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NSC

STRUCTURAL STEEL DESIGN AWARDS 2017

October 2017 Vol 25 No 9

Cover Image
The Leadenhall Building, London
Architect: Rogers Stirk Harbour + Partners
Structural engineer: Ove Arup & Partners Ltd
Steelwork contractor: Severfield
Main contractor: Laing O'Rourke
Client: C C Land
Photo: © Thomas Graham/Arup

NSC
October 2017
Vol 25 No 9

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

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Steel shows collaboration benefits

Nick Barrett - Editor

The London commercial market and the demand for large sheds might have peaked for the moment but the quality of design and construction using steelwork continues to grow, as this year's crop of SSDA winners shows.

One thing that makes the SSDA unique is that the judges actually visit all of the shortlisted projects, which means that they get to meet the construction teams. One of the elements that the judges singled out for mention this year is the high level of collaboration they observed between the members of the construction teams involved, which is good to hear when collaborative working has become such a strong theme in efforts to improve construction industry performance.

Is collaboration made any easier by using steel? There is a good case to be made for saying so. One of the best tools for enhancing collaboration is Building Information Modelling, and steel construction was already BIM-ready when its use became mandatory for public sector projects. The steel sector has long been well used to working this way and collaboration is second nature to steelwork contractors.

Some of this year's SSDA Award winning projects could hardly have been achieved at all without a high level of successful collaboration. The 224 metre high Leadenhall Building for example is a complex structure where stability is provided by a perimeter based steel mega-frame on the outside of the building. Close and creative collaborative working between architects and engineers was essential to its success.

Similarly with the innovative T-Pylon that will gradually replace older designs of lattice towers carrying Nationalgrid power supplies. The new design has been hailed as a steelwork design classic. Producing such an aesthetically pleasing, functional, cost-efficient, innovative pylon drew on the combined skills of the entire design and construction team.

Collaboration between specialists conducting lab tests to determine how historic steel could be married to new steelwork for the retained façade of a Leicester Square office building project, and designers of the new structure, led to a trouble-free on-site welding process to create what is said to be Europe's largest retained façade.

Also in London, redevelopment of Selfridges store on Oxford Street involved collaboration with the store's staff as it had to be kept operational while works including installation of a 50m-long, 165t steel-framed bridge structure took place.

High team spirit was commented on at Scotland's new world-class Sports Performance Centre in Edinburgh. Collaboration between the main contractor and steelwork contractor particularly led to realisation that some concrete piers would be better brought within the steelwork package, delivering programme and cost benefits.

Similar comments could be made about all of the diverse projects awarded Commendations or Merits.

More collaborative ways of working are surely the way ahead for the construction industry, and this year's SSDA clearly shows that the steelwork sector is already performing.

PROJECT OF THE YEAR

The Leadenhall Building, London

AWARDS

The Leadenhall Building, London

T-Pylon

LSQ London

HGV Egress Ramp, Selfridges, London

Oriam, Heriot-Watt University, Edinburgh

COMMENDATIONS

The Curve, Slough

West Croydon Bus Station

Central Square, Leeds

STIHL Treetop Walkway, Westonbirt, the National Arboretum

The Hurlingham Club Raquet Centre

Watermark Westquay Footbridge, Southampton

MERITS

A400M MRO Facility, RAF Brize Norton

Wellcome Collection Dynamic Stair, London

Market Place Shopping Centre, Bolton

Waterford Fire Station

Layered Gallery, London

Maxwell Centre, Cambridge

STRUCTURAL STEEL DESIGN AWARDS 2017

Steel sector's professionalism highlighted at Awards

Five projects were Award winners, with one also picking up the first ever Project of the Year accolade, at this year's Structural Steel Design Awards (SSDA) held at the Museum of London.

The five winning projects at the 49th annual SSDA were The Leadenhall Building, London; T-Pylon; LSQ London; HGV Egress Ramp, Selfridges, London; and Oriam, Heriot-Watt University, Edinburgh.

The Leadenhall Building also won the Project of the Year, a new award category recognising outstanding achievement and design in steel construction.

From an initial shortlist of 17 projects, all of this year's entries scored highly in sustainability, cost-effectiveness, efficiency and innovation, with six schemes getting Commendations and six collecting Merits.

Chairman of the Judges, David Lazenby CBE said: "Once again we've had a high number of entries to the Award scheme, slightly more than last year, characterised by a high standard of quality and efficiency. The results are genuinely impressive, and demonstrate resilience and responsiveness.

"From the largest Goliath to the smallest speciality, the challenges faced by each team are similarly demanding. Indeed, we have been particularly impressed with the purposeful and close team collaboration which has been demonstrated in so many of the projects. Perhaps this is the outstanding characteristic this year, underlining its importance in achieving success."

British Constructional Steelwork Association President Tim Outteridge said: "The quality of the projects on display underlines the UK's world leading position in steel design and construction. And, of course, all of the project teams here tonight have used their own skills and expertise to get the best out of steel.

"This expertise shines through the entire shortlist, and I would like to congratulate every one of you for your outstanding achievements.

"The consumption of structural steelwork in the UK, which rose by 4% last year, is of course closely aligned to the fortunes of the UK's construction sector.

"We all know that this year is proving to be somewhat more challenging due to political and Brexit uncertainty. We've seen the London offices market peak for the time being and it looks like the market for mega sheds has slowed a little as well.

"On the other hand, the government's continued support for infrastructure delivery provides me with confidence for the forthcoming years and as it will provide an offsetting effect to any uncertainty."

Chairman of the Judges, David Lazenby

BCSA President, Tim Outteridge

The team display the first ever Project of the Year Award for The Leadenhall Building, London

The Award winning teams

The Leadenhall Building, London

T-Pylon

LSQ London

HGV Egress Ramp, Selfridges, London

Oriam, Heriot-Watt University, Edinburgh

NEWS IN BRIEF

Updated versions of **Tekla** Structures, Tekla Structural Designer and Tekla Tedds are now all available for download via the company's link: *download.tekla.com*

Kloeckner Metals UK, one of the largest mill independent multi-metal stockholder and distributors in the UK has launched a new online shop. The company said that the launch heralds the start of a new era, as it is implementing a wide range of digital solutions. The new online shop follows the launch of the order overview tool and contract platform, two digital solutions the company introduced at the beginning of this year.

Software provider **Strumis** said it has continued a strong start to 2017 with the latest release of BIMReview V8.3, which focuses on the standalone application functionality.

Severfield has announced that its own registered charitable incorporated organisation (the Foundation), set up during the Spring of 2016, has raised £55,000 in its first year. The amount will be split between partner charity Prostate Cancer UK and a selection of other charities local to Severfield sites.

Rushden Lakes retail and leisure destination in Northamptonshire has opened to the public. It is located at the gateway to the Nene Wetlands nature reserve; one square mile of wild and man-made habitats, managed for wildlife and people by The Wildlife Trust for Bedfordshire, Cambridgeshire and Northamptonshire. Working on behalf of main contractor Winvic Construction, Caunton Engineering fabricated, supplied and erected some 2,000t of steel for the project.

NSC would like to point out the tension rods connecting the balconies on the Highpoint project, featured in last month's issue, were in fact supplied by **Daver Steels**, and not Macalloy as stated.

PRESIDENT'S COLUMN

Ever had a late payment? I'm sure we all have at some point.

