMG concluding there is sufficient structural steelwork capacity in the UK to meet current as well as future demand.

The number of entries to the awards rose this year. The quality of entries is there for all to see, and seems to be rising over time even as we see, as Chairman of the Judges David Lazenby pointed out, an increase in the complexity of modern projects. The judges' comments on the Award winners repeatedly focus on how steel construction was used to overcome technical challenges imposed by boundary pushing designs, logistics or site constraints.

All the shortlisted projects were, uniquely among award schemes of this type, visited by judges. And all of them have strong merits and a strong case for an Award – but the Awards only go to those that catch the judges' attention as being a cut above the others and that show steel construction at its finest.

As always there has been a wide geographic spread. There is also an encouragingly wide spread of type and size of project among the award winners – major sports arenas, education buildings, museums, a national memorial, energy schemes and no fewer than five footbridges. It is notable that constructional steelwork is benefitting ancient structures like Harlech Castle and modern growth industries like energy from waste, creating new icons such as the Bomber Command Memorial Spire as well as extending and reviving older commercial buildings and large stadiums.

The 2016 SSDA shortlisted projects all exemplify the efficiency, cost-effectiveness, high aesthetics, sustainability and innovation that structural steelwork routinely delivers. They instil confidence that next year's entries will continue the trend of improving excellence in steel construction.

STRUCTURAL STEEL DESIGN AWARDS 2016

Industry's expertise highlighted at Awards

Five projects were Award winners at this year's Structural Steel Design Awards (SSDA) held on 5th October at the Museum of London.

The five winning projects at the 48th annual SSDA were the London Olympic Roof Conversion; Harlech Castle Footbridge; Thames Tower Redevelopment, Reading; South Stand Expansion, Etihad Stadium; and The Memorial Spire, International Bomber Command Centre, Lincoln.

From the shortlist of 20 projects, all of this year's entries scored highly in efficiency, cost-effectiveness, aesthetics, sustainability and innovation.

Chairman of the Judges, David Lazenby CBE said: "It is reassuring that we have seen an increase in the number of submissions for the Awards scheme this year, and the quality and appeal of the projects is as high as ever.

"The spread of the projects, both geographically and in type, demonstrates how steelwork is used successfully in almost any type of work. Bearing in mind the great ingenuity applied by designers and practitioners there are scarcely any limits to the nature of the submissions."

British Constructional Steelwork Association [BCSA] President Wendy Coney said: "While it is well known that single storey sheds are almost all built in steel, tonight's shortlist demonstrates that steel is also the structural material of choice for schools, offices, sports stadia, power generation facilities, footbridges, and a wide range of other structures.

"Much has changed since our 2015 Awards ceremony. It has been a tumultuous year for UK steelmakers. But the supply of structural steel was unaffected and confidence in steel as the framing material of choice has been maintained.

BCSA steelwork contractor members continued to source their steel from high-quality domestic and imported sources, supported by a strong distribution and stockholding sector. This enabled us to meet demand for the full range of projects and clients."

Chairman of the Judges, David Lazenby

BCSA President, Wendy Coney

Attendees gather before the ceremony at the Museum of London

AWARDS

- Thames Tower Redevelopment, Reading
- London Olympic Roof Conversion
- South Stand Expansion, Etihad Stadium
- Harlech Castle Footbridge
- The Memorial Spire, International Bomber Command Centre, Lincoln

COMMENDATIONS

- Land Rover BAR America's Cup HQ Building, Portsmouth
- The Diamond Engineering Building, The University of Sheffield
- Lagan Weir Pedestrian and Cycle Bridge, Belfast
- 6 Bevis Marks Roof Garden, London

MERIT

- Leeds Station Southern Entrance
- Energy from Waste Facility, Ardley

NATIONAL FINALISTS

- Energy from Waste Facility, Peterborough
- New Watford Market
- University of Cambridge Primary School
- Sports Hall & Sixth Form Centre, Channing School, London
- South Bank Tower, London
- Whyke Horizon Footbridge, Chichester
- Strabane Pedestrian and Cycle Bridge, Co. Tyrone
- Information Age Gallery, The Science Museum, London
- Kiosk and Shelter, Bournemouth Pier Approach

The award winning teams

Thames Tower Redevelopment, Reading

London Olympic Roof Conversion

South Stand Expansion, Etihad Stadium

Harlech Castle Footbridge

The Memorial Spire, International Bomber Command Centre, Lincoln

NEWS IN BRIEF

The **Steel Construction Certification Scheme** (SCCS) is looking for experienced contract auditors to join their team. Interested candidates should send their CV to: Ms Kim Feneley, SCCS, Unit 4, Hayfield Business Park, Field Lane, Auckley, Doncaster DN9 3FL or email: *kim.feneley@steelconstruction.org*

Structural steel manufacturer **ArcelorMittal** has updated two of its pre-design software packages with the launch of ABC v3.42 and Angelina v3.03. ABC enables designers to consider shallow steel solutions incorporating Integrated (IFB) and Slim Floor Beams (SFB) in both the cold and fire conditions for multi-storey buildings. Angelina assists designers looking for the advantages of castellated beams with sinusoidal openings in single and multi-storey buildings. Both ABC and Angelina software packages facilitate design according to the principles of the Eurocodes and are free to download from *http://sections.arcelormittal.com/download-center/design-software.html*

Barrett Steel has secured £80M from HSBC as part of a funding package as it aims to grow its turnover to £300M. It has a five-year plan with which it aims to secure customers in new sectors and boost its turnover by £50M, by 2020.

The Ordsall Chord project in Manchester has won the Best Infrastructure category at the **Tekla Global BIM awards**, which recognise jobs that are pushing the boundaries of BIM to create impressive structures. The civil engineering contractor, Skanska BAM JV, appointed a joint venture between AECOM and Mott MacDonald, at tender stage along with steelwork subcontractor Severfield.

Billington Holdings has announced its strongest ever order book with plentiful work into next year. Interim results for the six months up to 30 June 2016 produced a profit before tax of £1.74M with a 10% increase in revenue to £27M.

AROUND THE PRESS

Construction News
30 September 2016
Musical build forces team to box clever
[Birmingham University Conservatoire] - "That's where structural steelwork works," says Galliford Try Senior Project Manager Keith Lilley. "You can set down pads, put down an oversized base plate for the columns – so you can pin that down, build up the main frame and put in the precast planks so you haven't got any formwork underneath."

The Times
28 September 2016
Grand Designs
There is no law stating that all homes have to be serious and practical. Why can't a house, like a wicked great-uncle, be full of fun? That is more-or-less what Matt and Sophie White from Sussex believe. They want to build a huge family house for themselves and their children — a mysterious and magical place kitted out with revolving bookcase doors, secret dens, hiding places behind one-way mirrors and a fireman's pole. Because they want it to evolve, they adopt a steel-frame system that allows them to change the layout whenever they want. Now let the wild rumpus start.

Construction News
16 September 2016
Wham, bam: Manchester's tallest office
[No 1 Spinningfields] - Even as the steelwork is being erected high above, the way the process has been planned means internal M&E works will also be installed at lower levels at the same time.

Construction News
2 September 2016
Steel and concrete
Infrastructure has been a strong area for steel contractors, with Highways England and Network Rail providing a steady pipeline of work. Severfield and Cleveland Bridge agree the increasing demand for replacement bridges and bypasses represents a boost.

Steel prototype building demonstrates sustainable approach

A steel-framed prototype building, being exhibited as part of the London Design Festival, is demonstrating the viability of a circular sustainable economy within the construction industry.

Known as the Circular Building, the project has been designed and delivered with 100% components and materials that can be reused, re-manufactured or recycled.

Arup Director Stuart Smith said: "The circular economy is all about tackling waste in the construction sector, all of this building's components can be dismantled and then returned to the supply chain to be reused."

In conjunction with BAM Construction, Arup decided that a steel frame was the best and most sustainable solution for the single storey house.

"We didn't want bespoke steelwork, we just wanted to use whatever the supplier had in its stockyard so the project could get under way quickly," added Mr Smith.

Consequently ArcelorMittal supplied larger sections than would have ordinarily been used for a single storey dwelling.

Lindapter was contacted to design and supply the connection system that was used to secure the building's roof panels, wall panels, and glazing supports to the structural steel frame.

Engineers from Lindapter's technical support team detailed four bespoke connection designs utilising the CE Marked Type B steelwork fixing, which contractors subsequently used to quickly construct the major elements of the building envelope.

In keeping with the principles of the circular economy, all of Lindapter's products are said to provide flexibility, longevity, ease of deconstruction and the potential to be reused or recycled.

Project Architect Simon Anson of Arup Associates commented: "The circular economy provides an opportunity for all of us to rethink how we can create a future that values natural capital, improves humanity and leaves a better world for future generations.

"It challenges us to rethink how we live, own, design and build our communities, towns and cities."

Steel frame starts at major Stockport scheme

Work at the Redrock Stockport project has reached an important milestone as the steel frames have started to be erected.

Billington Structures, working on behalf of main contractor Wates Construction, has begun erecting steel sections for the £45M project's new 10-screen cinema.

Opening its doors next year, Redrock will transform a large swathe of Stockport town centre with new shops, restaurants and leisure facilities.

Councillor Kate Butler, Executive Member for Economy and Regeneration at Stockport Council said: "It is great to see the steel frames starting to go up at Redrock and how the work is beginning to take shape.

"I am really excited about everything taking place across our town centre at the moment and how the town is changing."

The entire Redrock project is due to be completed by mid-2017.

Flagship Welsh school opens to pupils

Holywell School in Flintshire, one of the first projects in Wales' 21st Century Schools Programme (see *NSC* Feb 2016) has opened.

The flagship £30M steel-framed super school provides a combined facility for 600 high school students and 315 infant and junior school pupils.

Requiring 700t of structural steelwork, erected by EvadX, the new building replaces the old High School, which is situated next door, and two local primary schools.

Main contractor Galliford Try began work on the project in January 2015 and it has now begun phase two of the scheme that consists of demolishing the old school buildings to create new sports pitches.

The new Holywell School has an elaborate design combining a three-storey secondary school with a single storey primary school both housed within two elliptical-shaped zones.

Apart from the sports hall, drama hall and dining areas, the entire school is curved both on plan and elevation.

The steel frame forms a stretched figure of eight shape with the primary school formed around an open elliptical-shaped courtyard in the top loop, and a three-storey atrium infilling the lower loop surrounded by the secondary school classrooms.

Steel producer hits key profitability targets

British Steel, the newly-formed steel manufacturer, has announced that it is on track to return to profit for the financial year ending 31 March 2017.

The company, launched on June 1, is said to be on course to complete its return to sustainable growth, after successfully implementing the first stages of its turnaround plan.

In addition to efficiency and cost saving initiatives, £50M of capital investments have been committed for this financial year. This investment has been focussed on several major projects to improve competitiveness and broaden the offering to customers that include steelwork contractors, and manufacturers such as Caterpillar and Toyota.

British Steel Executive Chairman Roland Junck said: "I am delighted to be able to announce that we have hit our performance targets and returned the business to profitability in our first 100 days as an independent company.

"I believe we are now better placed to capitalise on our strong heritage, vastly experienced and skilled workforce and world-class products. The transformation of our business will make sure we maintain the pace of growth and move forward as an outward-looking profit-making business. But while our future remains firmly in our hands, the UK steel industry still faces many challenges.

"That is why we are pleased to remain in constructive dialogue with the Government about the strategy needed to support British Steel and ensure that it is operating on a level playing field."

Channel island finance centre goes up

The next phase of Jersey's International Finance Centre [IFC] is under way with the steel frame for Building Four nearing completion.

Elland Steel Structures is erecting approximately 600t of steel for the project that will create 6,200m² of brand new, high quality office space.

IFC Jersey will provide a world-class business hub providing environmentally sustainable Grade A office space within six buildings all designed to achieve BREEAM 'Excellent' ratings.

Slough's iconic Curve opens to the public

Forming an important part of Slough's town centre regeneration, the long-awaited £22M Curve learning centre has opened to the public.

Councillor Phillip Wright said this is an iconic community building.

"You're going to see a different Slough now. It's a community-based building and we want the community to use it."

The Curve (see *NSC* Feb 2015) is a steel-framed building rectangular in shape and plan. Each of the building's elevations feature either cantilevers or sloping and curving facades.

The main north side presenting the most striking aspect with a long sweeping, predominantly glazed, elevation looking on to the adjacent listed St Ethelbert's Church.

The three-level building is 89.7m long, 15.5m high and has a width, which is 34m at its maximum and 16.5m at its narrowest.

With an overall floor space of 4,500m², the centre houses a library, café, office space and a 280-seat performance space.

Working on behalf of main contractor Morgan Sindall, Caunton Engineering erected 370t of structural steelwork for the project.

Initially the Curve was to be built with reinforced concrete, but a redesign of the project, instigated by Morgan Sindall and involving project engineer Peter Brett Associates, resulted in the frame changing to structural steelwork.

Diary

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

Tuesday 18 October 2016
Portal Frame Design - Part 3
This webinar covers the major connections in a portal frame – eaves, apex, base and bracing.
One hour webinar free to BCSA and SCI Members

Wednesday 9 November 2016
SCI Annual Event
3D Printing - the future of design and manufacture.
London.

Software for steel construction

NSC takes a look at the computer software sector which today forms an integral part of design and construction.

The steel construction sector has been using 3D design software for over 25 years and is well versed in the benefits and efficiencies it provides to construction programmes.

Today computer software is integral to the design, fabrication, erection and everyday operational processes at most steelwork contractors' facilities.

Software use is interwoven into each stage of the steel fabrication process supporting activities such as internal knowledge and bid management, project planning, frame analysis, connection design, 3D modelling and BIM co-ordination.

In multi-storey buildings a structural engineer is usually responsible for the steel frame design, and once this is completed a steelwork contractor will then design the connections, prior to starting the fabrication process. However, for those single storey buildings that are procured on a design and build basis, the steelwork contractor designs both the frame and connections.

Software for the design of connections has been around for a long time and there is a large range of specialist solutions available to the steelwork contractor. The range and functionality of these packages is continually being upgraded.

"New structural analysis software is now able to link with construction modelling software, helping us to improve workflows and increase efficiency," explains Caunton Engineering Director of Engineering and Innovation Robert Berry.

The use of computer software ensures that data created in the design phase of the project can then be used through further phases to the final sign off of the erected steel on site, ensuring essential process integration in the supply chain.

During the design phase, the structural steel will be modelled to fabrication levels of detail. Materials Resource Planning software then processes a bill of materials data from the model which is used for procurement of materials, manages data to drive automated cutting and fabrication machinery, plans logistics, as well as piece weights for crane planning. These technology advancements have allowed steelwork contractors to operate on a "just-in-time" basis.

Another important aspect of the steelwork design process is the analysis of other components that make up a steel-framed building such as composite floor slabs.

Software to carry out analysis of structural elements was one of the first used by the steel construction industry and consequently it has also been around for quite a while. During this time it has developed from rudimentary analysis to comprehensive analysis of very complex structures.

In more recent times the advent of BIM has further pushed the drive for better integration between analysis and construction modelling software packages.

BIM is about working collaboratively and bringing the supply chain together from day one to produce good designs with fully-coordinated construction interfaces by sharing data electronically. This then provides the building owner with the data to manage and maintain the asset over its lifetime.

On-site, actual progress of the steel erection can be captured and reported back using mobile services.

Looking to the future the next technological advance is likely to be the wider adoption of automatic assembly machines within the structural steel industry. Software providers know they need to be ready to be able to service this new way of manufacturing and are currently making advances in this field.

"Steelwork contractors have been working with BIM long before the acronym was ever created. If BIM is creating a 3D model with intelligent data and allowing that information to be used elsewhere in the process then that has been available for over two decades.

"The key difference now is that other disciplines can also produce models of their parts of the project and with the use of collaboration platforms can federate these models, compare designs and communicate discrepancies effectively in the same environment," says Trimble Solutions (UK) Structures Division Managing Director Richard Fletcher.

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Structural Steel Design Awards 2016

Pictured: South Stand Expansion, Etihad Stadium, Manchester

The Judges

Chairman of the Structural Steel Design Awards judges **David Lazenby CBE** had a distinguished career as a consulting engineer, and as chairman of the lead European committee he led the huge pan-European exercise to develop the Eurocodes. A new turn in the 1990s saw him directing British Standards (BSI).