So why is this happening? According to CN100, the UK's top 10 contractors shared a combined turnover of £32bn while managing to turn in a pre-tax loss of £52.9m. With too many problem jobs and low industry margins leading to losses like this, main contractors are desperate to hold onto their sub-contractors' cash.

And while not condoning late payment in any shape or form, it's no surprise that payments to sub-contractors are disturbingly slow. I actually believe that government reporting on late payment, is fundamentally flawed as when there are variations to the contract, as there invariably are, getting a reasonable valuation agreed for such extra work can take months. This means that any resulting payment, even if made months after the work is done, isn't "late" until it is certified by the contractor as due and the contractual final date for payment has passed. It's a bit like an iceberg – difficult to see and outside the reporting mechanisms – for the time being. Other contractors offer reverse factoring schemes, which I believe pose a huge risk to the industry as they're complicated, costly and largely unregulated.

It's SMEs that are bearing the brunt of the main contractor losses with 15% of their turnover tied up in late payments. Crossflows' recent survey put this number for the sector at an estimated £22.6bn. That's an enormous amount that could be used to invest in new plant and equipment, hire new staff and apprentices, and even deliver much needed R&D which would drive innovation and cost saving, something our customers are pressing us to do.

I can't believe that Whitehall is saying contractors are making too much money and Lord Adonis has dismissed fears over low margins. Something has to give, and at the moment sub-contractors are the losers.

The industry needs to change and I'm pleased to see that CN is picking up the issue. Maybe times are changing; or have we heard it all before?

Tim Outteridge
BCSA President & Sales Director Cleveland Bridge

Brittle fracture guide available

Commissioned and funded by the British Constructional Steelwork Association and Steel for Life, a new Steel Construction Institute (SCI) guide (P419) Brittle fracture: selection of steel sub-grade to BS EN 1993-1-10, as featured in last month's technical article, has been added to *www.steelconstruction.info* - the free encyclopedia for UK steel construction information.

Selection of steel sub-grade is an important responsibility for all steel designers, in order to manage the risk of brittle fracture. The design rules in the Eurocode were developed for structures subject to fatigue such as bridges and crane supporting structures, and it is acknowledged that their use for buildings where fatigue plays a minor role is extremely safe-sided.

This new publication presents modified steel thickness limits which may be used in buildings where fatigue is not a design consideration. These new limits have been derived using the same approach behind the Eurocode design rules, but crucially reduce the crack growth due to fatigue.

The word "reduce" is used, since to assume no growth at all would be to eliminate the effect of fatigue altogether. According to the SCI it was decided that some fatigue should be allowed for even though for the structures within the intended scope, fatigue would not be a design consideration. Based on indicative guidance from a DIN Standard, 20,000 cycles were chosen.

The term "quasi-static" would cover such structures – in reality that there may be some limited cycling of load, but that would not normally be considered – the design approach is to consider all loads as static.

The key to the new approach is the formula to express the crack growth under 20,000 cycles. Experts at the University of Aachen (who were involved with the development of the Eurocode) provided this all-important expression.

Steel up for new Lydd coastguard base

The final 38.5m-long steel truss has been lifted into place to form the roof of the new hangar at Lydd Airport's Search and Rescue (SAR) base.

The hangar at the Kent airport is the final new build base constructed for the UK SAR helicopter service, which is operated by Bristows Helicopters on behalf of HM Coastguard.

Two state-of-the-art helicopters will be housed inside the new hangar, which was erected by steelwork contractor BHC. The company has previously worked on five other UK SAR bases around the UK.

There are 10 coastguard bases distributed strategically around the UK, providing vital life-saving support - on and offshore - to the fishing and other marine industries, as well as to land-based incidents including mountain rescue, missing persons and other medical emergencies.

Each base is staffed by a group of dedicated pilots and specialist winchman paramedics, winch operators, engineers, and support staff, many of whom transferred to the new Coastguard SAR service from the former military operation.

The Lydd base is due to be completed in February 2018.

Work starts on sports outlet

Main contractor ISG and steelwork contractor Walter Watson have started work on a circa £5M contract with Sports Direct to deliver its first new build outlet in Scotland.

Designed specifically to house the company's leading retail fascias under one roof, including Sports Direct, Flannels, USC and an Everlast Fitness Club, the new development is located close to Glasgow Fort shopping destination.

The scheme comprises the refurbishment and reconfiguration of a former retail unit adjacent to an existing Morrisons store on Auchinlea Way, along with the construction of a three-storey steel-framed extension, totalling over 16,700m² of retail space.

The design for the new unit includes a gullwing roof structure, extensive glazing and cladding panels, including distinctive coloured mosaic feature panels to the façade.

ISG will complete the construction of the new outlet towards the end of the year, with the store fit out due to commence in early 2018.

BCSA gives IStructE exam help

Help is at hand for engineers taking the Institution of Structural Engineers (IStructE) exam, as the British Constructional Steelwork Association (BCSA) and Steel for Life have commissioned the Steel Construction Institute (SCI) to deliver a series of model answers that present steel solutions for selected questions from previous membership examinations.

Each model answer is contained within a stand-alone publication that includes: a summary of the question; the development of the required solutions; the design calculations for the principal structural elements, along with a commentary and drawings, such as general arrangement plans, sections and elevations.

Other required documentation such as method statements, construction programmes and client letters are also included in the model answers.

SCI Associate Director David Brown said: "The membership exam is a considerable challenge, so these model answers should be a real help in demonstrating typical steel solutions.

"The commentary to the calculations should also assist with identifying the assumptions needed to simplify the design, which is important in the limited time available. Engineers can review the model answer, including the geotechnical aspects, method statement and client letter as part of their preparations for the examination."

Candidates for the IStructE exam must demonstrate the validity of the training and experience they have acquired. Examiners must be satisfied that the candidate has conveyed an understanding of structural engineering principles, an ability to initiate and communicate structural design and provide an effective solution to a structural design problem.

The model answer series is intended to assist candidates preparing for the IStructE chartered membership examination. The first model answer to Question 1 from 2013, which was for a factory and adjoining office/storage building, is now available at: *http://www.steelconstruction.info/Continuing_Professional_Development#Model_answers_to_IStructE_exam*

Steel erection starts on Edinburgh World Heritage Site

Forming 84 new residences, steel erection work has begun on the CALA Homes project set within the grounds of the historic Donaldson's College in Edinburgh.

Working on behalf of main contractor BAM Construction, Hescott Engineering is fabricating, supplying and erecting steelwork, as well as installing precast planks and stairs.

The entire development, worth more than £90M, is said to be among the most ambitious projects ever undertaken by CALA.

The site was vacated some years ago and the project will bring to life one of the most important sites in Scotland.

The scheme includes the construction of a sweeping curve of 84 steel-framed, glass-fronted, contemporary residences set within one of the Scottish capital's most iconic locations. The new build terrace will be similar in form and height to many of the famous Georgian terraces in the city.

The works also include the renovation and conversion of the adjacent A-Listed Playfair building into apartments.

David McGrath, Managing Director of CALA Homes (East) said: "This has been a major focus of ours for the past few years and we fully understand the responsibilities of developing within the World Heritage Site."

Bruce Dickson, Regional Director of BAM Construction, said: "CALA Homes is recognised as the pre-eminent developer of upmarket homes in Scotland.

"We are thrilled to be involved in such an ambitious project here at The Crescent. CALA Homes have brought BAM on board for our expertise in delivering major complex construction projects.

Roof up on Kings Cross Coal Drops retail destination

Severfield has completed the steel erection for the Coal Drops Yard retail destination, located in the heart of the Kings Cross redevelopment scheme.

The Coal Drops consist of two long brick and cast iron Victorian buildings, once used to carry four high-level railway tracks from which wagons dropped coal into storage hoppers below.

The buildings, known as East Coal Drops and West Coal Drops, are approximately 150m and 120m-long respectively, and sit side-by-side while splaying outwards in a southerly direction.

As part of the programme to convert these buildings into a world-class retail destination, a steel-framed roof structure has been erected between the two buildings at the northern end where the gap between the structures narrows to about 30m-wide.

The roof structure is approximately 75m-long on one side and 65m-long on the other. It curves inwards, from the south and north ends, and then rises up in the middle to a maximum height of 25m.

Two 'ribbon' trusses, sat atop of each building, help form the undulating shape of the roof structure.

The trusses were fabricated from 610mm CHS members with 508mm CHS verticals and bracings made from 219mm CHS sections.

Tubular sections were used as the geometry of the trusses is so complex no other steelwork sections would have worked without a considerable amount of extra fabrication.

The Coal Drops Yard is scheduled to open towards the end of 2018.

Diary

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

Tuesday 17 October 2017
Acoustics
An introduction to the acoustic performance of steel-framed buildings. Background on sound and implications for acoustic detailing, regulations and requirements, difference for walls and floors, detailing for integration of structural elements, performance prediction tools and case studies. Webinar.
Repeated on Wednesday 18 October 2017

Thursday 2 November 2017
Steel Building Design to EC3
The course focuses on orthodox construction, covering the primary design issues for practicing engineers. Sheffield.

Tuesday 7 November 2017
Curved Steel
Webinar presented by David Brown
Repeated on Wednesday 8 November 2017

Tuesday 14 November 2017
SCI Annual Event - Steel Construction Opportunities and Needs
Speakers will look at some of the developments that could become of growing relevance over the coming decade, including new forms of construction, solutions to minimise the use of new materials and maximise the benefits offered by steel, and the appearance of a second generation of Eurocodes. Royal College of Phsyicians, Regents Park, London.

An introduction to cellular beams

Beams with web openings, commonly known as 'cellular beams', are extremely popular and versatile structural steel components.

Cellular beams are often used to facilitate long spans resulting in flexible, column-free internal spaces, reduced substructure costs and shorter steel erection times. They can be made from rolled steel sections or fabricated from steel plate. In this article, NSC will provide an overview of these components; the types available, how they are produced, and the key benefits they provide in terms of service integration.

Rolled beams with web openings

Reserve capacity exists over much of the length of a rolled steel section such as a UB or UC and this permits rectangular or circular openings to be cut in the web, provided these openings are located away from the supports, to allow services to pass through the beam.

Relatively large openings can usually be provided without the need for strengthening with horizontal stiffeners, provided that there is adequate shear resistance in the remaining web. Circular openings are more efficient structurally than rectangular openings. If larger service zones are necessary, more costly 'stiffened' rectangular openings are required. Opening sizes and positions can be tailored to meet the specific requirements of a particular service distribution strategy.

Cellular beams fabricated from rolled steel sections

Cellular beams can be fabricated from rolled UB or UC steel sections. They are produced by cutting rolled steel sections longitudinally and re-welding them to create deeper beams with a series of circular holes. The sections are structurally efficient and relatively large openings can be created through which services can be passed. The production process allows the sections to be pre-cambered during production.

Cellular beams are more suitable for use as long span secondary beams than for primary beams, as the shear capacity of the web is considerably weakened by the openings. However, they can be designed for use as primary members by strengthening the openings where shear forces are very high, either by infilling the openings or by using horizontal stiffeners.

For cellular beams of this type, the opening diameter is typically 0.6 to 0.8 times the final beam depth and the centre-centre spacing is typically 1.5 times the opening diameter. Where shear forces are low, the openings may be elongated by removing the 'web post' separating two adjacent openings. For composite beam design, the top Tee or flange may be significantly reduced in size relative to the bottom Tee or flange to maximise structural efficiency.

Cellular beams fabricated from steel plate

Cellular beams are also commonly fabricated from plate. In these plate girder type sections the flange and web sizes, thicknesses and overall depth can be selected to be the most efficient for the applied loading, form of construction and opening requirements. The fabrication process using automated equipment suits the production of both cellular beams/ plate girders with a series of regular openings, and beams with bespoke openings in terms of size, shape and position.

Fabricated beams/ plate girders provide an efficient solution for both long span secondary cellular beams and more heavily loaded primary beams, as the web thickness can be increased relatively easily. Again, for composite construction the top flange may be significantly reduced in size relative to the bottom flange to maximise structural efficiency. The web plate can be profile-cut with a pre-determined camber prior to welding to suit any eventual pre-camber requirements.

The ability to shape the web plate prior to welding the three components into a beam configuration also means that beams with holes need not be of a constant depth, opening up all sorts of architectural possibilities with haunched or tapered girders.

Cellular beams, be they fabricated from either rolled sections or plate, are used where a high degree of flexibility in service routing is required and this form of construction has become the most common way of designing for long spans of 13 to 18m typically. The most appropriate solution to adopt can often depend on the size, shape and regularity of the openings required.

The benefit of service integration

Distributing services within the structural zone through the use of beams with web openings leads to economies in the construction by reducing the floor-to-floor height, which has a double benefit of reducing the external cladding required and also reducing heat loss through the envelope. In multi-storey buildings, service integration can allow extra floors to be provided within the same overall building height and careful layout of the structural elements can lead to flexibility in service distribution and ease of future maintenance.

"The use of all types of cellular and fabricated beams has increased dramatically in recent decades as the number of suppliers with the capability, capacity and resources to competitively offer excellent options for such products has increased. This means it is now easy and cost-effective for steelwork contractors to offer this popular solution on their projects." Jamestown's Managing Director Fiacre Creegan.

Structural Steel Design Awards 2017

Pictured: T-Pylon

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 organisation 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 a 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 was a member of BCSA's Council from 1994 to 2017.