David Lazenby's career began with Balfour Beatty, then moved to consultant Andrews Kent & Stone, where he stayed for 30 years, becoming managing partner and subsequently a director. In 1990/91 he was one of the youngest ever Presidents of The Institution of Structural Engineers.

In parallel he had become involved in developing codes and standards, advancing from technical committees and sector boards to become a non-executive director of BSI Group. In 1997 he was asked to become the Director of British Standards, one of three executive directors of the group responsible for over 5000 staff in 100+ countries. His experience both as a user and developer of standards led to a new focus on market relevance. Bringing global success to the organization and establishing British Standards as a world leader in its field, as well as making it profitable, has been almost unique among national standards bodies. He was awarded the CBE in 2002.

Since 2003 he has operated his own consultancies, Eurocode Consultants and DWL Consultants, in the fields of certification and construction company direction. He was elected President of the International Building Study Group in 2012.

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 is currently a member of BCSA's Council.

Martin Manning is a Structural Engineer. He is an Arup Fellow. He joined the firm directly from university and for over 40 years has worked in Arup offices and on projects around the world, most recently on buildings in the transport sector. He is a past Chairman of the SCI, a Fellow of the Royal Academy of Engineering and a Member of The Institution of Structural Engineers.

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.

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 40-storey office tower on Leadenhall Street.

Joe Locke retired in 2004 from his position at William Hare, where he was responsible for the engineering aspects of the company's activities and also Executive Director of subsidiary Westbury Tubular Structures; having previously retired in 1998 as Chief Executive Officer of Watson Steel. Joe was an apprentice with Watson and sat his associate membership of The Institution of Structural Engineers at only 23. Joe worked at home and overseas on a considerable number of high prestige contracts, including Sellafield nuclear power station's massive thermal oxide reprocessing plant and the terminal building of Kansai airport, Japan. Joe Locke was awarded an MBE in 1990 for his contribution to the structural steelwork industry. In 2007 he recieved a Gold Medal of The Institution of Structural Engineers.

Christopher Nash is a senior Consultant Architect. He graduated in 1978 from Bristol University School of Architecture, and was at Grimshaw Architects for 30 years and a Director/Partner from 1992 to 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. Having spent ten years as Managing Partner, Chris returned to leading 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.

Bill Taylor is an architect in private practice. He joined architects Michael and Patty Hopkins straight from the Sheffield School of Architecture in 1982 and in 1988 became their partner. He was a pivotal figure in the development and success of the practice 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 left Hopkins Architects in Spring 2010 to concentrate on his own projects. He has been a member of the RIBA National Awards Group, is a Senior Assessor for the RIBA Competitions programme and was a founding member of Tensinet, the pan-European organisation that researches lightweight structures and membrane architecture.

Pictured: The Memorial Spire, International Bomber Command Centre, Lincoln

Introduction

by David W. Lazenby CBE - Chairman of the Judges

It is reassuring that we have seen an increase in the number of submissions for the Award scheme this year, and that the quality and interest of the projects remains as high as ever.

One strong impression is that these days there are few easy projects. For reasons of technical difficulty, timetabling or late-evolving scheme requirements, there are very few projects that do not present great challenges. This means that the teams must work closely and constructively together, and the importance of a well-committed and collaborative client cannot be overstated.

We have a good geographical spread, as well as a broad range of types of project. With two major sports arenas, school and university buildings, and exciting works in museums and national memorials, the usual areas are well represented. But we also have important energy schemes, commercial and residential rehabilitations, as well as five exciting footbridges. Altogether they represent a major contribution to the built environment.

In a real sense they are all winners. But the final list of projects to receive Awards, Commendations and recognition of Merit, reflect the strength and diversity of the industry.

Thames Tower Redevelopment, Reading

A 1970s office block has been given a new lease of life with enlarged floorplates and four extra steel-framed floors above level 11.

The project's original scheme concept was to demolish the existing concrete-framed Thames Tower in Reading town centre and replace it with a new 25-storey high tower, which would have necessitated the requirement for new supporting foundations.

However, after an innovative design proposal provided by Peter Brett Associates, the core of the existing structure was maintained and developed using a series of strengthening works throughout the height of the concrete frame, along with the provision of four new additional steel-framed office floors to increase the nett usable internal areas.

This proposal also provided huge 'value-engineering' savings to the scheme, as the basic core of the structure was maintained and no enhancement of the existing concrete foundations was necessary.

dn-a Director, Stuart McLarty comments: "Thames Tower originally had stumpy proportions, which contradicted its name as a tower. Adding four additional floors, squaring the corners and removing the concrete spandrels to allow for towering windows created a more elegant, proportionate building."

Refurbishment work also includes stripping the building right back to its structural frame with the removal of its cladding, which will be replaced with a terracotta system to mirror redbrick buildings in the town.

"Steel is ideal for this kind of project as it is quick to erect and lightweight in comparison to other materials," says Peter Brett Associates Project Engineer Roderick Wilson.

"By strengthening some of the concrete columns we have added new floors to the

top of the building, and crucially we have been able to reduce costs by re-using all existing foundations."

As well as the four additional steel-framed floors, steel construction has also played a role in maximising and extending the existing floors of the tower.

The structure's original design had the perimeter columns protruding beyond the floorplates. For the new design, project steelwork contractor Shipley Structures has installed a series of new perimeter support beams that have been fitted and connected to the existing concrete columns.

These beams support new metal decking and a concrete topping, which brings the floors flush to the exterior face of the columns.

"The beams have also provided the necessary support to allow the existing concrete perimeter upstand beams at level two up to 11 to be removed," says Bowmer & Kirkland Senior Project Manager Bill Poole.

Altering the four corners of the building has further increased each of the tower's existing commercial floorplates. Previously the corners featured a 45-degree chamfer, which has now been infilled to create a new perfectly square structure.

This was achieved by Shipley Structures installing a new steel column in each of the building's four corners. Two new connecting floor beams were then added at each floor which, in turn, support metal decking that forms the new floor space.

This work has increased the tower's floor space from 13,600m² to approximately 17,000m² of offices and 740m² of restaurant/café space.

"Before the four new storeys of steelwork could be erected it was necessary for the existing concrete frame to be strengthened," explains Shipley Structures Director Chris Murphy. "And the concrete frame also needed to be strengthened in order to support the tower crane that was needed for the erection programme."

A 500t-capacity mobile crane was required to install the site's tower crane. However, due to the poor ground conditions surrounding the site, the chosen spot for this large crane had to be piled and strengthened prior to its arrival.

"While these groundworks for the crane were being completed, we not only strengthened the concrete columns, but we also completed all of the perimeter steelwork for the existing tower," says Mr Murphy. "As there was no tower crane we had to use hoists and lift most of the steel up through the cores."

To strengthen the existing columns flat 15mm-thick steel plates were fabricated and installed to two faces of all internal columns from level six up to level ten. At levels nine and 10 further strengthening plates were also fitted to the perimeter columns.

At level 10 additional plates and stiffener brackets were fitted to three internal concrete columns located below the tower crane location. After all of these strengthening plates had been anchored into place they were then sealed and resin bonded to the existing concrete columns.

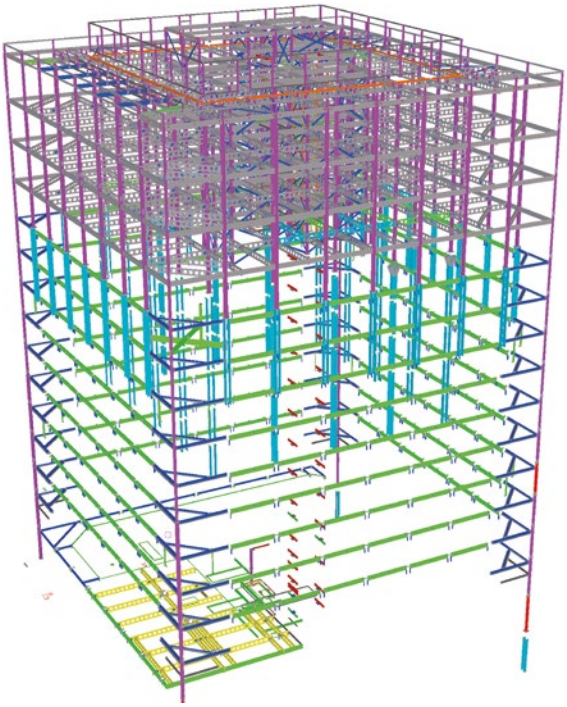
Once the strengthening works had been completed and the tower crane installed, Shipley began the erection of the new steel floors at the top of the tower.

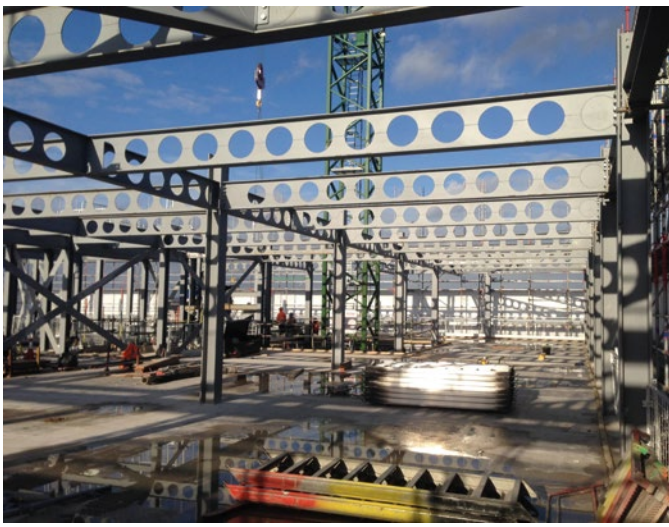
The new steelwork connects and is bolted to the existing concrete columns, while in the corners the frame connects to the new steel columns previously erected by Shipley.

Predominantly based around a 6.3m × 5.8m internal grid to match existing columns below, each new floor is formed with a series Westok cellular beams that accommodate services and support metal decking.

Summing up the judges say, this is a thorough and rigorous project which has been carried out with ingenuity and skill. With both painstaking analysis and inventive thought a substantial, but unloved, city-centre concrete building has been enlarged upwards and horizontally by the creative use of steelwork.

FACT FILE
Architect: dn-a
Structural engineer: Peter Brett Associates LLP
Steelwork contractor: Shipley Structures Ltd
Main contractor: Bowmer & Kirkland Ltd
Client: Landid Property Holdings Ltd





London Olympic Roof Conversion

The stadium built for the London 2012 Olympic & Paralympic Games has been transformed with the addition of the world's largest spanning tensile roof.

When West Ham United Football Club kicked off the current season at its new home in Stratford, it signalled the culmination of nearly three years of work to transform the former London 2012 Olympic Stadium.

Components have been added, replaced, reused, and enhanced, creating a world-class venue of permanence. The stadium now boasts a new cantilever roof which at 45,000m² and an 84m maximum span is nearly six times the weight of its predecessor, and is the largest spanning tensile roof in the world.

The roof was specifically designed to improve acoustics and heighten the spectator experience, focusing sound and projecting it towards the pitch, all while reducing noise for the surrounding residential areas.

"Due to the very long spans and weight restrictions, steel was the only viable construction solution," says BuroHappold Engineering Partner Matthew Birchall.

When Populous designed the London Olympic Stadium, they did so with an ethos of 'embracing the temporary' in the knowledge that, post-Games, the stadium's function would change and, as a result, the structure would need to change too.

One of the main stipulations for the future use of the stadium was that it would retain its running track. To prevent this from adversely affecting the atmosphere at football matches, an automated system of retractable seating was included in the new design, with all four sides of the lower bowl able to move over the running track when in football mode. To meet UEFA rules, the roof extends fully over the retractable seating.

In order to preserve some of the Olympic Stadium's identity, the iconic triangular lighting tower design that used to stand over the old roof has been inverted and they now appear to hang underneath the new larger roof.

The project to transform the venue began in late 2013. To facilitate the works, the existing structure had to be strengthened to accommodate far greater loads than originally designed for in the 2012 Olympic mode.

The new structure included 8km of steel cables weighing 930t, 112 steel rafters, 2,308 purlins, 422 struts, 9,900 roof panels and 14 light paddles each weighing 43t, with the whole structure weighing in at around 4,700t, nearly six times the weight of its predecessor

Early works involved the de-construction of the old roof and the strengthening of the existing structure, foundations, V-shaped main columns and the perimeter compression truss.

Strengthening of the existing structure was one of the major challenges for William Hare. Due to the additional weight of the new roof, it was necessary to replace and/or strengthen the existing V-columns and significant strengthening works were carried out to the existing compression truss.

A total of 14 new lighting paddles are positioned beneath the new roof. Each lighting paddle houses up to 41 lamps, many of which are the original lamps that shone over the stadium during the London 2012 games.

Four 600t-capacity cranes operated in tandem to lift the lighting paddles and the other roof members into position.

The tolerance in the fabrication and quality of finish was expected to be very high and the design was made with security in mind. Most of the geometry was complex and William Hare manufactured specialised jigs to fabricate some of the complex tubular nodes.

A total station was employed to set out all of the brackets for the lighting paddles, which all lean towards the pitch and are all slanted in three opposing planes. Not least, the oval shape of the stadium and the movement and tolerance requirements only gave the opportunity for single pieces to be replicated twice, this meant that half of the stadium structure was fabricated with unique members.

Following the V-column and compression truss strengthening work to maintain equilibrium until the oval was fully formed, the erectors worked in two teams at opposite ends of the stadium working in a clockwise rotation constructing the back roof first, then the front roof complete with the lighting paddles and walkways.

To ensure the correct distribution of forces through the cable support structure to the compression truss, the front and back roof are completely independent of each other.

However, for the installation of the lighting paddles, the front roof had to be temporarily tied to the back roof to ensure that the lighting paddles did not overturn until the full ring stiffness of a complete oval was achieved.

"The roof construction represented the biggest technical challenge both in terms of sophistication of design and programme," concludes Mr Birchall.

4D programming via BIM modelling was also key to delivering this successful project to a very high profile deadline, which was originally the 2015 Rugby World Cup, taking place in September last year. However this was brought forward to fit in the Sainsbury's Anniversary Games which took place in July 2015. This meant that all major construction was complete by May 2015.

The challenges have been met superbly and the project is a triumph for the team and for structural steelwork, say the judges.

FACT FILE
Architect: Populous
Structural engineer: BuroHappold Engineering
Steelwork contractor: William Hare
Main contractor: Balfour Beatty Major Projects
Client: London Legacy Development Corporation

South Stand Expansion Etihad Stadium

With the stadium operational during the works, the challenging expansion of Manchester City's Etihad Stadium South Stand has added 6,000 new seats.

An architecturally sympathetic extension of an existing catenary ringed structure, the project to extend Manchester City's Etihad Stadium South Stand increased the capacity of the stadium during the 2014/15 football season, adding 6,000 new seats in the stand through a third tier and a further 1,500 additional seats around the pitch.

Steelwork contractor Severfield supplied, fabricated, and installed 4,000t of structural steelwork for the job.

"We also dismantled the existing roof, carried out all temporary works and designed connections," explains Severfield Project Manager Paul Hulme.

"The project was delivered to an extremely tight programme and within a fixed price, agreed with the contractor at an early stage of the design process to de-risk the process for the client. Input from the contractor at inception was critical to determine how to make the best of the two short closed windows, when operations not possible to achieve in the football season could be completed."

The design was technically complex as the existing roof involved a cable net structure with a tension ring, from which steel roof rafters hung. The structural integrity of the existing tension ring relies on it running around the whole circumference of the roof; therefore any modification to the roof could not affect this, even in areas where roof rafters were removed.

Protection of the existing cable was vital as there was no repair procedure in place and damage would have resulted in the need for a replacement and a potential two-year closure of the stadium.

Extensive design optimisation exercises were undertaken, particularly for the steel roof and the stability cores. A whole series of geometric studies evaluated the effects of different stay and mast angles, concluding on a final solution to satisfy both minimum material requirements and cost.

The stability cores were formed of steel vertical brace planes with the inclusion of outrigger bracing to add efficiency. A detailed schedule of steelwork was established for all elements, tabulating section type, weight, and tonnage and fabrication effects.