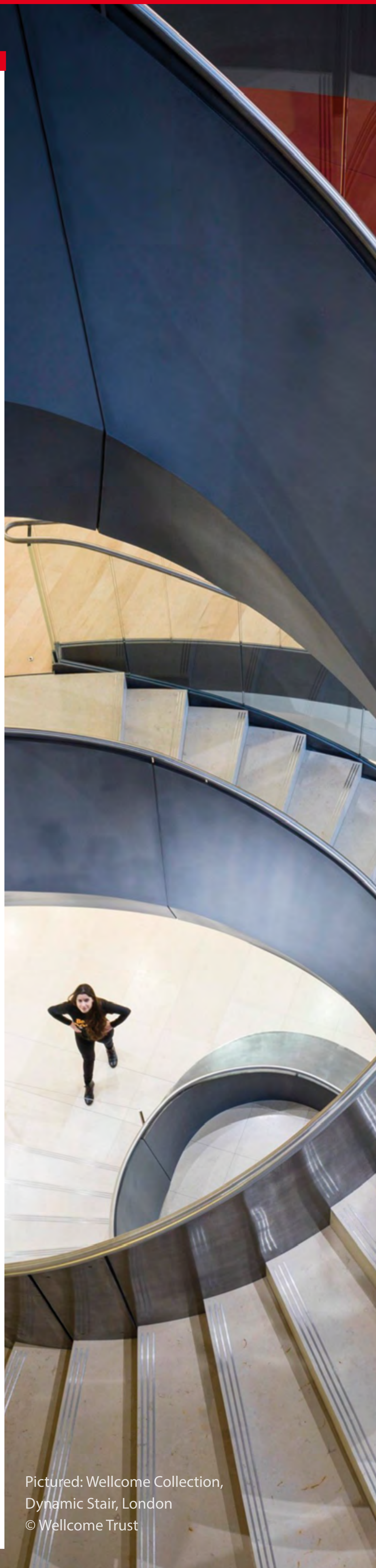
Roger Plank is a structural engineer and, having recently retired as Professor of Architecture and Structural Engineering at the University of Sheffield, is currently a director of Vulcan Solutions Ltd offering software and consultancy services in fire engineering. He has collaborated extensively with 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 50-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. In 2011, together with Robin Snell, they formed Robin Snell and Partners and continue in practice from their London studio. 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: Wellcome Collection, Dynamic Stair, London
© Wellcome Trust

Introduction

by David W. Lazenby CBE - Chairman of the Judges

Once again, an increase in the number of entries to the Award scheme is accompanied by a high standard of quality and effectiveness. The results are genuinely impressive and demonstrate the resilience and responsiveness of our structural steelwork industry.

With a geographical spread across UK and Eire, we have a broad range of project types. From massive offices and commercial premises, including challenging refurbishments; through military, sporting and cultural projects; some unusual bridges; and the "little gems" which so delight us every year.

The judges have visited all the shortlisted projects, and we remain convinced that this is absolutely essential in making informed and realistic judgements.

We have appreciated the opportunity to meet the teams, including many of the clients, and we have found their enthusiasm and dedication to be really infectious. From the largest Goliath to the smallest speciality the challenges faced by each team are similarly demanding. Indeed we have been particularly impressed with the purposeful and close team collaboration which has been demonstrated in so many of the projects. Perhaps this is the outstanding characteristic this year

Overall, the industry should be proud of the results, and I hope that they will inspire us all.

David Lazenby

PROJECT OF THE YEAR

The Leadenhall Building, London

Reaching a height of 224m, the City of London's landmark Leadenhall Building was designed as a wedge-shaped structure to minimise its impact on views of St Paul's Cathedral.

Photos on this spread © Paul Carstairs/Arup

Commonly referred to as the Cheesegrater, The Leadenhall Building was designed as a wedge-shaped structure in order to meet the client's aspiration for an outstanding City of London landmark tower

Part of its unique design are the panoramic lifts which have been placed on the vertical north elevation, so they can serve all the office levels. As a result, there is no central core, and stability is provided by a perimeter braced steel mega-frame, placed outside of the building envelope.

"The use of steel is fundamental to the value of this building. It is visibly integrated into the architecture to an extent that is highly unusual for a skyscraper, creating a powerful tectonic quality which enables people to appreciate and take delight in the way that the building is constructed," says Arup Director Nigel Annereau.

"Steel was chosen because of its high strength-to-weight ratio and tension capacity, making it the obvious choice for a tall braced structure. A concrete alternative would have been much bulkier, more complicated and slower to construct.

"Steel also offered the ability to create large column-free spaces both in the typical floors and at ground level. Transparency was maximised by integrating the steelwork with the cladding."

The steel design is said to allow the floors to be exceptionally open, with views in every direction and spans of up to 16m. There are no more than six internal columns within floor plates of up to 43m × 48m.

The architectural vision for the building was for it to express its engineering systems wherever possible. According to Arup, this significant challenge demanded a holistic and creative approach, with the engineers and architects working closely together from the outset.

The most striking example of this is in the mega-frame bracing system. It is formed with vertical columns, positioned where they are most needed, on the east, west and north faces, and a diagrid structure on the more lightly-loaded south face.

Connections are made through a family of separate fabricated node pieces. This ensures that the complex geometrical relationships between members are always resolved within welded joints and the site connections remain simple and standardised.

The shapes of the members are tailored to the requirements of the connections. A small number of large diameter pre-loaded studs are employed for strength and speed of construction.

At the bottom of the building, floors are cut away and hang from the levels above, forming a large open space known as the galleria.

Within this space, floor beams are exposed, enhancing the structure's character. At level five these beams project beyond the mega-frame to form a canopy over Leadenhall Street. The levels below are suspended via hangers whose bespoke end connections provide a seamless transition between the rods and the supporting steel beams.

The mega-frame columns and braces around the galleria are unrestrained over a height of 28m. Standard mega-frame sections have been subtly adapted, with tapering webs and additional stiffening plates, to significantly increase their buckling resistance without undermining the node connection principles or aesthetic proportions.

Steelwork is corrosion protected and fire protected where required. In wet external areas, epoxy intumescent coatings are employed for durability, and great care was taken to ensure a neat finish. Cast intumescent caps were placed over the ends of the mega-frame fasteners to preserve the 'nuts and bolts' aesthetic.

Main contractor Laing O'Rourke pushed for as much of the structure to be prefabricated as possible. Consequently, 80% of the building was constructed offsite, reducing waste and improving quality, safety and programme.

Explaining the project's prefabrication ethos, Severfield Operations Director Alex Harper says: "The nodes were delivered to site as complete pieces and then bolted into place, this was made complex by the massive scale of the components and the bolts together with the difficult access. However, using large prefabricated pieces with bolted splices was a quick and efficient method."

The primary steel system within the north core was built as a series of storey-high tables, with the services and concrete floor slabs pre-attached to them, minimising the number of crane lifts required.

The building was predicted to move sideways to the north during construction. An innovative approach was deployed to counter this, known as 'active alignment'. The structure was initially erected straight, and movements regularly monitored. At a later point, adjustments were made to the mega-frame diagonals which pulled the building back sideways, reversing the gravity sway. This allowed the mega-frame nodes to be fabricated with a simple orthogonal geometry and improved the overall accuracy of construction.

Arup says that architecturally exposed steelwork is featured to a degree that is very rarely seen in office buildings. Systems are presented honestly and legibly, contributing to a public delight in the construction process. Through a collaborative spirit and an open-minded approach, the design team overcame significant technical challenges and met demanding aesthetic standards.

Summing up, the judges say this project had a committed client, architectural and engineering excellence, fabrication precision and construction ingenuity and innovation. They all combined to make a project whose achievements are even greater than the sum of the parts.

Structural steel is rigorously controlled to generate an architecture that is clear and legible throughout the building. Like most ground-breaking projects there were lessons to be learned, but the client and the team persevered to achieve final success.

This world-class project is an exemplar for large commercial buildings.

FACT FILE
Architect: Rogers Stirk Harbour + Partners
Structural engineer: Ove Arup & Partners Ltd
Steelwork contractor: Severfield
Main contractor: Laing O'Rourke
Client: C C Land

T-Pylon

The result of a design competition to find a 21st Century power pylon for Nationalgrid UK, the T-Pylon has very few parts, can be erected quickly and requires virtually no maintenance.