The project contains a number of highly bespoke details tuned to the complex geometries and design challenges. These include the multi-stay connection at the top of the masts and column bases formed of spherically machined plates and rotational bearings; to allow the new design to accommodate differential movements between the new and existing structures.

"Steel was the natural choice for the roof given its high strength-to-weight ratio. Steel enables large long span structures to be formed with no internal columns thus providing unobstructed sightlines for viewers," says BuroHappold Engineering Project Director Fergus McCormick.

Consequently the inherent beneficial strength-to-weight ratio made it the only

FACT FILE
Architect: Populous
Structural engineer: BuroHappold Engineering
Steelwork contractor: Severfield
Main contractor: Laing O'Rourke
Client: Manchester City Football Club

choice for the long span roof formed of steel box section girders 45m long.

Steel also provided an advantage over concrete for the bowl frame because it could be constructed rapidly. The entire project needed to be constructed in and around the operational stadium and this required installation of preformed accurately made components.

"For the frame and bowl, the benefits of steel were its natural high accuracy of construction, and speed of erection," explains Mr McCormick.

An area of complexity centred on the temporary modes of the stadium. For typical stadium conversions an additional tier can be built behind the existing building and a new roof constructed over the existing roof, with little interaction between old works and new.

This was not the case at the Etihad as the roof profile and supports at the end stands extended further back behind the seating, and the new upper tier would therefore project through the existing roof profile.

"We were tasked with developing a design that enabled new construction to proceed to a demanding programme, while retaining cover for spectators," says Mr Hulme.

The 'Interim Roof' solution involved cutting and removing the existing back of the roof and acknowledging that this meant cutting into roof rafters which had significant locked-in forces from the dead loading of the roof. The existing roof was formed into paired bays either with or without in-plane bracing and underpinning.

Controlling geometry and movements through the construction sequence to ensure structural adequacy of the existing roof and cladding was essential. To address this, columns were jacked in pairs to offer sympathetic control.

The existing roof was removed to reveal the new terrace behind and 7.5 weeks of works were undertaken in less than 4 weeks. The new design respects the geometry of the existing building and, while the inserted end stand is significantly larger than the previous stand, it blends in as part of the original design.

For modification works, access was required to the underside of the existing roof above the current terracing. A unique solution invented for this was a movable platform that supported the weight and dynamic effects of the MEWP operating on it.

The extension, completed within 16 months, was opened on the 16 August 2015 in front of a record crowd of 54,331 people. Transforming football stands is about capacity and ticket sales and the new stand sets the parameters for further expansion through its masterplan.

Summing up the judges say, the work tested all facets of steelwork construction to their limits, including design, fabrication and construction. A stunning testimony to all concerned and to the capabilities of steelwork, which merges seamlessly into the existing structure.

Harlech Castle Footbridge

Designed as an S-shaped Vierendeel truss, a new footbridge links Harlech Castle with a new visitor centre and dramatically improves visitor access.

Harlech Castle is said to be one of the finest surviving 13th Century castles in the UK and consequently it is a Grade I Listed Building, a Scheduled Ancient Monument and also part of a World Heritage Site.

The many visitors who arrive at the site every year would testify that in the past access to the castle was strenuous as it was via a series of timber steps with no provision for the disabled.

A new footbridge has changed all of that, by dramatically improving access and linking a new visitor centre to the castle.

Project client, Cadw always had a clear vision for the footbridge and due to the sensitive nature of the historic site the aesthetics were an important consideration.

Client consultants Mott MacDonald explored various concepts to satisfy the constraints of functionality, alignment, heritage and visual impacts before finally opting for the S-shaped low profile Vierendeel truss design.

Both horizontal and vertical alignments were constrained by the need to connect straight through the castle's gatehouse while maintaining a suitable gradient acceptable to those with impaired mobility.

To minimise the impact of the views of the distant mountains of Snowdonia, tapering the bottom chords of the trusses and eliminating any diagonal bracing avoided a cluttered appearance and reduced the profile of the bridge.

"Steel as a construction material offered a variety of structural solutions that satisfied the constraints of alignment, functionality, heritage and visual impact," says Mott MacDonald Senior Engineer – Bridges & Civil Structures Katalin Andrasi.

The visual lightness of the bridge is also significantly improved by the selection of a stainless steel mesh infill to the parapets. The deck is 2m wide in general, however it widens up to 3m above the middle support to provide an area where people can enjoy the views.

To ensure that the bridge was future-proofed provision was made for services to be run in a duct under the bridge deck helping to supply power to a new venue within the castle where events and performances can be hosted.

FACT FILE
Concept designer: Mott MacDonald
Structural engineer: David Dexter Associates
Steelwork contractor: S H Structures Ltd
Main contractor: RL Davies & Son Ltd
Client: Cadw

Photo © Cadw 2016

The first key area for development was the truss and deck configuration. The original proposal had fin plates welded to the back of the CHS (circular hollow sections) Vierendeel truss bracing elements, which then became the tee web in the handrail upright.

This arrangement posed some fabrication challenges and raised the possibility of weld distortion in the fin plate attached to the CHS.

An alternative was therefore adopted where SHS (square hollow sections) bracing was used and the handrail fabricated tee upright orientation was reversed. The face of the SHS vierendeel bracing then aligned with the flange of the tee to the balustrade and this was tapered to give an elegant transition to the handrail.

To maximise headroom clearances under the bridge, and to give a more efficient structural solution at the supporting columns, the depth of the truss profile was modified and the bottom chord form was achieved from a combination of curved and straight sections of tube.

The bridge's dynamic performance required very careful consideration in the design. The columns needed to be very stiff in the transverse direction so an elliptical section was used which, when partly filled with concrete, achieved the required result.

This choice also had the added architectural benefit of the elliptical column being less obtrusive on elevation, whilst approximately matching the profile of the truss chord.

Before work started on site the existing façade was digitally scanned and the 3D survey was incorporated into the design model to ensure the critical dimensional interface between the castle entrance and the bridge was achieved.

Bridge sections were set up in bespoke jigs to control weld distortion and maintain their geometry during welding.

The bridge is lit with a bespoke integrated LED lighting system that delivers bright white task lighting to the walkway, but has the added benefit of having a number of colour-changing effects that can be accessed for special events.

Controlled by a central PC, the lighting can also be operated via a smartphone or iPad, offering simple and intuitive day-to-day management.

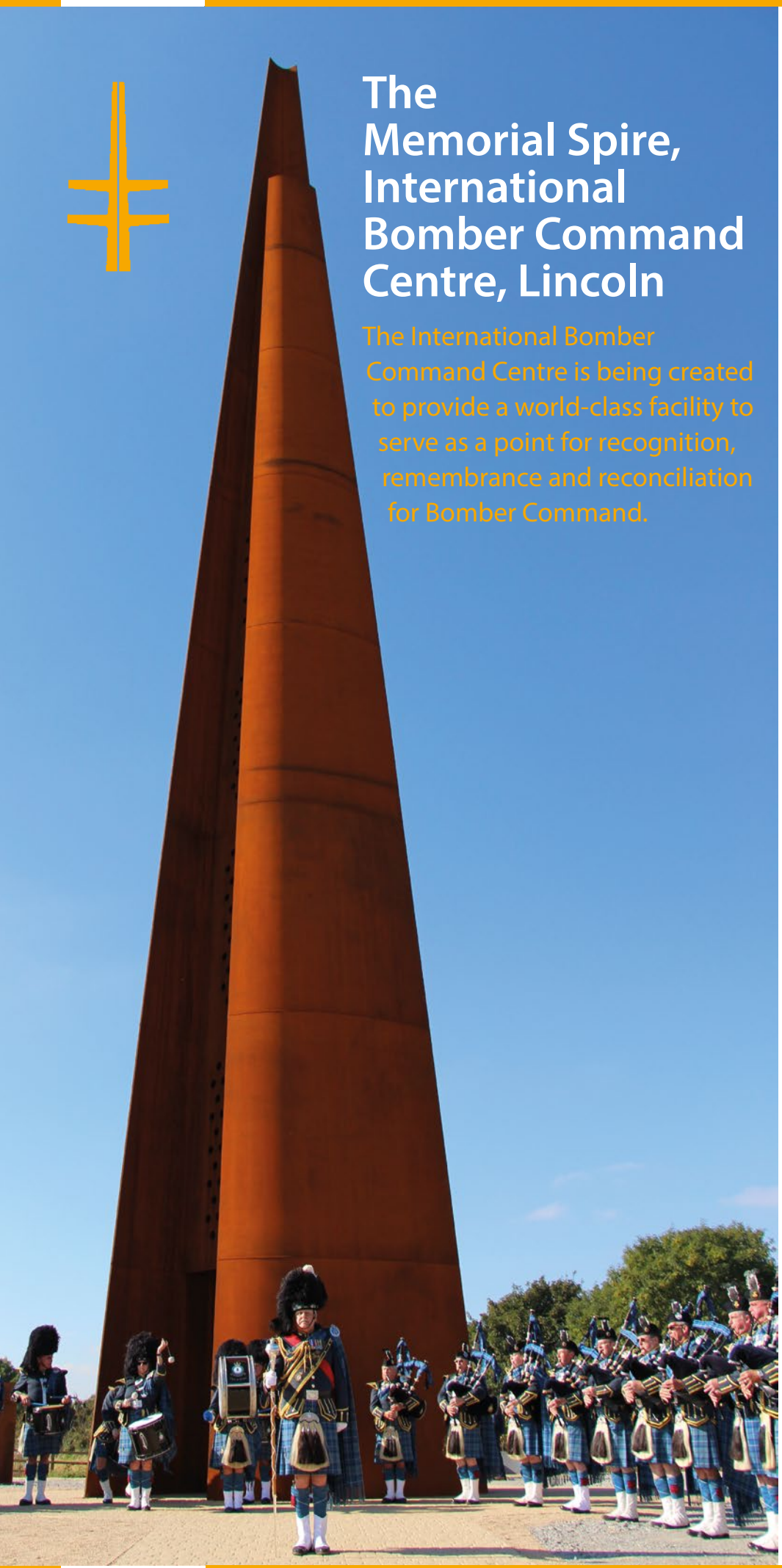
According to S H Structures Sales and Marketing Manager Tim Burton, perhaps the biggest challenge was the limited footprint of the site and the restricted access through Harlech. These challenges were overcome with the careful selection of the multi-wheel steer mobile crane and rear wheel steer transport trailers.

Steel erection required meticulous planning and attention to detail to ensure a smooth and safe installation process. However, the unique historic nature of the site put even more responsibility onto the erection team.

Following offsite matching of the deck units the assembly on site was perfect and the three main spans were installed without any significant problems. With the bridge sections in place the careful coordination of the fitting of the timber deck, parapets, lighting and services allowed the bridge to be completed in good time.

Opened in the summer of 2015, the new footbridge has been very well received and welcomed as an attractive addition to the historic site while enhancing the visitors' experience.

In a very sensitive setting this elegant bridge provides level access to the historic castle, whilst minimising its visual impact. The detailing and fabrication of the curved deck are exemplary, sum up the judges.



The Memorial Spire, International Bomber Command Centre, Lincoln

The International Bomber Command Centre is being created to provide a world-class facility to serve as a point for recognition, remembrance and reconciliation for Bomber Command.

The construction of the International Bomber Command Centre (IBCC) is an ongoing project being driven by The Lincolnshire Bomber Command Memorial Trust, in partnership with the University of Lincoln.

The City of Lincoln has been chosen as the site for the IBCC as the county earned the title of Bomber County because it was the home of 27 operational bases during the Second World War.

At the heart of the IBBC is the Memorial Spire. Sitting majestically above the City of Lincoln, the weathering steel structure will act as a beacon marking the courage and bravery of those who served.

Designed by Place Architecture the architectural references are taken from the airframe and wings of an Avro Lancaster Bomber.

The structure represents two wing fragments tapering towards the sky separated by perforated plates similar to those used in the aircraft's frame construction.

Further references can be found in the Spires dimensions; standing 31.9m high this represents the same span of a Lancaster's wing and at 5m wide at its base is the same width of the aircraft's wing.

"By using weathering steel we fulfilled the brief, but we also created a multi-layered sculpture that references flight, aircraft manufacture and is also a nod to nearby Lincoln Cathedral," says Place Architecture Project Architect Stephen Palmer.

"Weathering steel also allowed us to design a sculpture with an organic feel and one that has a changing hue, which is ideal for its countryside setting."

The Spire's orientation was carefully considered and it is placed so that visitors who walk through it will be rewarded with a framed view of Lincoln Cathedral. The Cathedral Spire was very familiar to the aircrew as it was a welcoming familiar landmark to those who returned from their many sorties during the war.

S355J2W normalised rolled weathering steel plate fulfilled all the structural and aesthetic requirements of the project.

The first part of the manufacturing and fabrication process, performed by S H Structures, was to cut the individual plates from the stock material. Using the information generated by the computer model the plates were carefully nested to minimise the overall waste of material.

The external profiled plates had to be curved to form the wing-like form. Press-breaking the individual plates to the desired shape using files extracted from the 3D model achieved this.

The formed plates were built up in purpose-made jigs prior to being welded together to form the complete spire sections

that would go to site as two loads.

"Due to the significant amount of welding, a great deal of care had to be put into the development of the weld procedure to ensure there was no distortion in the plates, particularly along their leading edges where any defects would be most noticeable on the finished spire," says S H Structures Sales and Marketing Manager Tim Burton.

Before being delivered to site the steel sections were shot blasted, a process that ensured any fabrication marks were removed. This also allowed the structure to develop an even patina as the weathering steel gradually turned its familiar rusty colour.

Once on site, the spire sections, with a total weight of 55t were safely installed onto their holding down bolts, which were part of the foundations installed by local contractor Lindum Group.

"All of the joints are expressed welded joints and by leaving them visible they add to the contemporary design of the Spire," says Mr Palmer.

The spire is surrounded by memorial walls that record the names of the 25,296 aircrew that lost their lives flying with Bomber Command, while serving in 1 and 5 Groups that were headquartered in Lincolnshire.

The walls, arranged around the Spire in concentric circles, are made from curved 20mm thick weathering steel plate. Welded onto these plates are 4mm thick steel panels with the airmen's names laser cut into them.

In a second phase of work further panels are to be added around the spire commemorating the airmen that flew from other UK Bomber Command bases. These additional panels will bring the total of named individuals to more than 55,500.

"It is a great privilege to work on projects like this and contribute to what will undoubtedly become a lasting legacy to the memory of those who gave their lives serving in Bomber Command," says Mr Burton.

"We were fortunate enough to be visited by one of the surviving veterans during our involvement in the scheme. Ex-Flight Lieutenant RAFVR Roy Hill arrived with his wife and daughter on the morning we were loading out the completed sections of the spire. Roy was kind enough to relate some of his experiences during his visit and it really brought home the significance of the project."

International Bomber Command Centre Project Director Nicky Barr comments: "The Memorial Spire dominates the skyline as a fitting tribute to the efforts of all in Bomber Command, both those who lost their lives and those who survived."

"The project is already making a huge impact within Lincolnshire and with the planned interpretation building, the Chadwick Centre, will provide an educational facility and tourism centre attracting international audiences."

The judges say, this excellent project is a fitting testament to the memory of the World War II bomber crews that flew from Lincolnshire and other parts of the UK. The architectural arrangement of the various elements has been carefully considered, taking cues from the local context. The choice of weathering steel is most successful.

FACT FILE
Architect: Place Architecture
Structural engineer: s h e d
Steelwork Contractor: S H Structures Ltd
Main Contractor: Lindum Group Ltd
Client: The Lincolnshire Bomber Command Memorial Trust

Land Rover BAR America's Cup HQ Building, Portsmouth

The headquarters building for Sir Ben Ainslie's challenge to host the America's Cup in 2021 is a steel-framed structure combining a manufacturing area with all the other facilities necessary to support the bid.

FACT FILE
Architect:
HGP Architects Ltd
Structural engineer:
Reuby & Stagg Ltd
Steelwork contractor:
T A Colbourne Ltd
Main contractor:
Allied Developments Ltd
Client:
Land Rover BAR

By using structural steelwork the project team for the Land Rover Bar America's Cup Headquarters Building in Portsmouth was able to complete the job within a very tight and challenging construction programme.

The designers and contractors were required to work from a standing start in February 2014 and have the America's Cup boats' manufacturing facility ready for occupation in March 2015 with complete handover to the client the following June.

Steel was the only possible solution for this project due to the very short lead-in and tight programme.

Delivery was key to the success of this project and the flexibility of steel meant that a huge number of changes to the frame design could be accommodated during the construction phase to ensure that the internal workings of the building could meet the client's needs.

It was essential that as much of the building structure as possible should be manufactured offsite. Due to the evolving nature of the design it was also essential that an adaptable form of structure was chosen, one which would allow layout and space requirements to be accommodated as late into the programme as possible.

The required large clear span areas, some of which act as transfer structures and the requirement to provide up to four overhead electric cranes within the ground floor area, meant that steelwork was the best framing option for the project.

The choice of a steel frame also had the advantage of minimising foundation loads, as pile diameters and locations were restricted.

When the steelwork layouts and details were issued to the steelwork contractor for construction there were several areas still under development and changes occurred, and additional mezzanine areas added, all happening up to the point of fabrication.

"These were all absorbed and incorporated without disruption to the initial hand-over or completion. This would not have been possible with anything other than a steel frame," says Reuby & Stagg Partner Malcolm Reuby.

HGP Architects avoided producing a slab sided box by adopting a plan shape with the north and south elevations tapering to the curved eastern elevation, while the western end provides the access to three manufacturing bays.

In order to reduce the mass of the building each of the upper floorplates at first, second and third is of a different size and shape to the one below providing large external terraces at each level.

The client's brief not only required a state-of-the-art facility, but it also aspired to a zero carbon status and a BREEAM 'Excellent' rating.

Summing up the judges say, encompassing industrial, commercial and public spaces has required varied forms of steelwork, from long-span lattice girders to well-detailed exposed structure in open areas. The team worked closely and effectively to produce a striking building and satisfy the client and public.

6 Bevis Marks Roof Garden, London

Photo © Robert Leslie & Fletcher Priest Architects

Tubular steelwork supporting an ETFE canopy has created a striking covered roof garden atop a prestigious City of London commercial office block.

FACT FILE
Architect: Fletcher Priest Architects
Structural engineer: David Dexter Associates
Steelwork contractor: Tubecon
Main contractor: Skanska Construction UK Ltd
Client: Bevis Marks Developments Ltd

Photo © Nicholas Worley

The roof canopy is said to be the most striking feature of the 6 Bevis Marks building, providing all-weather protection for the 204m² sky court – the largest of three roof gardens in the development.

"The roof is a very special top to the building, picking up on the same criss-cross diamond grid as that of the nearby Gherkin," says Fletcher Priest Architects Partner Ed Williams.

The roof is a light steel structure supported on a series of branch columns and clad with a canopy of ETFE cushions to give rain protection. It has open ends and is conceived as a covered external garden relating to the open terrace garden of the levels below. It wraps over the south façade to clearly define the upper element of the building and to support the solar shading to this southwest facing elevation.

The desired scale, lightness and transparency for this canopy structure could only have been achieved through the use of steel framing.

The structure consists of a continuous CHS (circular hollow section) diagrid frame that spans over the rooftop garden and sails down the façade. The diagrid structure is supported on eight tree columns that cantilever up from the main building's 16th floor steelwork.

Additional struts extend from the ends of the cantilevered main building steelwork to restrain the clad sidewalls. Further supports are provided off the façade for the open mesh apron, while a bearing detail ensures that these only restrain the steel frame in the direction perpendicular to the façade.

The geometry of the structure is complex – the asymmetry of the support positions that are set out based on the main building grid below results in eight different tree columns, while the roof diagrid is subtly pitched in four directions to generate falls.

The canopy structure was fabricated and installed by Tubecon (the exposed steelwork division of Billington Structures). Tubecon was appointed early in the design development of the structure to ensure the buildability of the final frame.

Due to the number of site and structural constraints, the only feasible option was to fabricate and deliver the structure in individual pieces, which were assembled and bolted together on site.

However, in order to achieve Fletcher Priest's intent to give a seamless appearance to the structure, it was key that none of the bolted splice connections were visible. The structure also needed to interface with main building steelwork with all the associated tolerance considerations.

The roof grid joints are fully welded connections formed with the help of complex CNC laser-cuts, a highly accurate and automated process, to the ends of each CHS branch stub member. Joints in the steel diagrid were achieved using hidden splices, where bolted connections are formed within the tubes themselves.

The canopy was fixed to the façade of the primary structure using architectural stainless steel pin connections and brackets. The tolerance levels were such that Tubecon's team of site engineers had to carry out detailed and accurate three-dimensional locational surveys of the primary structure, before feeding the relevant coordinates back to the Tubecon technical team.

The diagonal-framed steelwork and ETFE canopy is a most effective feature distinguishing this office building in a densely packed city. Challenging technical constraints were effectively resolved to provide a most desirable and popular roof garden, say the judges.

The Diamond Engineering Building, The University of Sheffield

Representing The University of Sheffield's largest ever investment in teaching and learning, The Diamond Engineering Building is a new undergraduate facility.

Sheffield University's 19,500m² Diamond Engineering Building will provide specialist engineering laboratories, lecture theatres, flexible seminar rooms, open-plan learning and social spaces, integrated formal and informal learning environments, a library and a café.

The intention is that the six-storey building will promote collaborative working and multi-disciplinary learning for the 5,000 student study spaces available.

The Diamond's design is said to be both conceptual and practical, as well as being sympathetic to the existing architecture of the area - in particular the stone tracery of St George's Church windows from which the exterior panelling was inspired.

Designed by London-based Twelve Architects, the building's name derives from its unique exterior façade of interconnected diamonds in anodised aluminium that are fitted to the exterior glass cladding.

"Using steelwork within this hybrid designed building helped us create the central atrium with lightweight and slender columns," says Twelve Architects Director Matt Cartwright. "While the feature cladding system is also hung from a roof level steel truss."

With a BREEAM 'Excellent' rating, the structure is also environmentally efficient. The explicit positioning of windows maximises the inflow of natural light into the laboratories, and aids ventilation without the sole reliance on air conditioning.

The ground floor has three access points to the central atrium with full-height glazing on the north and south edges giving internal views into the specialist engineering laboratories. This showcases the diversity of research and learning, as well as the University's philosophy on cross-disciplinary study.

The glazed apertures between the higher levels allow both the roof lights and daylight to flood into the open-plan study spaces below, while also creating acoustic separation.

A large proportion of the structure below roof level was neither on grid, nor orthogonal in set-out but the adaptable and slender nature of steel construction lent itself to the unusual design. All steelwork below roof level was bevelled including the curved window frames.

The initially specified instruction for connections to the façade panels was a drilled and tapped detail, however this was not practical due to the building tolerances involved. Instead, the connections were formed using offsite shop-welded propriety studs which reduced costs significantly and saved weeks of additional construction time.

The steel was brought to site in approximately five to 10 tonne lots, to arrive and be erected in numbered sequence for safety, practicality due to limited on-site storage and stability during construction. The programme also had to consider minimising the disruption to the students; something the entire site team remained mindful of throughout the construction.

In the brief the University requested a building that would be a significant move toward their long-term goals of substantially increasing the Engineering Department, and becoming the UK's leading Engineering University.

"The Diamond has excelled expectations and we are proud to have been chosen as steelwork contractors by a local University, and especially to have been involved in the development of our future engineers," says Billington Structures Contracts Director Brian Turton.

Summing up the judges say, a testament to the success of this imaginatively designed university building is how well it is used by the students. Exposed steelwork elements, including an immaculate spiral staircase, contribute to the architectural language of the interior. This well-crafted building with its excellent internal environment is bound to inspire all who use it.

FACT FILE
Architect: Twelve Architects
Structural engineer: Arup
Steelwork contractor: Billington Structures Ltd
Main contractor: Balfour Beatty
Client: The University of Sheffield

Photo © Billington Structures Ltd

Lagan Weir Pedestrian and Cycle Bridge, Belfast

Around 16,000 people every week now use Belfast's new footbridge that connects Donegall Quay with Queens Quay.

Early site investigations, both physical and through various old drawings, led to the overwhelming decision that a primarily steel-framed footbridge would be most suitable structure for this scheme.

"We needed a structure that was lightweight, durable, robust, slender and curved in both elevation and plan. Steel was the obvious choice," explains AECOM Senior Structural Engineer James McCann.

One of the main construction challenges on this project was the erection process and the need for a crane, which was suitable to lift 25t sections of the bridge deck at a reach of around 70m. As a result a 1000t-capacity crane had to be used for the main bridge deck lifts.

The overall length of the footbridge is 120m and it is 8m wide at the widest point. The total tonnage of structural steel for the project was 270t.

The bridge is connected to the existing 'Pier Houses' via four steel truss-type frames or 'trees', each of which is unique as a result of the bridge bring curved in two directions. The 'trees' were all made from CHS sections, which were laser cut using files produced from the Tekla 3D model.

Each of the 'trees' has four feet, two at the front and two at the rear. The 'trees' are anchored at the rear into the inside of the existing reinforced concrete 'Pier House' using two M76 tension rods, which were adjustable to aid levelling and alignment of the bridge deck after erection.

The four 'trees' were the first parts to be erected, two set in from each side of the river.

According to steelwork contractor M Hasson & Sons, the next process was the erection of the bridge deck sections. There are a total of nine deck sections, which are all unique, with the largest being approximately 17m long.

The main framing of the deck sections were made from a combination of 610mm × 229mm × 101mm UBs for the internal beams and 500mm × 300mm × 16mm RHS (rectangular hollow sections) for the perimeter beams.

Individual bespoke 10mm thick large fin plates were welded to the RHS perimeter member to form the curved profile on plan.

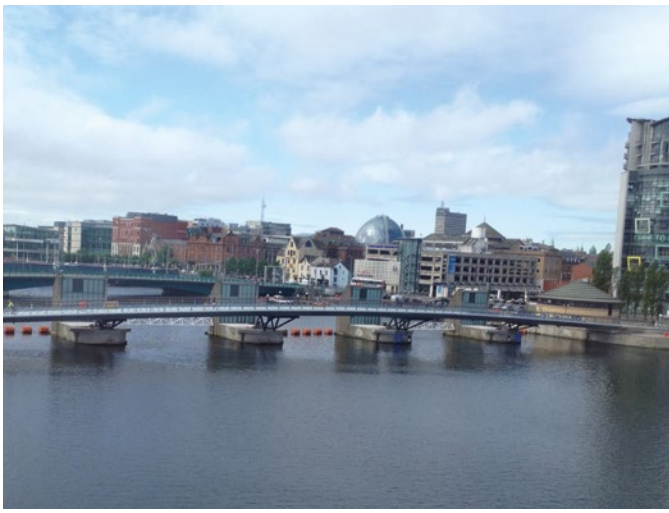
These are at approximately 1m centres to correspond with the handrail posts. The deck plates are all 15mm thick and fully welded to the framing beams and act as part of the main structure. Due to the size of the large crane it was necessary to erect all of the bridge sections as far as the halfway point from one side of the water before moving to the other side and repeating the process.

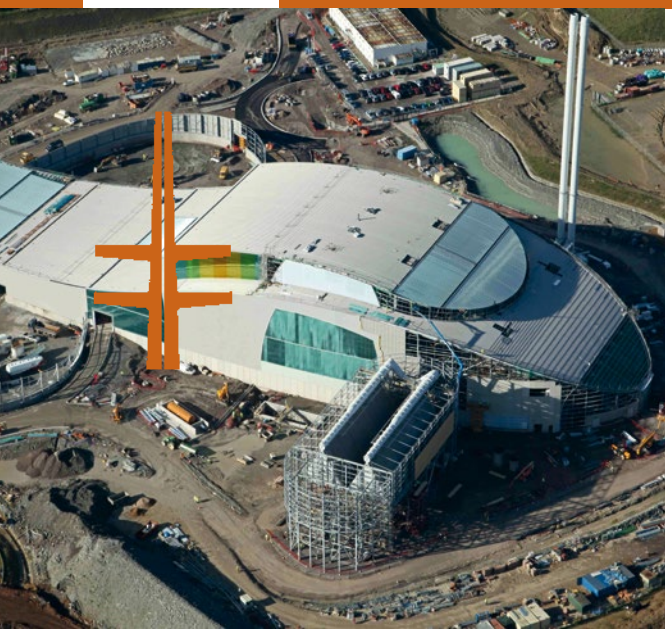
The deck sections over the 'trees' were set in first to create the main supports and then the infill sections erected into the gaps.

"The most crucial infill section was the final one in the middle of the bridge, which joined the two halves together and fitted easily. To facilitate access to the bolted splice locations the deck plates were site-measured and then welded in situ," adds Mr McCann.

Challenging survey, design and co-ordination were required in order for the bridge to be supported from the existing 'Pier Houses' that were part of Lagan Weir. The complex fabrication and erection of the support 'trees' and bridge deck were superbly executed by the steelwork contractor, say the judges.

FACT FILE
Architect: AECOM
Structural engineer: AECOM
Steelwork contractor: M Hasson & Sons Ltd
Main contractor: Graham Construction
Client: Belfast City Council





Energy from Waste Facility, Ardley

The Ardley Energy from Waste Facility near Bicester has been designed to sit low on the landscape and is built from materials reflecting the plant's modern technology.

The Ardley facility has been constructed to treat 300,000t of non-recyclable waste each year. It will divert at least 95% of Oxfordshire's residual municipal waste away from landfill and generate enough electricity to power around 38,000 homes.

The completed building is up to 229m-long, varying from 38m to 70m wide and between 15m and 35m high. Steel was the natural choice for the main frame due to the curved shape of the building, together with the clear height and internal space requirements.

Although the structure appears to look like one building, internally and under the cladding it is split into several zones which allowed different designs to be incorporated, resulting in over 2,000t of structural steelwork being used.

Some areas were constructed from ground level and had clear spans across the structure, while other areas were built from concrete supporting structures. With the internal processing plant taking up most of the internal areas, the use of computer modelling was crucial to make sure there were no clashes between key plant, equipment and their secondary supports and the main frame.

Within the facility's waste bunker, the crane beams and all connected steel members had to be designed and fabricated in accordance with Execution Class 3 requirements due to the high fatigue requirements caused by crane movements.

The waste bunker steelwork is located on top of an 18m- high concrete structure, which meant access for connections was very limited. So connections could be accessed, a removable MEWP platform was designed and constructed to fit on the top of the concrete structure.

As the internal process plant and associated secondary steelwork for access and support were constructed in advance of the main frame enclosure, the use of modular roof assemblies, some weighing 40t, had to be used. They allowed the 35m-high roof to be infilled with steelwork, which in turn supported the cladding systems.