The T-Pylon was a design competition winner in 2011 and has been designed to carry 2 × 400kV, but can be modified to alternative specifications.

The competition was a response to a global wave of public opposition towards conventional lattice towers, to find an alternative that would be a visual improvement to current solutions as well as cost-efficient and functionally superior. The idea was that the new design would also signal the transition into renewables.

The T-Pylon is made from steel, which has allowed for unique geometries. Contrary to conventional lattice tower designs, the arms of the T-Pylon are slightly raised, which give the pylon a more optimistic and positive appearance. The few parts making up the pylon have been welded together and subsequently painted white.

The tower design is shorter and leaner than traditional lattice towers for better aesthetics, less environmental impact, and a shorter installation process.

Nationalgrid former Executive Director Nick Winser says:

"In the T-Pylon we have a design that has the potential to be a real improvement on the steel lattice tower. It's shorter, lighter and the simplicity of the design means it would fit into the landscape more easily. In addition, the design of the electrical components is genuinely innovative and exciting."

The use of steel and the alternative design has made it possible to obtain the aesthetic and functional goal: to minimise the visual impact on the surrounding landscape, while also providing a resistant and durable solution.

"The T-Pylon blends better into its surroundings as it is shorter and sleeker than the conventional lattice pylon. The modern design is fit for the 21st Century and beyond," says Bystrup Business Development Manager Mette Mikkelsen.

"The new pylons are made to last for at least 80 years without routine maintenance. At the same time, they have to carry extreme loads from the conductors. Steel has been chosen because of the beneficial material characteristics that provides the most cost-efficient solution.

"By using steelwork, we have been able to optimise the construction according to the required strength. The shaft is produced in several sections in different thicknesses according to the loads. The T-node in the top of the shaft (connection of the arms and shaft) is cast SG iron, transferring the loads from the arms to the shaft and then to the foundation."

The total cost of the structure has also been optimised by using steel mono-piles for foundations. This has increased the speed of the roll-out and decreased the impact on the surroundings and the total cost of installation.

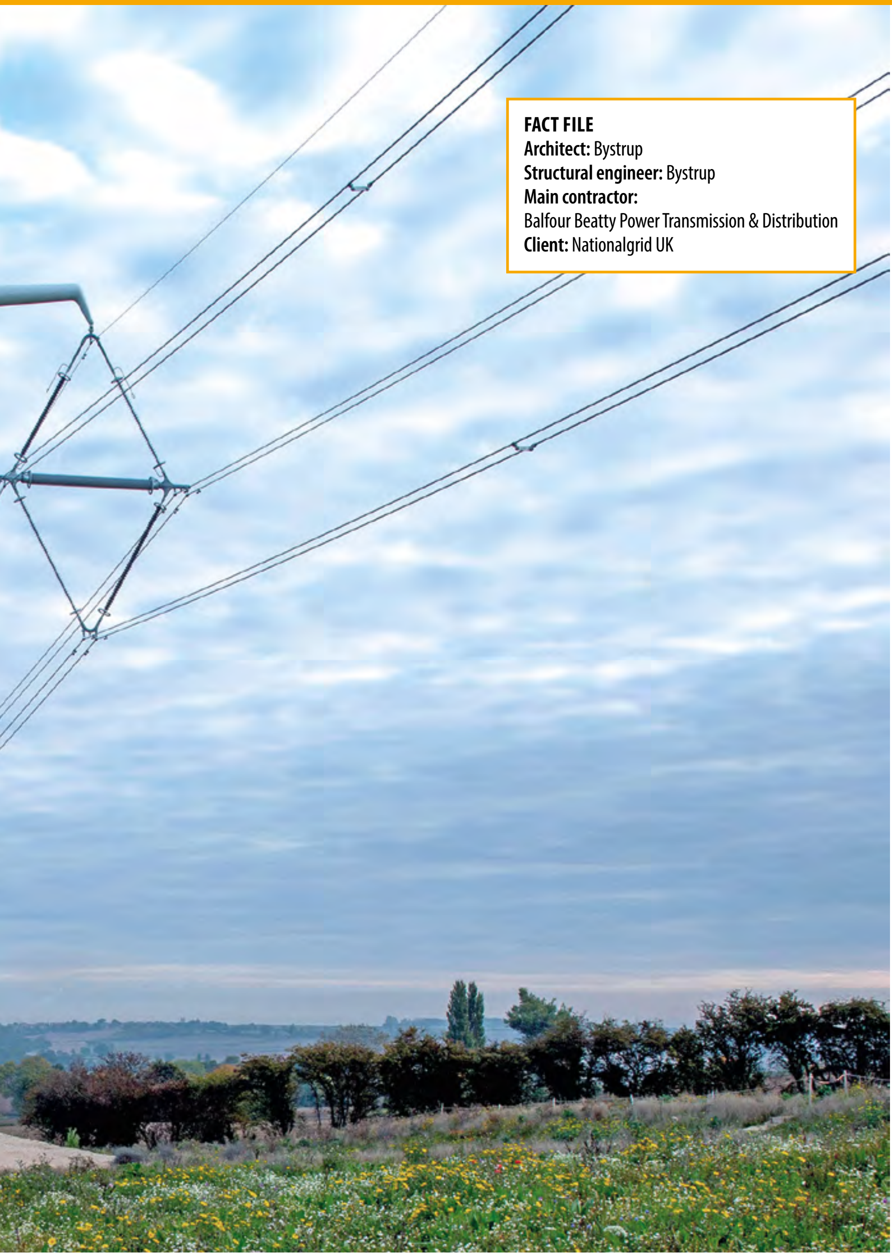
A radical innovation is the reassessment of the conductor/cable arrangement. The prismatic configuration of the cables allows a reduction in the pylon's height by more than 30%. The footprint of the power lines as well as the electro-magnetic field (EMF) radiation is reduced.

All of the conductors are carried by a single attachment point. Traditionally, such a structure would have three separate arms - each carrying an individual conductor.

This unique attachment point was studied closely to ensure its robustness and resistance to fatigue. Complex analysis and physical loading tests were carried out to simulate climatic conditions, such as extreme winds and ice loads. Investigations were made into the dynamic performance of the structure under simulated vibrations.

Dynamic external wind loads experienced on the pylon arms result in a bending moment at the pylon foundation. However, the cast node must withstand the transfer of internal stress from compression and tension at the node due to the pylon arm distributed load case. The cast node should be able to withstand the magnitude and the dynamic behavior of the load case.

"The biggest challenge when designing



FACT FILE
Architect: Bystrup
Structural engineer: Bystrup
Main contractor:
Balfour Beatty Power Transmission & Distribution
Client: Nationalgrid UK

a new power pylon is to develop a design that is visual acceptable, functional and cost-efficient at the same time. The T-Pylon is the result of a process where these factors have been incorporated in one single design," added Ms Mikkelsen.

"A survey has shown that the public prefer the T-Pylon design instead of the lattice tower. At the same time the operator has a long list of technical benefits such as reduced magnetic field, no routine maintenance in 80 years, easy installation, reduced audio noise and maybe the most important result - that the pylon is 22m lower than the traditional lattice tower, while carrying the same energy. The T-Pylon is a feasible solution that can be used for any transmission project in the future."