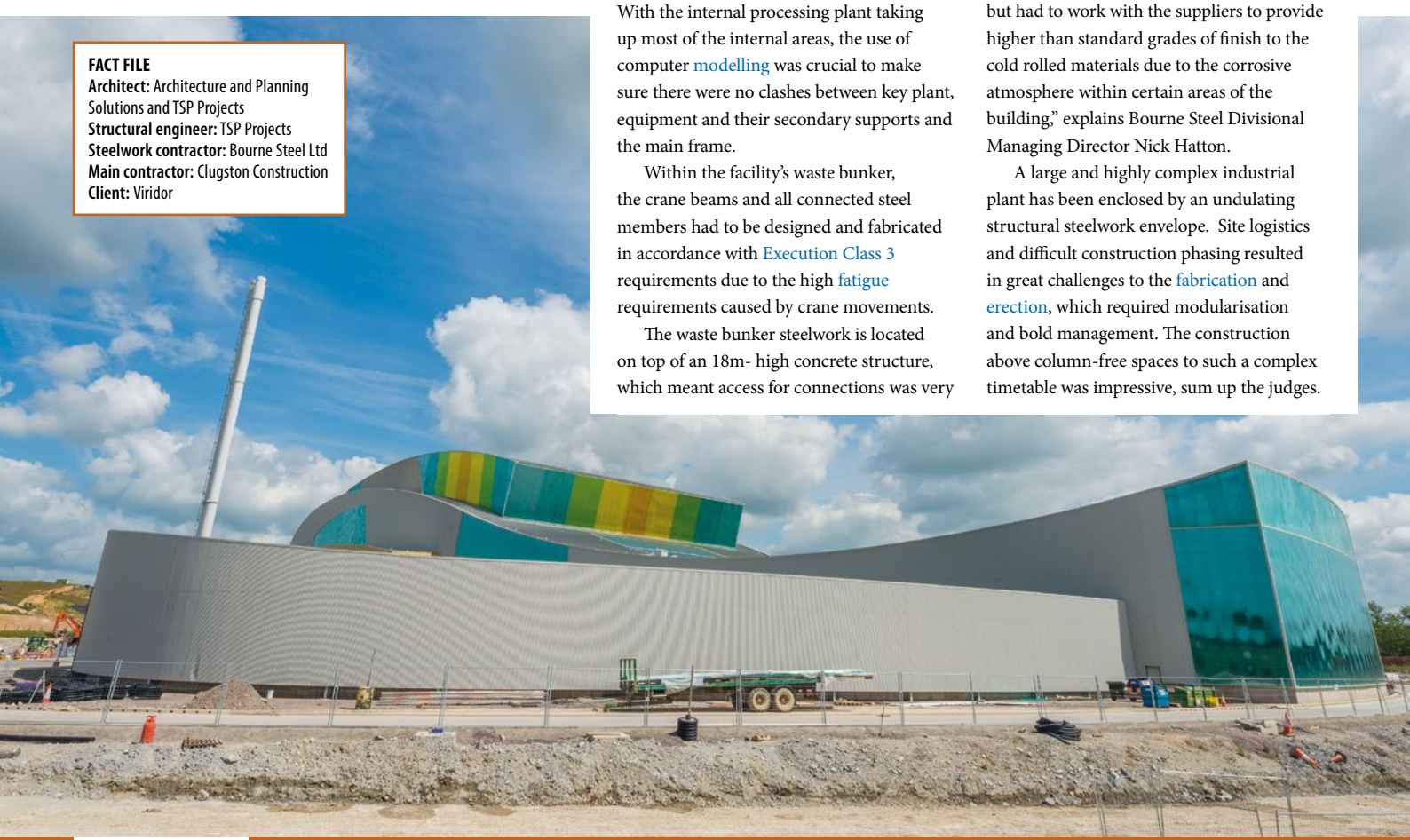
The majority of the project's steelwork was hot-dip galvanized to provide the necessary corrosion resistance, as well as providing a finish that had low maintenance requirements due to the difficulties in accessing the members after construction.

Other areas, mainly accommodation areas or rooms with daily occupancy, were painted with intumescent coatings to achieve the specific fire resistance requirements.

"For the cladding supports we supplied and installed the cladding purlins and rails, but had to work with the suppliers to provide higher than standard grades of finish to the cold rolled materials due to the corrosive atmosphere within certain areas of the building," explains Bourne Steel Divisional Managing Director Nick Hatton.

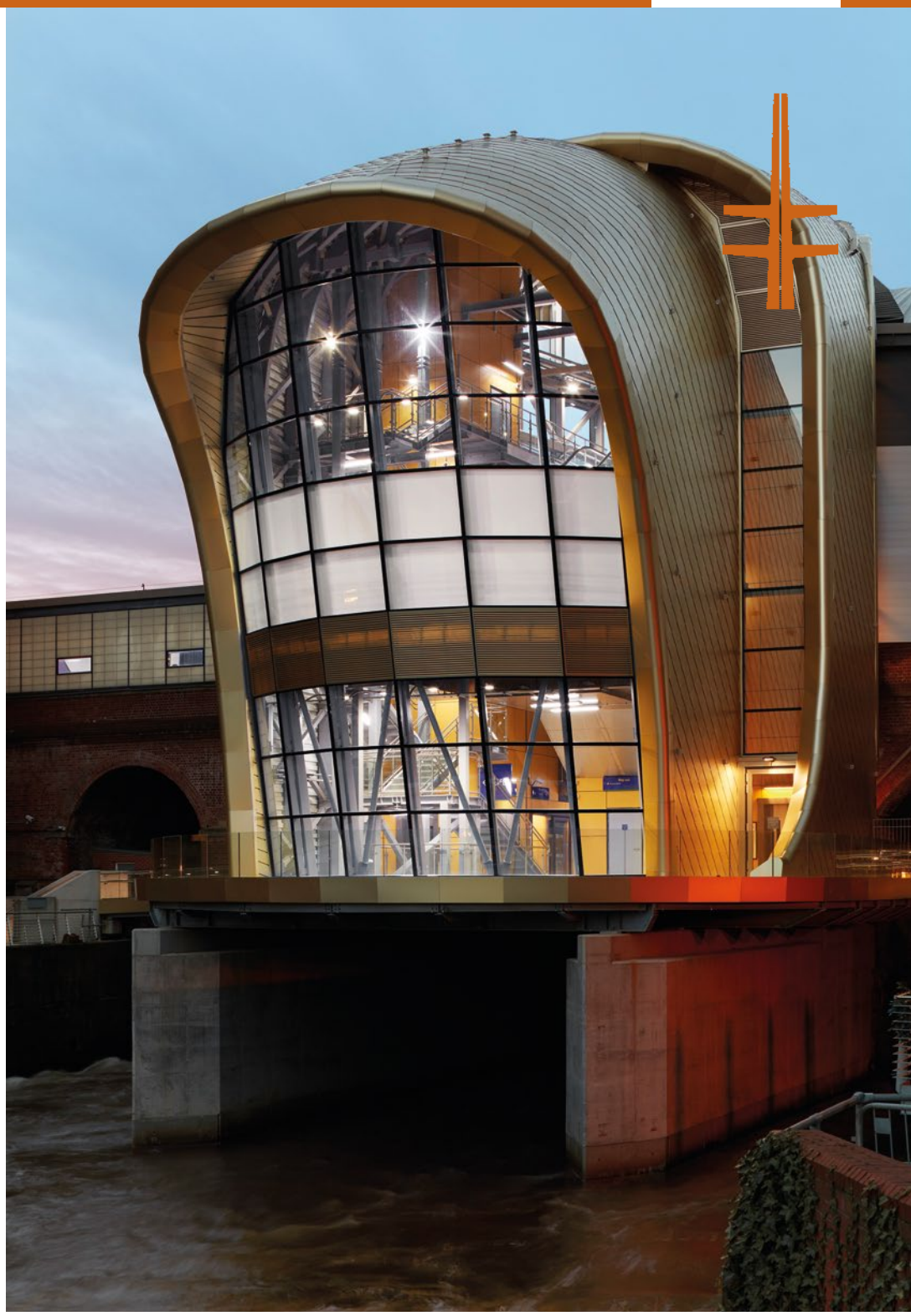
A large and highly complex industrial plant has been enclosed by an undulating structural steelwork envelope. Site logistics and difficult construction phasing resulted in great challenges to the fabrication and erection, which required modularisation and bold management. The construction above column-free spaces to such a complex timetable was impressive, sum up the judges.

FACT FILE
Architect: Architecture and Planning Solutions and TSP Projects
Structural engineer: TSP Projects
Steelwork contractor: Bourne Steel Ltd
Main contractor: Clugston Construction
Client: Viridor



Leeds Station Southern Entrance

The Leeds Station Southern Entrance has relieved congestion, future-proofed ticket line gate capacity and will encourage growth in the south of the city.



Available space for a new entrance to the south of Leeds Station was extremely limited, and as the design had to incorporate access to the existing high-level concourse, a location that straddles the River Aire was consequently the only option.

"We built it over water and so we had river safety issues, while apartment blocks on two sides meant the site was very constrained and required a large 63m-high tower crane," explains Network Rail Project Manager Luan Anderson.

"We were also working next to and at times over live rail lines so some of our work could only be done during night-time possessions."

Prior to the erection of the steel-framed entrance superstructure, main contractor Carillion Rail had to first install piled foundations and two concrete piers in the middle of the river.

The piers, supporting a transfer deck, were positioned and aligned with the existing rail viaduct arches so as not to impede the flow of the river during heavy rain.

The steel was installed via the on-site tower crane lifting the members off barges and positioning them directly between the new piers.

The transfer deck comprises a series of galvanized beams positioned at 1.8m centres. The beams span 10.2m between the new concrete piers and cantilever a further 3.5m beyond the centre line of each pier providing support to the columns above, as well as support to an access and maintenance deck around the perimeter of the building base.

The beams bear directly onto each pier via a simple baseplate connection. A series of beams cantilevers 2.3m beyond the southernmost primary beam to complete the curved plan profile of the deck.

"The main reasons why a steel deck was specified were the benefits brought by offsite fabrication and speed of erection that reduced the construction time above the river, which was considered to be a positive health and safety decision," says Mott MacDonald Project Manager Jon Svikis.

Sitting atop the transfer deck the entrance superstructure comprises a series of portalised arches at 1.8m centres.

The hoops are a maximum of 20m tall, with a horizontal span of approximately 12.5m. Each frame comprises two vertical legs and a curved arch section of varying radii of between 2.8m and 12.3m.

Generally the frames were erected in four pieces. The frames are braced out of plane via a series of SHS members, forming an inherently stable 'diagrid type' structure.

There are 11 frames at river deck level; with a further nine frames extending above three existing railway lines to form the connection with the high-level concourse.

This involved construction of a new Ticket Barrier level above platforms 15,16 and 17, crossing three electrified railway lines.

The new ticket barrier level concourse is hung from two primary trusses that span across the lines and were installed during weekend rail possessions. The eastern truss spans 17.7m and is 1.9m deep, while the western truss spans 19.5m and is 2.3m deep.

The judges were impressed by the team's planning and execution of the erection above the river and within a live station environment.

FACT FILE
Architect: AHR Architects
Structural engineer: Mott MacDonald
Steelwork contractor: William Hare
Main contractor: Carillion Rail Ltd
Client: Network Rail Infrastructure Ltd and West Yorkshire Combined Authority

Strabane Pedestrian and Cycle Bridge, County Tyrone

FACT FILE
Architect: WYG/Doran Consulting
Structural engineer: AECOM
Steelwork contractor: S H Structures Ltd
Main contractor: Fox Contracts
Client: Derry City and Strabane District Council

The Strabane Footbridge was conceived as a landmark pedestrian and cyclist bridge, crossing the River Mourne in the centre of Strabane, County Tyrone, Northern Ireland.

It provides a crucial missing link between the residential areas and schools south of the river and Strabane centre to the north.

It is a cable-stayed bridge with an inclined and curved main pylon, the upper reaches of which are stiffened by a wishbone-shaped pair of Vierendeel trusses.

Steel was the best choice of material for this structure, considering the aspiration for a lightweight structure with the minimum code-compliant section sizes.

"Steel allowed us to pre-fabricate all of the main elements offsite," says AECOM Project Engineer Danny Boothman.

"While the complex shape of the wishbone trusses would have been very challenging to form in another material."

Offsite fabrication also minimised site activities and associated disruption to the environment and the local transport network.

The cable-stayed solution was considered sufficiently visually exciting to become a landmark structure. Its efficient form also ensured a light structure, which would compliment its surroundings, rather than overshadowing them.


Photo © Peter French

Information Age Gallery, Science Museum, London

The Science Museum's newest gallery, 'Information Age: Six Networks That Changed Our World', explores the remarkable impact of communication technologies, revealing the personal stories behind over 200 years of inventions throughout 2,500m² of new exhibition space

The defining element of the project is known as the Whispering Gallery, a raised platform that runs throughout the gallery creating alternative physical and visual connections between the objects, and bridges the spaces in between six interactive 'story boxed' zones.

The fabrication of numerous steel components within the initial trussed frame proposal came in over budget and it was necessary to rethink the structural design approach.

Splices to the spine beam were introduced to limit the length and weight of the steel. A maximum 6.2m length could be transported and lifted into the gallery.

"The use of steel meant that the majority of the structure was manufactured offsite in lightweight cassette forms, which could easily be transported, lifted, and welded or bolted together on site," says Heyne Tillett Steel Associate Kelly Harrison.

"This was key to the construction programme as a whole, and particularly in limiting the impact on the listed fabric of the building and the bearing on operations within the remainder of the museum."

FACT FILE
Architect: Universal Design Studio
Structural engineer: Heyne Tillett Steel
Steelwork contractor: Ermine Engineering
Main contractor: Parkeray
Client: The Science Museum

Kiosk and Shelter, Bournemouth Pier Approach

FACT FILE
Architect: Poynton Bradbury Wynter Cole Architects Ltd
Structural engineer: Hydrock
Steelwork contractor: Weldrite Structures Ltd
Main contractor: Willmott Dixon Construction Ltd
Client: Bournemouth Borough Council

Two architecturally arresting steel-framed leaf-shaped structures provide a visitor information centre and a shelter in the centre of Pier Approach, representing the first phase of Bournemouth Borough Council's twenty-year strategy to develop a world-class seafront for the town.

Structurally, a leaf is a natural cantilever, with a singular 'stalk' (cantilever box-girder column) supporting the 'veins' (cantilever beams), which reach out to support the surface (roof). Following natural principles, the structure tapers from a thick base to thin edges, resulting in an elegant, symmetrical and pure structural form.

"Steel offers great potential for bespoke sculptural forms such as this and it was the obvious choice with many benefits over alternative structural materials.

"Steel can be easily cut and bent into the complex shapes that were required to generate the organic forms, using highly accurate pre-fabrication methods in a safe and controlled environment," says Hydrock Consultants Technical Director Jonathan Derwent.

Steel was also used because it can be both lightweight and strong, providing a structure that is capable of achieving the long spans and thin profiles that are required to form the delicate shape.

"The simple structure will also allow for future adaption if and when the client needs change," says Poynton Bradbury Wynter Cole Architects' Paul Perry.

Energy from Waste Facility, Peterborough

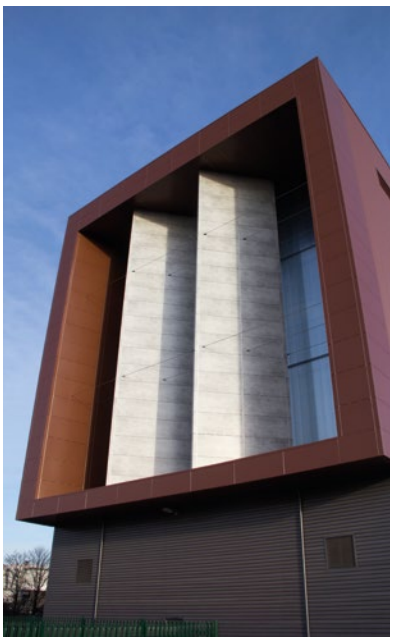
Peterborough Energy from Waste annually processes 85,000t of residual waste to generate 7.25MW of electricity, enough to supply 15% of the homes in the city, and reducing the volume of household waste sent to landfill by up to 94%.

The facility is composed of a steel-framed waste reception area with roller doors, an 8m-deep concrete bunker with cranes and a steel-framed roof, together with a 30m-high steel-framed process hall. The administration building was kept structurally independent from the main process building to avoid excessive vibrations and transmission of noise.

"Floorplates within the main plant building were known to be variable to suit the particular process and were ill-defined at an early stage," says MLM Consulting Engineers Director Nick Ash.

"A flexible design approach needed to be adopted to allow the structure to evolve and enable future changes to the internal process layout."

A lattice steel column and lattice roof beam structure enabled maximum flexibility of the internal floorplates allowing integration of the complex plant process equipment. These were fabricated from fully welded universal column sections into transportable lengths, which were then bolted together on site.



FACT FILE
Architect: BHP Design (UK) Ltd
Structural engineer: MLM Consulting Engineers Ltd
Steelwork contractor: Severfield
Main contractor: Interserve & Babcock Wilcox Volund
Client: Viridor Waste Management

New Watford Market

A modern, modular two-storey market constructed from recycled shipping containers and featuring a highly engineered stretched-canopy roof, Watford's new covered market is an important part of the town's regeneration.

This was a challenging urban renewal project delivered in a short timeframe and within a limited budget of just over £2M. Although costs have been kept to a minimum, it is an ambitious and considered design featuring innovative engineering to create a vibrant piece of public realm and a new asset for Watford.

Due to the complex arrangement of the containers, 15 different strengthening details were required in a variety of combinations to help transfer the load.

These details ranged from PFC sections with cut flanges, required to suit the sheeting profile, to combining SHSs, flat plates and steel angles together into a single member welded to the top of two containers to join them when the adjacent corrugated sheeting walls were removed.

An independent steel frame to support the canopy is carefully detailed and the use of elliptical hollow sections for the portal frame columns and beams is both economic and elegant, giving an ever-changing perspective of the structure as shoppers pass through the market.

"Visible to those driving into Watford, the canopy roof was always seen as a key feature," says AECOM Regional Director, Building Engineeing Michael Wright.

FACT FILE
Architect: tp Bennett LLP
Structural engineer: AECOM
Steelwork contractor: Nationwide Structures Ltd
Main contractor: TSP
Client: Watford Borough Council

University of Cambridge Primary School

The University of Cambridge Primary School was the first building to open as part of the University of Cambridge's North West Cambridge Development.

The school is a three-form entry primary school and University Training School. It opened in September 2015 to a local catchment of 120 pupils.

The building takes an iconic circular shape and a steel frame was the best match for the architectural brief as it creates opportunity for future flexibility - walls can be removed and partitions rearranged without changing the lateral stability of the building.

A steel frame also offered the right solution for a single storey open-plan flexible layout. It suited the long span radial column grid and enabled articulation of the roof while keeping the foundations loads minimal when compared to heavier materials.

Vertical loads were accommodated in different ways throughout the project. In the communal block the first floor and roof utilised precast hollow core units spanning 7.6m, in turn supported by steel frames at typically 9.6m centres.

Steel offered the project a shortened construction period and it was also critical for the success and timing of the programme, which saw erection of the steel frame mostly occurring during the winter months, allowing the school to open on time.

FACT FILE
Architect: Marks Barfield Architects
Structural engineer: Parmarbrook
Steelwork contractor: William Haley Engineering Ltd
Main contractor: Willmott Dixon Construction Ltd
Client: North West Cambridge Development, University of Cambridge

FACT FILE
Architect: BuckleyGrayYeoman
Structural engineer: Heyne Tillett Steel
Steelwork contractor: TSI Structures Ltd
Client: Channing School

Sports Hall & Sixth Form Centre, Channing School, London

Steelwork has played a key role in the construction of a new sports hall and sixth form centre for Channing Secondary School for Girls located off Highgate Hill in the London Borough of Haringey.

"Exposed steel roof members with triangulated Macalloy cable ties emphasise the roof construction to both the sixth form centre and sports hall and allow students to appreciate the engineering involved in the creation of such uninterrupted spaces," says Heyne Tillett Steel Technical Director Susan Mantle.

The team has created a double-pitched solution with no central support using four sloped steel trusses, which span 34m along the length of the building.

With only a 30-degree pitch, large horizontal forces from the roof attempting to spread are resisted by a series of exposed Macalloy ties between perimeter columns and the central valley chords of the trusses.

The central valley chords are preset to limit their vertical deflection. Rafters and bracing members are fabricated 20mm short of their finished geometry to allow the roof to fall into the desired position under the structures self weight and a percentage of the superimposed dead loading.

South Bank Tower, London

The South Bank Tower development by CIT in London has allowed the dramatic transformation of an unoccupied 1970s office scheme into state-of-the-art luxury apartments in the heart of the capital.

The residential accommodation is primarily located within the refurbished and extended tower building. The design intent was to extend the existing tower vertically by an additional 11 storeys.

"Steel was an essential choice for key aspects of this project to be realised," says AKT II Design Director Ed Moseley.

The solution was to hang the new structure off the central core utilising a combination of a tension bar system and cantilevering steelwork in conjunction with lightweight concrete floor slabs.

The tower and podium are united by a glazed steel roof that provides the continuity to the apartment complex as a whole, and transforms the space between the two buildings from a windswept urban canyon to a dramatic covered space with overlooking balconies and scenic lifts.

The extension of the existing tower meant that the design was dependent on working within the capacity of the existing structure below. This necessitated the use of a lightweight structural form that could achieve the considerable spans required to hit the points of the structure below which had residual capacity from the original design.

FACT FILE
Architect: Kohn Pedersen Fox Associates
Structural engineer: AKT II
Steelwork contractor: Severfield
Main contractor: Mace
Client: CIT Developments LLP

Whyke Horizon Footbridge, Chichester

Whyke Horizon Footbridge near Chichester is an innovatively designed structure spanning the A27.

Construction commenced in January 2015 and was finished in August of the same year. Steel fabrication took place in South Wales, while preparatory site activities occurred on the ground in Chichester.

The vast majority of site construction occurred in the verge of the A27, either under minimal or no traffic management, causing negligible disruption to the travelling public.

Steel was chosen primarily because it is lightweight and easy to erect.

"The bridge was fabricated offsite, including the access ramps and staircases. It was quality and dimensionally checked before arriving on site for erection, which meant road users were only disrupted for one night for the bridge deck installation," says Interserve Construction Contracts Manager Frank Leonforte.

Steel also provided the means to design a visually light and unobtrusive structure, important considerations given its proximity to residential properties and the flat coastal environment.

The use of stainless steel mesh enabled the ramps and stairs to appear as transparent as possible, while the use of steel also provided the flexibility to design a sculpturally beautiful bridge at relatively modest cost.

FACT FILE
Architect: WilkinsonEyre
Structural engineer: Balfour Beatty Mott MacDonald
Steelwork contractor: Mabey Bridge Ltd
Main contractor: Interserve Construction Ltd
Client: Highways England

celebrating

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The British Constructional Steelwork Association and Steel for Life have pleasure in inviting entries for the 2017 Structural Steel Design Awards.

The Awards celebrate the excellence of the United Kingdom and the Republic of Ireland in the field of steel construction, particularly demonstrating its potential in terms of efficiency, cost-effectiveness, aesthetics and innovation.

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BCSA

STEEL for life

The selection of steel subgrade

Richard Henderson of the SCI discusses the determination of the steel subgrade using BS EN 1993-1-10 and the UK National Annex. Examples are given where the temperature falls outside the values given in Tables 2, 3 and 4 of PD 6695-1-10: 2009.

The SCI Advisory Desk often receives calls from SCI members about the selection of steel subgrade and the application of the relevant documents. This article attempts to clarify the steps in the process of determining steel subgrade and show how the steps can be applied to service temperatures outside the ones usually met.

Published document PD 6695-1-10: 2009 provides non-contradictory complementary information (NCCI) for use in the UK with Part 1-10 of the Eurocode BS EN 1993 and its National Annex. It gives the preferred approach to selecting material subgrade and should be used unless features of the detail being considered fall outside the scope of the PD.

Part 10 of BS EN 1993-1 General Rules and Rules for Buildings and its UK National Annex deals with material toughness and through-thickness properties. According to BS EN 1993-1-1 clause 3.2.3, material "shall have sufficient fracture toughness to avoid brittle fracture of tension elements at the lowest service temperature expected to occur within the service life of the structure". The lowest service temperatures to be adopted for buildings and other quasi-statically loaded structures are given in the UK National Annex to BS EN 1993-1-1 as -5°C for internal steelwork and -15°C for external steelwork. For most bridges in the UK, the service temperature is -20°C or higher and Table 4 in the PD can be used. Otherwise the lowest service temperature should be determined according to the UK National Annex to BS EN 1991-1-5 for the bridge location. For other cases such as the internal steelwork in cold stores, the lowest service temperature should be taken as the lowest air temperature expected to occur during the design life of the structure.

The guidance in part 10 is to be used for the selection of material for new structures. The rules are applicable to tension elements, welded and fatigue stressed elements in which some portion of the stress cycle is tensile. According to part 10, the rules can be conservative for elements not subject to tension, welding or fatigue and fracture toughness need not be specified for elements only in compression. The UK National Annex covers elements in compression by including tensile stresses of less than zero.

The relevant design condition is given in clause 2.2(4)(i) which states the design actions should be the effects of the reference temperature (T_{Ed}) as leading action, in combination with the permanent actions (G_K), frequent variable actions ($\psi_1 Q_K$) and quasi-permanent values of the accompanying variable actions ($\psi_{2i} Q_{Ki}$) that govern the stress level in the material. The combination is considered to be an accidental combination because of the assumption of simultaneous occurrence of lowest temperature, flaw size and location and material property. The maximum applied stress should be the nominal principal stress at the location of the potential fracture initiation, calculated for the given combination. Note that the combination does not include any partial factors for permanent or variable actions.

T_{Ed} is defined in equation 2.2 as:

$$T_{Ed} = T_{md} + \Delta T_r + \Delta T_\sigma + \Delta T_R + \Delta T_\varepsilon + \Delta T_{\varepsilon cf}$$

The UK National Annex to part 10 does not say so but the first two terms taken together: ($T_{md} + \Delta T_r$) are the lowest service temperature. $\Delta T_\varepsilon + \Delta T_{\varepsilon cf}$ are for high strain rate (eg due to impact) and degree of cold forming respectively. The NA goes on to define ΔT_R in terms of a series of temperature adjustments as follows:

$$\Delta T_R = \Delta T_{RD} + \Delta T_{Rg} + \Delta T_{RT} + \Delta T_{R\sigma} + \Delta T_{Rs}$$

with the ΔT terms corresponding to detail type; gross stress concentrations; Charpy test temperature; applied stress level and strength grade respectively. Procedures in the NA are consistent with $\Delta T_\sigma = 0$ (cl. NA.2.1.1.1) which means adjustments for stress level are made through the ΔT_R value, specifically the choice of $\Delta T_{R\sigma}$.

Table 1 (over the page) summarizes the adjustments in the National Annex. The item numbers in the table are used for reference in the following examples.

Example 1

What is the limiting thickness for S355J2 used internally in a detail with moderate welding subject to a design tensile stress greater than half the yield stress?

Table E1

Temperature Adjustment	Comment	Item in table 1	Value and adjustment (°C)
$T_{md} + \Delta T_r$	Service temperature (internal)		-5
ΔT_{RD}	Detail type	3	0
ΔT_{Rg}	Stress concentration	8	0
ΔT_{RT}	Charpy test temperature (-20 – (-5) = -15 < 20)	12	0
$\Delta T_{R\sigma}$	Applied stress level	20	0
ΔT_{Rs}	Steel grade	26	0
			Use -5

From table 2.1 in EN 1993-1-10 maximum thicknesses are:

		Charpy Energy CVN		Reference temperature T_{Ed}		
				10	0	-10
Steel grade	Sub grade	at T(°C)	$= J_{min}$	$\sigma_{Ed} = 0.75 f_y(t)$		
S355	J2	-20	27	90	75	60

Interpolating for T_{Ed} = -5, the limiting thickness t = 67.5 mm.

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Table 1

Adjustments for detail type (NA.2.1.1.1.2 and Table NA.1)			
Detail		**Item**	**ΔT_{RD}**
Unwelded	As rolled, ground or machined surfaces	1	+30°C
	Mechanically fastened joints or flame cut edges	2	+20°C
Welded	Generally (described as 'moderate' in the PD)	3	0°C
	Attachment; transverse weld toe: length >150 mm; width ≤ 50mm (described as 'severe' in the PD)	4	-20°C
	Attachment; transverse weld toe: length >150 mm; width > 50mm (described as 'very severe' in the PD)	5	-30°C
	Member fabricated from plates: transverse butt weld	6	-20°C
	Rolled section: transverse butt weld	7	-30°C
Adjustment for gross stress concentration (Table NA.2)			
Stress concentration factor			**ΔT_{Rg}**
Guidance on stress concentration factors is given in PD 6695-1-9:2008	1	8	0°C
	1.5	9	-10°C
	2	10	-20°C
	3	11	-30°C
Adjustment for Charpy test temperature (Table NA.3)			
General (except bridges conforming to BS EN 1993-2). Obtain intermediate values by linear interpolation. The maximum difference between the Charpy test temperature and $T_{Ed} = (T_{md} + \Delta T_r)$ should be limited.	**$T - (T_{md} + \Delta T_r)$**		**ΔT_{RT}**
	≤ 20°C	12	0°C
	25°C	13	-10°C
	30°C	14	-20°C
	35°C	15	-30°C
Further restriction on joint types apply: see the NA	> 35 ≤ 40°C	16	-40°C
	> 40°C	17	Not permitted
Bridges conforming to BS EN 1993-2	≤ 20°C	18	0°C
	> 20°C	19	Not permitted
Adjustment for applied stress (Table NA.4)			
	σ_{Ed}		**$\Delta T_{R\sigma}$**
	$0.75 f_y(t)$	20	0°C
Use the values for $0.75 f_y(t)$ but adjusted for lower values of σ_{Ed}. Linear interpolation may be used for intermediate values.	$0.5 f_y(t)$	21	0°C
	$0.3 f_y(t)$	22	+10°C
	$0.15 f_y(t)$	23	+20°C
	≤ 0	24	+30°C
Adjustment for steel grade (Table NA.5)			
	steel grade		**T_{Rs}**
	< S355	25	+10°C
	S355	26	0°C
	> S355	27	-10°C

Example 2

What is the limiting thickness for S460N used externally in a detail with moderate welding subject to a design tensile stress greater than half the yield stress?

Table E2

Temperature Adjustment	**Comment**	**Item in table 1**	**Value and adjustment (°C)**
$T_{md} + \Delta T_r$	Service temperature (internal)		-15
ΔT_{RD}	Detail type	3	0
ΔT_{Rg}	Stress concentration	8	0
ΔT_{RT}	Charpy test temperature (-20 – (-15) = -5 < 20)	12	0
$\Delta T_{R\sigma}$	Applied stress level	20	0
ΔT_{Rs}	Steel grade	27	-10
			Use -25

From table 2.1 in EN 1993-1-10 maximum thicknesses are:

		Charpy Energy CVN		**Reference temperature T_{Ed}**		
				-10	**-20**	**-30**
Steel grade	**Sub grade**	**at T(°C)**	**$= J_{min}$**	**$\sigma_{Ed} = 0.75 f_y(t)$**		
S460	N	-20	40	60	50	40

Interpolating for T_{Ed} = -25, the limiting thickness t = 45 mm.

Example 3

What is the limiting thickness for S355JR used externally in the UK in a detail with severe welding subject to a design tensile stress greater than half the yield stress?

Table E3

Temperature Adjustment	**Comment**	**Item in table 1**	**Value and adjustment (°C)**
$T_{md} + \Delta T_r$	Service temperature (internal)		-15
ΔT_{RD}	Detail type	4	-20
ΔT_{Rg}	Stress concentration	8	0
ΔT_{RT}	Charpy test temperature (20 – (-15) = 35)	15	-30
$\Delta T_{R\sigma}$	Applied stress level	20	0
ΔT_{Rss}	Steel grade	26	0
			Use -65

Table 2.1 in EN 1993-1-10 does not have thicknesses for temperatures as low as this. However, such values are given in PD6695-1-10.

		Charpy Energy CVN		Reference temperature T_{Ed}		
				-50	-60	-70
Steel grade	Sub grade	at T(°C)	$= J_{min}$	$\sigma_{Ed} = 0.75 f_y(t)$		
S355	JR	20	27	10	10	5

Interpolating for T_{Ed} = -65, the limiting thickness t = 7.5 mm.

Example 4

What is the limiting thickness for S355J2 used externally where the service temperature is -40°C in a detail with moderate welding subject to a design tensile stress just less than 0.3 times the yield stress?

Table E4

Temperature Adjustment	Comment	Item in table 1	Value and adjustment (°C)
$T_{md} + \Delta T_r$	Service temperature (internal)		-40
ΔT_{RD}	Detail type	3	0
ΔT_{Rg}	Stress concentration	8	0
ΔT_{RT}	Charpy test temperature (-20 – (-40) = 20)	12	0
$\Delta T_{R\sigma}$	Applied stress level	22	+10
ΔT_{Rs}	Steel grade	26	0
			Use -30

From table 2.1 in EN 1993-1-10, maximum thicknesses are:

		Charpy Energy CVN		Reference temperature T_{Ed}		
				-20	-30	-40
Steel grade	Sub grade	at T(°C)	$= J_{min}$	$\sigma_{Ed} = 0.75 f_y(t)$		
S355	J2	-20	27	50	40	35

The limiting thickness t = 40 mm.

Example 5

What is the limiting thickness for S355JR used in a bridge where the service temperature is -20°C in a detail with moderate welding subject to a design tensile stress just less than 0.3 times the yield stress?