The design of the pylon's shaft is similar to the design of towers for wind turbines. Consequently, it has been possible for the manufacturer to use the experience from wind turbine towers to produce the shaft using automated processes in controlled factory conditions. This simplifies on-site operations and reduces construction labour as well as environmental impact.

In summary, the judges say the T-Pylon represents a generational step change in power transmission hardware. Analytical design from first principles included re-examination of arrangements for insulation and maintenance.

The result is a family of compact pylons which can be deployed in sensitive landscapes, with prefabrication enabling consistent finish, smaller land take and speedy erection.

This is a steelwork design classic.

LSQ London

Steel-framed retail and office accommodation have been created within what is said to be Europe's largest retained façade.

FACT FILE
Architect: make
Structural engineer: Waterman Structures
Steelwork contractor: Bourne Steel Ltd
Main contractor: Multiplex Construction Europe Ltd
Client: Linseed Assets Ltd

Formerly known as Communications House, LSQ is a 1920s building that overlooks London's famous Leicester Square. Over the past 90 or so years it has been enlarged several times and had become inefficient in terms of maximum utilisation of space.

"Our brief was to create a high-spec office building and we felt that the goal was not just to reimagine but reinvent, while also retaining the look and feel of the original building, which is liked and admired by so many people," says make Lead Architect Frank Filskow.

"Our design makes the best of the existing building by retaining the historic façades, and sensitively restoring them to maintain the integrity of the original architectural features and details.

"The design of the building naturally leant itself to using steel for the primary structural elements. The design of the new steel structure introduced a new central core, and enabled clear, open-plan floorplates, improving the office spaces within the building."

Waterman Structures Director Jody Pearce agrees and says: "One of the key aspects of a façade retention scheme is the alignment of new floors with existing window openings. We promoted the use of a steel frame as it offered the flexibility needed to suit the various interfaces that occur with the existing façade."

"By integrating the suspended services within the structural downstand beam zone, the depth of the floor zone against the façade was minimised, thus assisting the alignment of new floors with existing windows further."

The completed building was erected to the required tolerance of 15mm over the full height, making the project challenging for the engineering and delivery teams. It was however completed on time, to budget and to the client's satisfaction.

The existing building envelope is partially retained with new upper storeys of commercial floor space being provided. The design delivers two basements, two floors of retail space and seven floors of high quality office space with a new entrance on Whitcomb street.

The upper floors are enclosed by a new curved mansard roof. This contemporary roof design is supported by a structural steel-framed central core and new perimeter stanchions. The new office floors are column-free with spans of up to 12m providing what is said to be very efficient floor space.

A new two-storey basement was created by the installation of a secant piled wall inside the retained façade profile. Slimdek floor construction was determined to be the best option for the basement and ground floor slabs in order to maximise headroom in the below ground spaces, while minimising excavation depths.

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The project was designed using Revit 3D modelling techniques to capture the integration and interfaces of both architecture and building services. This assisted the design and construction activities, but also provided full integrated models for future use.

The steel-framed façade dates from the 1920s and 1930s, however some areas were added during the 1960s. The steel columns are all encased in Portland stone and consequently in good condition.

However, steelwork originating from various decades required extensive laboratory tests to determine its make-up and suitability prior to making welded connections.

"We installed a total of 250 brackets that

connect the new steel frame to the retained façade's steel-framed columns," explains Bourne Steel Divisional Manager Kevin Springett.

"The lab tests allowed for a trouble-free on-site welding process and, as we were sure of the existing columns' make-up, it meant works on-site ran smoothly and efficiently," adds Multiplex Project Director Asif Hashmi.

Above the retained façade, the new fifth floor is clad with Portland stone to integrate with the existing building. This floor level's steelwork is topped with a ring beam that goes around the entire perimeter of the building.

The ring beam is formed from jumbo box sections measuring 650mm × 450mm with a 25mm thickness. The sections were brought to site in 3.5m-long sections each weighing 3t. The box section ring beam performs two functions; one is to support the columns for the feature mansard roof as its columns are not aligned with the building's main columns, while the second function is to support the stone cladding for the sixth floor which is hung from the beam.

The steel feature roof slopes outwards from the two centrally positioned cores and is formed with a cranked steel frame, which in turn supports a lightweight aluminium frame and glazing.

This new and elegant curved mansard roof encloses the building and is said to offer a modern interpretation of the traditional mansard style where arch geometry sits atop a classical base.

The judges say the use of structural steel for the new internal structure, including cores, enabled new clear-span floorplates to be achieved, while respecting the existing listed façade. It minimised disruption during construction in London's busiest tourist area.

With its graceful three-storey 'top-knot', the building has a new lease of life as a striking yet respectful landmark in the West End.

This project showcases the role steelwork can play in the extension and re-purposing of historic buildings.

HGV Egress Ramp, Selfridges, London

© Kevin Sainsbury

The creation of a new egress ramp at a famous London department store involved a highly complex piece of engineering design and construction.

In 2012, a masterplan feasibility report was prepared for Selfridges that explored redevelopment opportunities across its store in Oxford Street, London. The aim was to create a unified retail block within the buildings bounded by Oxford Street, Orchard Street, Wigmore Street and Duke Street, something US founder Harry Selfridge wanted when the store originally opened in 1909.

Once work got under way, the first phase included the rearrangement of access to the store loading bays, located in the basement immediately below retail space.

The completed works update access to modern requirements and prepare for a second phase, which will see a dramatic refurbishment of the eastern store frontage, opening onto the new accessories hall when it completes in 2018.

This first phase of the project included major engineering interventions in a highly-constrained site.

"Steel was chosen as it was the most appropriate material for the project due to the site constraints imposed by the confinements of the existing building and compatibility with the existing structure," explains Expedition Engineering Associate Alessandro Maccioni.

"Using steel also allowed the frame to be broken down into elements of a size that could be erected within the tight site."

The Duke Street phase of the project also included forming a new staff entrance into the building below Edwards Mews and realignment of the HGV entrance ramp to the loading bays.

The primary feature of the first phase of works was the insertion of a new 50m-long 165t steel-framed bridge structure, through the existing store, to improve HGV egress from the basement loading bays.

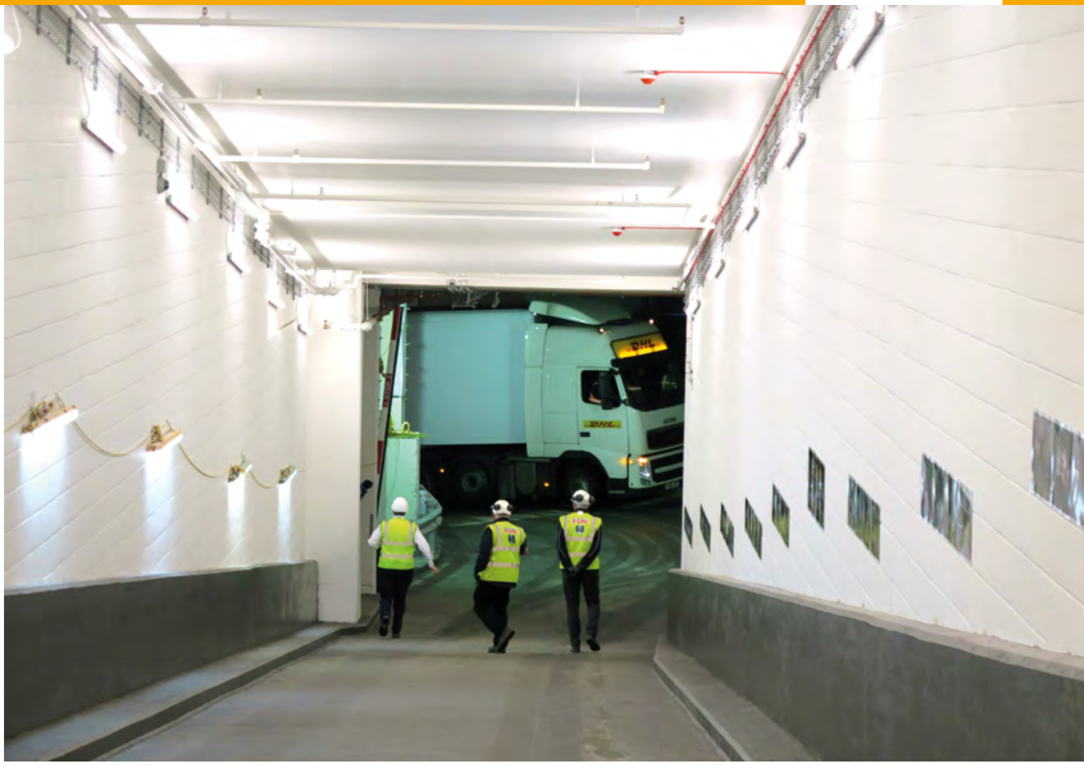
This new structure is a braced steel tube linking the loading bay within the basement to Duke Street.

The structural works were designed to keep the loading bay active throughout the works, while staff access was maintained and retail operations continuous within 1m to 2m of the structural works.

Design and execution of the structural interventions were made more complex by the limited existing building information, and numerous historical alterations that were discovered during the build. All of these required modifications to be made to the new construction as it progressed on site.

To maximise retail space for the client the preferred routing of the egress ramp was tight to the perimeter of the building. This routing allowed the ramp to be partially supported on the existing steel structure, but necessitated the partial removal of three existing columns that then had to be re-

FACT FILE
Architect: Gensler
Structural engineer: Expedition Engineering
Steelwork contractor: William Hare
Main contractors:
Blue Sky Building and SRM JV
Client: Selfridges



©David Lankester

supported on bespoke steel transfer girders integrated into the new ramp structure.

The routing of the ramp meant it would span over an occupied three-storey basement. To minimise disruption to these basement spaces, and to minimise the need for new foundations, support was taken from the existing 1920s steel structure along the northern edge of the ramp.

On the southern edge of the ramp vertical support was limited to two new columns between which a new steel truss would span. The new columns were threaded down through the existing building and supported on new hand dug pad foundations.

To allow the ramp to connect between road level and the loading bay within the basement a large slot was cut into the existing ground floor slab. Diaphragm action of the ground floor slab was maintained in the temporary condition via a temporary propping system until the diaphragm loads could be taken by the new ramp.

Two transfer structures used to re-support the columns above the ramp were deemed to experience vertical deflections exceeding acceptable limits for an occupied building.

To negate the existing structure experiencing these movements, an erection approach that utilised a jacking process was adopted.

This allowed the load from the existing column sections to be transferred into the new transfer structures in advance of the lower column sections being removed.

The jacks were used to push the transfer structures down, realising the anticipated deflections before connections were made to the existing columns. The result of this approach was to limit movements of the existing structure to just a few millimeters, while no noticeable damage to the building's finishes were observed.

These load transfers required very close coordination between the design team and the numerous trade contractors involved, and were carried out overnight when the building was unoccupied.

"A key challenge in the construction of the new ramp structure was the fact that it was to be constructed within a live existing building. Steel was the best and simplest way to achieve this, as keeping the store open and causing minimal impact on Selfridge's retail activities was key," explains Blue Sky Building/Sir Robert McAlpine JV Project Manager Martin Ewing.

As the structure was to support HGV vehicles the steel forming the structure was of a scale that could not be manhandled. The project team therefore developed a series of temporary works that spread the load of a spider crane across the existing suspended basement floor. The crane could then be safely driven into the space via the existing loading bay entrance without back propping through the levels below.

The creation of this new egress ramp within an existing steel structure was highly complex, yet successful. A key challenge for the engineering design and construction was that the work was to be carried out in a live and busy existing building, with ongoing high-end retail operations being immediately adjacent to the work zone, say the judges.

Oriam, Heriot-Watt University, Edinburgh

Scotland's new Sports Performance Centre provides high quality facilities for a number of national sports bodies, including the Scottish Football Association and Scottish Rugby Union.

The Oriam project will provide an arena for grass roots sports development through to high performance training for elite athletes.

It comprises a full size indoor 3G synthetic pitch for football and rugby with spectator seating for 500 people, a nine-court sports hall, a 100-station fitness suite, as well as a high-performance wing that includes areas for hydrotherapy, strength and conditioning, rehabilitation, offices and a classroom.

Designed by Reiach and Hall Architects, the project's key feature is the roof, comprising asymmetric steel arches and clad in tensioned PVC. Its form was inspired by the angle and trajectory of a Roberto Carlos' goal scored against France for Brazil in 1997.

The design has a simple layout with two routes running east to west through the building – a public route to the north and a high-performance route to the south; this allows the two areas to operate autonomously.

Steel arches at 7m centres span over the football hall and sports hall from buttresses on each side onto a central street of piers.

The simplicity of the arrangement masks the technical challenges in realising the form. The football hall roof uses an asymmetric arch profile, following Reiach and Hall's concept for the geometry.

In order to meet the project's budget, Engenuiti worked together with the steelwork contractor to develop a simple and elegant 2D truss design for the arches, which required less prefabrication than a previous design and provided material savings for the project.

The sports hall roof again comprises steel arches on a 7m grid, with straight secondary steel members spanning between the arches and curved tertiary steel members spanning between secondary beams to provide intermediate support for the roof cladding.

Central piers support the ends of the football pitch and sports hall arches, which converge at a single point behind the listed wall in an area known as the street.

Initially these piers were conceived as reinforced concrete elements. However, a review of the material options explored the overall programme advantages of bringing this element within the steel package. Following this review, the steelwork option was selected giving both programme and cost advantages.

The roof structure acts as an umbrella over the public fitness area and high-performance wing, which are both constructed as conventional steel-framed structures.

The roof arch is formed from three curves meeting at tangents and, while this is stable once vertical, it has little structural strength in its minor axis. This meant that building the trusses flat on the ground and then lifting them vertically would require extensive temporary works, which with 13 to lift would have substantially increased the build costs. Building the trusses vertically on the ground was also ruled out due to the height of any temporary frames which would have been required for

FACT FILE
Architect: Reiach and Hall Architects
Structural engineer: Engenuiti
Steelwork contractor: J & D Pierce (Contracts) Ltd
Main contractor: Bowmer & Kirkland
Client: Heriot-Watt University

temporary stability during assembly.

The solution was to utilise the permanent design for the temporary works. Simple stubs were designed to transfer the load from truss to truss with chord ties and then the stubs were matched at each truss. Components could then be connected directly to the previous section; this allowed a full truss to be built in the air.

The challenge was then how to erect the first truss. As this was at a gable the slender gable posts, which were themselves trussed, could be propped first and then roof truss segments landed on top and joined together to form one complete arched truss.