Table E4

Temperature Adjustment	Comment	Item in table 1	Value and adjustment (°C)
$T_{md} + \Delta T_r$	Service temperature (internal)		-20
ΔT_{RD}	Detail type		
ΔT_{Rg}	Stress concentration		
ΔT_{RT}	Charpy test temperature (20 – (-20) = 40 > 20)	19	Not permitted
$\Delta T_{R\sigma}$	Applied stress level		
ΔT_{Rs}	Steel grade		

Use of the proposed sub grade is not permitted.

Comparison of the results from examples 1 to 5 with the tables in PD6695-1-10 will show that the same values appear.

Conclusion

The determination of the maximum thickness for a given material subgrade and set of conditions has been illustrated, using EN 1993-1-10 and its National Annex and can be seen to correspond to the values given in PD6695-1-10.

It is noted in the JRC Scientific and Technical Report EUR 23510 EN – 2008 entitled Commentary and worked examples to EN 1993-1-10 by Sedlacek et al, September 2008, in section 1.4.3(1) that "As EN 1993-1-10, section 2 has been developed for structures subjected to fatigue (such) as bridges … , its use for buildings where fatigue plays a minor role would be extremely safe sided."

New and revised codes & standards

From BSI Updates September 2016

BS EN PUBLICATIONS

BS EN ISO 3581:2016
Welding consumables. Covered electrodes for manual metal arc welding of stainless and heat-resisting steels. Classification
Supersedes BS EN ISO 3581:2012

BS EN ISO 6892-1:2016
Metallic materials. Tensile testing. Method of test at room temperature
Supersedes BS EN ISO 6892-1:2009

BS EN ISO 14171:2016
Welding consumables. Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels. Classification
Supersedes BS EN ISO 14171:2010

BS EN 15048-1:2016
Non-preloaded structural bolting assemblies. General requirements
Supersedes BS EN 15048-1:2007

BS EN 15048-2:2016
Non-preloaded structural bolting assemblies. Fitness for purpose
Supersedes BS EN 15048-2:2007

BRITISH STANDARDS UNDER REVIEW

BS EN 1011-2:2001
Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS EN 10130:2006
Cold rolled low carbon steel flat products for cold forming. Technical delivery conditions

BS EN 10131:2006
Cold rolled uncoated and zinc or zinc-nickel electrolytically coated low carbon and high yield strength steel flat products for cold forming. Tolerances on dimensions and shape

BS EN 10140:2006
Cold rolled narrow steel strip. Tolerances on dimensions and shape

BS EN 10143:2006
Continuously hot-dip coated steel sheet and strip. Tolerances on dimensions and shape

BS EN 10162:2003
Cold rolled steel sections. Technical delivery conditions. Dimensional and cross-sectional tolerances

NEW WORK STARTED

EN 10080
Steel for the reinforcement of concrete. Weldable reinforcing steel. General
Will supersede BS EN 10080:2005

EN 10225-1
Weldable structural steels for fixed offshore structures. Plates

EN 10225-2
Weldable structural steels for fixed offshore structures. Sections

EN 10225-3
Weldable structural steels for fixed offshore structures. Hot finished hollow sections

EN 10225-4
Weldable structural steels for fixed offshore structures. Cold formed hollow sections

EN 10340-1
Steel castings for structural uses. General
Will partially supersede BS EN 10340:2007

EN 10340-2
Steel castings for structural uses. Technical delivery conditions
Will partially supersede BS EN 10340:2007

EN 104031
Corrosion resistant reinforcing steels

DRAFT BRITISH STANDARDS FOR PUBLIC COMMENT – NATIONAL BRITISH STANDARDS

16/30337162 DC
BS 8548 Guidance for arc welding of reinforcing steel
Comments for the above document were required by 27 September, 2016

DRAFT BRITISH STANDARDS FOR PUBLIC COMMENT – ADOPTIONS

16/30340638 DC
BS EN 1993-1-5 AMD1 Eurocode 3. Design of steel structures. Part 1-5. Plated structural elements
Comments for the above document were required by 20 September, 2016

BUILDINGWITHSTEEL

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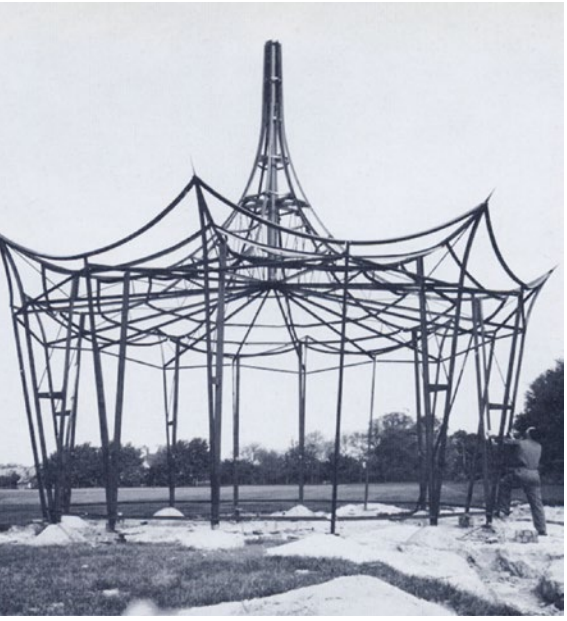

An intriguing sports pavilion design

When designing the sports pavilion and club house for a Cambridge firm the architects felt that if a sense of recreation and release were to be achieved the form should make a strong contrast with the adjacent solid rectangular buildings. This has been done by the creation of a most intriguing design.

The County Planning Department was very sympathetic and helpful in guiding the application through local opposition to its unusual appearance, which was fanned by rumours that it was a 'rocket launching site' and that the spire was to carry flashing neon signs. Steel was chosen for the frame because the members of the building would be more slender than if other materials were used, and also because of ease of erection and cheapness. Other factors influencing the choice of steel were its suitability to reproduce the shape of the pavilion and the fact that it provided a strong rigid frame to which the external and internal coverings could be fixed without difficulty.

To produce the shape required by the architects a light welded frame of channels, angles and square and rectangular hollow sections was designed: the rectangular hollow sections incorporate the down pipes at the eight lower points of the roof. To facilitate production of the members of the frame

AD 401: Appropriate anchorage of parallel decking

Where profiled steel decking is parallel to the supporting beam, BS EN 1994-1-1:2004 (incorporating corrigenda April 2009) allows the shear resistance of a headed stud to be based on the resistance in a solid slab multiplied by a reduction factor that is given in expression (6.22), without the need for additional reinforcement, provided that the decking is continuous across the beam or is 'appropriately anchored' and the studs are located within a certain region (Figures 6.12 and 9.2).

One purpose of providing appropriate anchorage is to prevent loss of any containment to the concrete rib provided by the decking, thus avoiding a reduction in stud resistance. A second purpose is to prevent so-called splitting of the concrete, which would be a non-ductile mode of failure.

Where the sheeting is not continuous across the beam and is not appropriately anchored, clause 6.6.4.1(3) requires 6.6.5.4 to be satisfied, which involves dimensional restrictions and rebar bent into the trough, as illustrated in Figure 6.14. It is impractical, on the scale of typical composite slab profiles, to provide bent bars such as would be provided in a formed haunch. It is therefore all but obligatory to provide appropriate anchorage and 6.6.4.1(3) notes that the means to achieve appropriate anchorage may be given in the National Annex.

UK NA.4 refers to Non-Contradictory Complementary Information (NCCI), which is available in a recently updated NCCI document (PN003b-GB), now available on www.steel-ncci.co.uk and defines three alternatives for ensuring decking is appropriately anchored when through deck welded studs are not present. In order of increasing 'complexity' these are presented as Options 1 to 3 here.

Option 1

Finite Element Modelling has been used to show that when the geometry of the haunch and detailing of the shear studs satisfy the requirements defined below, then only nominal fixity is needed in order to contain the concrete around the studs and prevent longitudinal splitting of the slab. The provision of nominal fixity (1 kN/m) is valid when:

- The decking geometry, flange width and stud placement is such that the angle between the base of the stud and shoulder of the decking is no more than 50°.
- There are single studs fixed along the beam centreline, providing edge cover of not less than 50 mm. Multiple studs at a given cross section must be avoided because of their potential to transfer a higher force into the concrete.
- The longitudinal stud spacing is not less than 200 mm. When studs are more closely spaced there is an increased likelihood of interaction between adjacent studs resulting in slab splitting, but the FEM demonstrated that even at slips of 10 mm - which is almost twice the slip anticipated by BS EN 1994-1-1 ; there is no interaction for studs at 200 mm centres (Figure 1 here).
- The beam is simply supported.

Note that the detailing rules above are similar to those presented in BS EN 1994-1-1 as necessary to assure adequate concrete confinement around the studs in a haunch.

Option 2

When the limits given above are not satisfied, it seems reasonable to assume that it will suffice to provide resistance equal to the force which would be needed to 'unfold' the profile if it were subject to transverse tension, as this sets a limit to the containment provided by the profiled decking. It can readily be calculated that a 60 mm deep profile, 0.9 mm thick, grade S450, with plastic hinges top and bottom, will unfold at less than 4 kN/m. Fixings at 250 mm centres, which is also a spacing close enough to ensure reasonable proximity to the zone of influence of any one stud, should suffice to provide this level of fixity. With thicker decking, the bearing resistance of the screw or nail will improve more than commensurately with the demands made on it. With a profile depth less than 60 mm, a more relaxed view can be taken, as the studs should normally be at least 95 mm in height (100 mm, if welded direct to the beam), reducing the need for containment. It seems reasonable to provide fixings at 250 mm, as for the deeper profile.

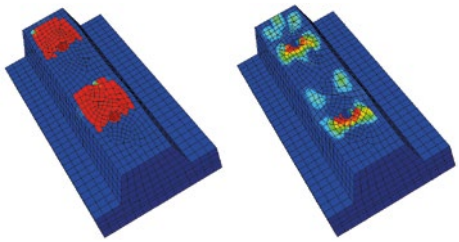

Figure 1: Concrete damage in a) Compression and b) tension at a slip of 10 mm

Option 3

The third option open to designers is to provide additional reinforcement in the haunch, in accordance with BS EN 1994-1-1, clause 6.6.5.4.

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the architects made a 1-in. scale plywood and polystyrene model, from which the curves were measured and set out for fabrication. The frame was erected around a temporary centre post carrying the apex unit and hoisted to the vertical position and held with guy ropes. The roof frames and the legs were then built out from the apex and the centre frame removed.

Large areas of glass provide unobstructed views across the playing fields and inside remove any feeling of restrictive enclosure. Natural materials have been used for cladding and muted colours chosen: these features, together with the planting of shrubs, the laying of paving and the reinstatement of the surrounding grass were designed so that the pavilion will merge into its rural setting.

Architects – Ellis & Gardner; Structural Engineers – Jubb and Luxton.

Steelwork contractors for buildings

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

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

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

- **C** Heavy industrial platework for plant structures, bunkers, hoppers, silos etc
- **D** High rise buildings (offices etc over 15 storeys)
- **E** Large span portals (over 30m)
- **F** Medium/small span portals (up to 30m) and low rise buildings (up to 4 storeys)
- **G** Medium rise buildings (from 5 to 15 storeys)
- **H** Large span trusswork (over 20m)
- **J** Tubular steelwork where tubular construction forms a major part of the structure
- **K** Towers and masts
- **L** Architectural steelwork for staircases, balconies, canopies etc
- **M** Frames for machinery, supports for plant and conveyors
- **N** Large grandstands and stadia (over 5000 persons)
- **Q** Specialist fabrication services (eg bending, cellular/castellated beams, plate girders)
- **R** Refurbishment
- **S** Lighter fabrications including fire escapes, ladders and catwalks

FPC Factory Production Control certification to BS EN 1090-1
1 – Execution Class 1 **2** – Execution Class 2
3 – Execution Class 3 **4** – Execution Class 4
BIM BIM Level 2 assessed
QM Quality management certification to ISO 9001
SCM Steel Construction Sustainability Charter
(● = Gold, ● = Silver, ● = Member)

Notes

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

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

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
A & J Stead Ltd	01653 693742			●	●					●	●			●	●		2			Up to £200,000
A C Bacon Engineering Ltd	01953 850611			●	●	●	●				●			●			2			Up to £3,000,000
A&J Fabtech Ltd	01924 439614	●					●		●	●	●		●	●		✔	3			Up to £400,000
Access Design & Engineering	01642 245151					●				●	●			●	●	✔	2			Up to £4,000,000
Adey Steel Ltd	01509 556677				●	●	●	●		●	●			●	●	✔	3		●	Up to £2,000,000
Adstone Construction Ltd	01905 794561			●	●	●	●									✔	2	✔	●	Up to £3,000,000
Advanced Fabrications Poyle Ltd	01753 653617				●	●	●	●		●	●			●	●	✔	2			Up to £800,000
AJ Engineering & Construction Services Ltd	01309 671919			●	●					●	●			●	●	✔	4			Up to £2,000,000
Angle Ring Company Ltd	0121 557 7241												●			✔	4			Up to £1,400,000
Apex Steel Structures Ltd	01268 660828			●	●	●	●			●	●			●			2			Up to £2,000,000
Arminhall Engineering Ltd	01799 524510	●			●	●		●		●	●			●	●	✔	2			Up to £400,000
Arromax Structures Ltd	01623 747466	●		●	●	●	●	●	●	●	●	●		●	●		2			Up to £800,000
ASA Steel Structures Ltd	01782 566366			●	●	●	●			●	●			●	●	✔	4			Up to £800,000
ASME Engineering Ltd	020 8966 7150				●	●				●	●			●	●	✔	3		●	Up to £2,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●	●	●				●			●	●	✔	2			Up to £1,400,000
Austin-Divall Fabrications Ltd	01903 721950			●	●		●	●		●	●			●	●	✔	2			Up to £800,000
B D Structures Ltd	01942 817770			●	●	●	●				●	●		●		✔	2			Up to £800,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✔	4			Up to £1,400,000
Barnshaw Section Benders Ltd	0121 557 8261												●			✔	4			Up to £2,000,000
BHC Ltd	01555 840006	●	●	●	●	●	●	●			●	●		●	●	✔	4		●	Above £6,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●	●	●	●	●		●	●	✔	4		●	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●		4			Up to £3,000,000
Bourne Construction Engineering Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	●	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●			●	●	✔	4			Up to £6,000,000
Builders Beams Ltd	01227 863770			●	●	●	●	●		●				●	●	✔	2	✔		Up to £1,400,000
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●				●	●	✔	4		●	Up to £3,000,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●		●	●	●		●	●	✔	4	✔	●	Up to £6,000,000
Cementation Fabrications	0300 105 0135	●			●			●			●		●		●	✔	3		●	Up to £6,000,000*
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	●		●		✔	4		●	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 £800,000
D H Structures Ltd	01785 246269			●	●		●				●						2			Up to £100,000
D Hughes Welding & Fabrication Ltd	01248 421104				●	●	●	●		●	●		●	●	●	✔	4			Up to £800,000
Duggan Steel	00 353 29 70072		●	●	●	●	●	●	●		●	●			●	✔	4			Up to £6,000,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●	●	●	●	●			●	●	✔	3			Up to £3,000,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●	●	●	●	●	●		●		✔	4		●	Up to £6,000,000
EvadX Ltd	01745 336413			●	●	●	●	●	●	●	●	●				✔	3		●	Up to £3,000,000
Four Bay Structures Ltd	01603 758141			●	●	●	●	●		●	●			●	●		2			Up to £1,400,000
Four-Tees Engineers Ltd	01489 885899												●		●	✔	3		●	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
Gregg & Patterson (Engineers) Ltd	028 9061 8131			●	●	●	●	●				●		●		✔	3			Up to £3,000,000
H Young Structures Ltd	01953 601881			●	●	●	●	●		●	●			●	●	✔	2		●	Up to £2,000,000
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)
Had Fab Ltd	01875 611711				●				●	●	●				●	✔	4			Up to £3,000,000
Hambleton Steel Ltd	01748 810598		●	●	●	●	●	●				●		●		✔	4		○	Up to £6,000,000
Harry Marsh (Engineers) Ltd	0191 510 9797			●	●	●	●				●	●			●	✔	2			Up to £1,400,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●	✔	2			Up to £3,000,000
Intersteels Ltd	01322 337766				●	●	●	●					●			✔	3			Up to £2,000,000
J & A Plant Ltd	01942 713511				●	●									●		4			Up to £40,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●				●	●		●			4			Up to £6,000,000*
John Reid & Sons (Strucsteel) Ltd	01202 483333		●	●	●	●	●	●	●	●	●	●		●	●	✔	4			Up to £6,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445			●	●	●	●	●	●	●	●	●		●	●	✔	4		●	Up to £6,000,000
Kloeckner Metals UK Westok	0113 205 5270												●			✔	4			Up to £6,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●					✔	2		○	Up to £6,000,000
Legge Steel (Fabrications) Ltd	01592 205320			●	●		●		●	●	●			●	●		3			Up to £800,000
Luxtrade Ltd	01902 353182									●	●				●	✔	2			Up to £800,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●				●	✔	4			Up to £2,000,000
M J Patch Structures Ltd	01275 333431				●	●				●	●				●	✔	2			Up to £800,000
M&S Engineering Ltd	01461 40111				●				●	●	●			●	●		3			Up to £1,400,000
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			●	●	●	●				●						2			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 £1,400,000
Nusteel Structures Ltd	01303 268112						●	●	●	●						✔	4			Up to £4,000,000
Overdale Construction Services Ltd	01656 729229			●	●		●	●			●				●		2			Up to £400,000
Painter Brothers Ltd	01432 374400								●		●			●	●	✔	2		●	Up to £6,000,000
Pencro Structural Engineering Ltd	028 9335 2886			●	●	●	●	●	●		●			●	●	✔	2			Up to £2,000,000
Peter Marshall (Steel Stairs) Ltd	0113 307 6730									●					●	✔	2			Up to £800,000*
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●		2			Up to £1,400,000
Rippin Ltd	01383 518610			●	●	●	●	●						●	●		2			Up to £1,400,000
S H Structures Ltd	01977 681931	●			●		●	●	●	●	●	●				✔	4	✔	○	Up to £2,000,000
SDM Fabrication Ltd	01354 660895	●	●	●	●	●	●				●			●	●	✔	4			Up to £2,000,000
Sean Brady Construction Engineering Ltd	00 353 49 436 4144			●	●	●	●			●	●			●	●		2			Up to £800,000
Severfield plc	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4		●	Above £6,000,000
SGC Steel Fabrication	01704 531286				●					●				●	●	✔	2			Up to £800,000
Shaun Hodgson Engineering Ltd	01553 766499	●		●	●		●			●	●			●	●	✔	3			Up to £800,000
Shipley Structures Ltd	01400 251480			●	●	●	●		●	●	●			●	●		2			Up to £1,400,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●	●	●	●			●				●		2	✔		Up to £1,400,000
South Durham Structures Ltd	01388 777350			●	●	●				●	●	●			●		2			Up to £800,000
Southern Fabrications (Sussex) Ltd	01243 649000				●	●				●	●			●	●	✔	2			Up to £800,000
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			●	●	●	●	●	●		●			●	●	✔	2	✔	○	Up to £2,000,000
TSI Structures Ltd	01603 720031			●	●	●	●	●			●			●		✔	2	✔		Up to £1,400,000
Tubecon	01226 345261						●	●	●	●				●	●	✔	4		●	Above £6,000,000*
Underhill Engineering & Building Services Ltd	01752 752483				●		●	●	●	●	●			●	●	✔	4			Up to £3,000,000
W & H Steel & Roofing Systems Ltd	00 353 56 444 1855			●	●	●	●	●						●	●		4			Up to £2,000,000
W I G Engineering Ltd	01869 320515				●					●					●	✔	2			Up to £200,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✔	4			Up to £6,000,000
Westbury Park Engineering Ltd	01373 825500	●		●	●		●	●	●	●	●				●	✔	4			Up to £800,000
William Haley Engineering Ltd	01278 760591			●	●	●			●	●	●			●		✔	4		●	Up to £4,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	●	Above £6,000,000
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)

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
A Lamb Associates Ltd	01772 316278
Balfour Beatty Utility Solutions Ltd	01332 661491
Bluefin Group	020 3040 6723
Griffiths & Armour	0151 236 5656
Highways England Company Ltd	08457 504030
Kier Construction Ltd	01767 640111

Company name	Tel
PTS (TQM) Ltd	01785 250706
Sandberg LLP	020 7565 7000
Structural & Weld Testing Services Ltd	01795 420264
SUM Ltd	0113 242 7390
Welding Quality Management Services Ltd	00 353 87 295 5335

RQSC
The Register of Qualified Steelwork Contractors Scheme

Steelwork contractors for bridgeworks

BCSA

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

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

- **FG** Footbridge and sign gantries
- **PG** Bridges made principally from plate girders
- **TW** Bridges made principally from trusswork
- **BA** Bridges with stiffened complex platework (eg in decks, box girders or arch boxes)
- **CM** Cable-supported bridges (eg cable-stayed or suspension) and other major structures (eg 100 metre span)
- **MB** Moving bridges
- **RF** Bridge refurbishment
- **AS** Ancilliary structures in steel associated with bridges, footbridges or sign gantries (eg grillages, purpose-made temporary works)
- **QM** Quality management certification to ISO 9001
- **FPC** Factory Production Control certification to BS EN 1090-1
  1 – Execution Class 1 2 – Execution Class 2
  3 – Execution Class 3 4 – Execution Class 4
- **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	FG	PG	TW	BA	CM	MB	RF	AS	QM	FPC	BIM	NHSS 19A	NHSS 20	SCM	Guide Contract Value (1)
A&J Fabtech Ltd	01924 439614	●	●	●	●				●	✓	3					Up to £400,000
Bourne Construction Engineering Ltd	01202 746666	●	●	●				●	●	✓	4	✓		✓	●	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	✓	4			✓		Up to £6,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●			●	●	✓	4			✓	●	Up to £3,000,000
Cementation Fabrications	0300 105 0135	●	●						●	✓	3				●	Up to £6,000,000*
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	✓	4		✓	✓	●	Above £6,000,000*
D Hughes Welding & Fabrication Ltd	01248 421104	●		●			●	●	●	✓	4			✓		Up to £800,000
Donyal Engineering Ltd	01207 270909	●						●	●	✓	3			✓	●	Up to £1,400,000
ECS Engineering Ltd	01773 860001	●	●	●	●		●		●	✓	3					Up to £3,000,000
Four-Tees Engineers Ltd	01489 885899	●	●	●	●		●	●	●	✓	3			✓	●	Up to £2,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●		●				●	●	✓	4			✓	●	Up to £6,000,000
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		✓	✓		Up to £4,000,000
S H Structures Ltd	01977 681931	●		●	●	●	●		●	✓	4	✓		✓	●	Up to £2,000,000
Severfield (UK) Ltd	01204 699999	●	●	●	●	●	●	●	●	✓	4			✓	●	Above £6,000,000
Shaun Hodgson Engineering Ltd	01553 766499							●	●	✓	3					Up to £800,000
Taziker Industrial Ltd	01204 468080	●	●	●	●			●	●	✓	3		✓	✓		Above £6,000,000
Underhill Building & Engineering Services Ltd	01752 752483	●	●	●	●			●	●	✓	4			✓		Up to £3,000,000
Non-BCSA member																
Allerton Steel Ltd	01609 774471	●	●	●	●				●	✓	4			✓		Up to £4,000,000
Centregreat Engineering Ltd	029 2046 5683	●	●	●	●		●	●	●	✓	4					Up to £800,000
Cimolai SpA	01223 836299	●	●	●	●	●	●	●	●	✓	4					Above £6,000,000
CTS Bridges Ltd	01484 606416	●	●	●	●	●	●		●	✓	4			✓	●	Up to £800,000
Francis & Lewis International Ltd	01452 722200							●	●	✓	4			✓	●	Up to £2,000,000
Harland & Wolff Heavy Industries Ltd	028 9045 8456	●	●	●	●	●		●	●	✓	3					Up to £2,000,000
HS Carlsteel Engineering Ltd	020 8312 1879	●	●					●	●	✓	3			✓		Up to £400,000
IHC Engineering (UK) Ltd	01773 861734	●							●	✓	3			✓		Up to £400,000
Interserve Construction Ltd	020 8311 5500							●	●	✓	N/A					Above £6,000,000*
Lanarkshire Welding Company Ltd	01698 264271	●	●	●	●	●	●	●	●	✓	4		✓		●	Up to £2,000,000
P C Richardson & Co (Middlesbrough) Ltd	01642 714791	●						●	●	✓	N/A					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				●	Above £6,000,000

Industry Members

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

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

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

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

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM	BIM
AJN Steelstock Ltd	01638 555500								●		M		
Albion Sections Ltd	0121 553 1877	●									M		
Arcelor Mittal Distribution - Scunthorpe	01724 810810								●		D/I		
Autodesk Ltd	01252 456893		●										
AVEVA Solutions Ltd	01223 556655		●								N/A		
Ayrshire Metals Ltd	01327 300990	●									M		✓
BAPP Group Ltd	01226 383824									●	M		
Barrett Steel Services Limited	01274 682281								●		M		
Behringer Ltd	01296 668259					●					N/A		
British Steel	01724 404040				●						M		
BW Industries Ltd	01262 400088	●									M		
Cellbeam Ltd	01937 840600	●									M		
Cellshield Ltd	01937 840600							●			N/A		
Cleveland Steel & Tubes Ltd	01845 577789								●		M		
CMC (UK) Ltd	029 2089 5260								●		D/I		
Composite Profiles UK Ltd	01202 659237	●									D/I		
Cooper & Turner Ltd	0114 256 0057									●	M		
Cutmaster Machines (UK) Ltd	01226 707865					●					N/A		
Daver Steels Ltd	0114 261 1999	●									M		
Dent Steel Services (Yorkshire) Ltd	01274 607070								●		M		
Duggan Profiles & Steel Service Centre Ltd	00 353 56 7722485	●							●		M		
easi-edge Ltd	01777 870901							●			N/A	●	
Fabsec Ltd	01937 840641	●									N/A		
Ficep (UK) Ltd	01924 223530					●					N/A		
FLI Structures	01452 722200	●									M	●	
Forward Protective Coatings Ltd	01623 748323						●				N/A		
Goodwin Steel Castings Ltd	01782 220000	●									N/A		
Graitec UK Ltd	0844 543 8888		●								N/A		
Hadley Group Ltd	0121 555 1342	●									M	●	
Hempel UK Ltd	01633 874024						●				N/A		
Highland Metals Ltd	01343 548855						●				N/A		
Hilti (GB) Ltd	0800 886100									●	M		
Hi-Span Ltd	01953 603081	●									M	●	

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM	BIM
International Paint Ltd	0191 469 6111						●				N/A	●	
Jack Tighe Ltd	01302 880360						●				N/A		
Jamestown Cladding & Profiling Ltd	00 353 45 434288	●									M		
John Parker & Sons Ltd	01227 783200								●	●	D/I		
Joseph Ash Galvanizing	01246 854650						●				N/A		
Jotun Paints (Europe) Ltd	01724 400000						●				N/A		
Kaltenbach Ltd	01234 213201					●					N/A		
Kingspan Structural Products	01944 712000	●									M	●	
Kloeckner Metals UK	0113 254 0711								●		D/I		
Lindapter International	01274 521444									●	M		
MSW UK Ltd	0115 946 2316	●									D/I		
Murray Plate Group Ltd	0161 866 0266								●		D/I		
National Tube Stockholders Ltd	01845 577440								●		D/I		
Peddinghaus Corporation UK Ltd	01952 200377					●					N/A		
PPG Performance Coatings UK Ltd	01773 814520						●				N/A		
Prodeck-Fixing Ltd	01278 780586	●									D/I		
Rainham Steel Co Ltd	01708 522311								●		D/I		
Sherwin-Williams Protective & Marine Coatings	01204 521771						●				M	●	
Sika Ltd	01707 384444						●				M		
Simpson Strong-Tie	01827 255600									●	M		
Structural Metal Decks Ltd	01202 718898	●									M	●	
StruMIS Ltd	01332 545800		●								N/A		
Tata Steel Distribution UK & Ireland	01902 484000								●		D/I		
Tata Steel Ireland Service Centre	028 9266 0747								●		D/I		
Tata Steel Service Centre Dublin	00 353 1 405 0300								●		D/I		
Tata Steel Tubes	01536 402121				●						M		
Tata Steel UK Panels & Profiles	0845 3088330	●									M		
Tension Control Bolts Ltd	01948 667700						●			●	M		
Trimble Solutions (UK) Ltd	0113 887 9790		●								N/A		
voestalpine Metsec plc	0121 601 6000	●									M	●	
Wedge Group Galvanizing Ltd	01909 486384						●				N/A		
Yamazaki Mazak UK Ltd	01905 755755					●					N/A		

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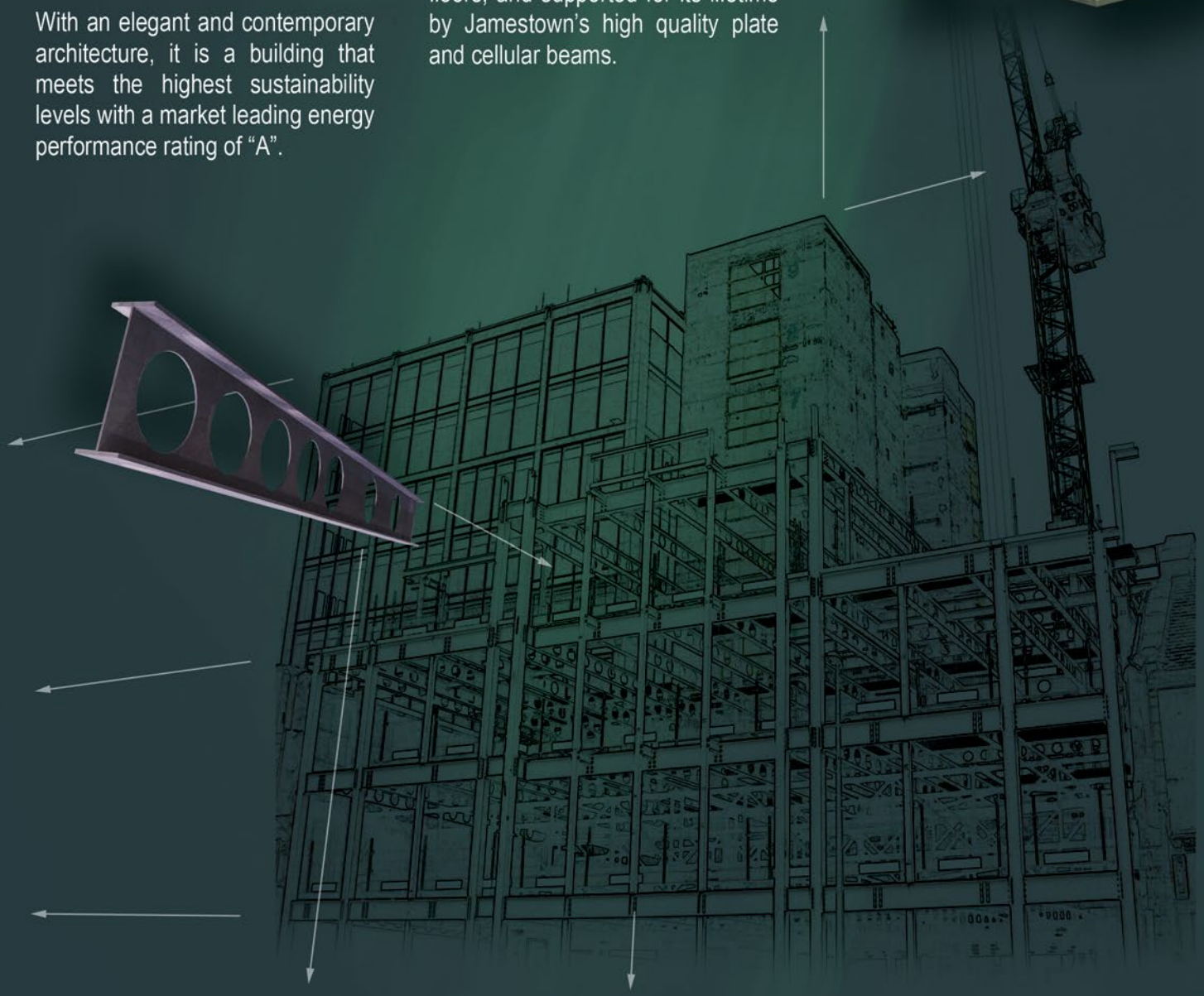

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