Oriam's steel structures are durable and require little maintenance, extracting maximum value from and minimising its whole-life costs. They can also be re-used or recycled at end of life further enhancing sustainability.

The steel-framed structures and regular column grid arrangement for the office, café and elite sports areas are all adaptable for future changes of use.

As Oriam's steel structures are durable and can be readily adapted, it also improves the economic viability of the centre for modernisation in the future.

Catriona McAllister, Chief Executive Officer of Oriam stated 'Heriot-Watt University, in partnership with the City of Edinburgh Council, worked extensively with Sport Scotland and the partner sports to create a world-class facility that also provides extensive access for the local community.'

'There was a great team spirit amongst everyone involved in the delivery of the project – it was a very exciting process from start to finish. The finished project is something that all of Scotland should be extremely proud of, and the response from everyone who has toured the site since its completion confirms that a truly world-class facility has been delivered. We are absolutely thrilled with it.'

Summing up, the judges say two parallel vaulted forms spring from a central spine; the larger one covers a football pitch, whilst the smaller covers a sports hall. The elegant lightweight steel trusses resulted from a collaborative effort by the designers and contractor, with the construction methodology informing the roof structure and supports from which it springs.

All photos on this spread © Reiach and Hall Architects

The Curve, Slough

A new multi-purpose community venue forms a central element of the larger heart of Slough regeneration project.

© David Butler

FACT FILE
Architect: BBLUR architecture and CZWG architects
Structural engineer: Peter Brett Associates
Steelwork contractor: Caunton Engineering Ltd
Main contractor: Morgan Sindall
Client: Slough Borough Council

The three-level Curve 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 includes a library, café, office space and a 280-seat performance space.

The building's form, a curved 'tube,' features fully-glazed entry façades, and opens onto two new public squares, created at each end of the building.

Constructing a building with this kind of complex shape brings with it a whole host of geometry and setting out challenges. The use of a BIM model, shared between the entire project team, made the design process less onerous.

The steel structure has falls in three directions, bull-nosed perimeters on two edges and cantilever projections on the other two faces. The 3D modelling and early engagement with the cladding contractor made steel the standout solution for this element of the building.

The low weight of the construction compared to a reinforced concrete frame provided significant savings in the deep concrete foundations, whilst reducing material movements off site and speeding up the construction programme.

The geometry of the façade presented particular design challenges.

Detailed three-dimensional modelling allowed efficiencies to be gained in specifying a constant bend radius for the façade members and limiting the supporting tubular transfer beam to three discreet bend radii.

This 45m curved CHS beam was then spliced using carefully detailed non-visible connections. Curved edges to the internal atrium required cantilever decking sections to arrive at site with the bend radii pre-cut.

Staircases both front and back-of-house were formed offsite in steel and installed quickly and prop-free to open up the site to the follow-on trades.

"Our expertise in BIM and 3D modelling using Tekla software has been a great benefit on this project, enabling us to integrate the original architect's model with our own," says Caunton Engineering Contracts Manager, Phil Ratcliffe.

Peter Brett Associates Project Engineer, Mark Way adds: "BIM was the best solution as it allowed everyone to see the same model and this made it possible to detect any possible problems well in advance.

Referring to why structural steelwork was chosen as the project's framing material he adds: "Using steelwork made it much easier to design and form such a challenging shape."

The steel composite frame was largely fabricated offsite and erected with minimal propping or insitu alterations. The offsite nature of the fabrication process that included coating application increased the quality of finished steelwork coating system and meant the application process was not sensitive to weather conditions on-site. During construction, the frame was instantly ready to be used as a support frame for subsequent operations and for the complex cladding package to begin.

The composite steel frame allowed floor depths to be kept within a stringent floor zone, while allowing for the services distribution. The main plant spaces were restricted to a stacked two-storey housing above the main vehicular access road onto the site. The span over the road was achieved with a two-level Vierendeel truss, clad with removable louvred cladding, to allow the plant installation and its future repair/replacement.

The installation of the Vierendeel truss, spanning over the main site access road, was done quickly with minimal closure of the thoroughfare.

The judges say in summary, the Curve provides popular and accessible community facilities. Its striking curved form arose from its proximity to a church and probably could only have been achieved by an integrated team using coordinated BIM design, analysis, fabrication and erection.

Elegant and effective steelwork meets unusual demands.

West Croydon Bus Station

An unsightly, uninviting and poorly functioning 1980s 'shed' has been transformed into a customer friendly landmark that supports the area's regeneration.

The old West Croydon bus station building was said to be an embodiment of poor 1980s design that gave little thought to customer experience or making a positive contribution to the community. Transport for London's (TfL) brief sought to address these issues, on a constricted site and within a constrained budget.

The new building features an open concourse under an elegant weathering steel canopy. The canopy wraps around and connects two small buildings – a retail unit and a bus operations building.

The design also opens up the view from Station Road to the Grade I listed Saint Michael and All Angels Church, and provides a better urban scale.

The design, led by TfL's in-house architects, addressed problems with site constraints, increasingly high footfall and the poor design of the previous station, while also supporting the West Croydon Masterplan. The client regarded the project as an excellent opportunity to demonstrate the difference good architecture and use of concisely detailed steelwork can make.

"The choice of materials was carefully considered to reduce whole life costs. The primary material of the project is weathering steel which is used throughout the canopy structure, in combination with translucent panels, to create a structure requiring minimal ongoing maintenance," says Price & Myers Project Engineer Charlotte Benbow.

Weathering steel was supplied in plate form that was profile cut. The canopy is based around a repeating module where canopy and supporting columns are linked by a curved haunch. This haunch is perforated with variable sized holes to both create interesting visual effects and demonstrate the changing stress intensity across the haunch.

Guttering, downpipes and lighting have all been integrated into the structure to ensure services are not visible nor impact on the final impression of the structure.

All elements are digitally fabricated profiles that integrate with each other to produce a visually seamless and well optimised load path.

The design of the steelwork had to incorporate minimal tolerances for the pre-ordered roof units and the rakes in the roof.

The buildings are highly sustainable and environmentally friendly - with solar panels, air source heat pumps, LED lighting, and building materials that maximise the building's performance. A building management system ensures energy efficiency and reduces light pollution.

The opaque canopy provides natural lighting and manages glare and heat transfer. Night lighting on the canopy creates an attractive and safe environment.

The project introduced soft landscaping and integrated new trees with the canopy. An existing mature London Plane tree was retained during construction and is now enveloped within the canopy. This approach means the station contributes to urban air quality.

Anti-social behaviour was a significant issue at the old bus station. The new improved open layout, architectural lighting, and soft landscaping tackle this issue and create a safer more socially sustainable environment.

Summing up, the judges say high quality design and careful selection of materials, with low maintenance a major objective, are evident in this project. The lightweight canopy is framed in weathering steel, carefully prepared and detailed, to provide visual interest.

This is a facility which has transformed passenger experience and provided a significant contribution to the environment.

FACT FILE
Architect:
Transport for London
Structural engineer:
Price & Myers
Steelwork contractor:
B&W Engineering Services Ltd
Main contractor:
Quinn London Ltd
Client:
Transport for London

© Alex Upton

Central Square, Leeds

FACT FILE
Architect: DLA Design
Structural engineer: WSP
Steelwork contractor: Elland Steel Structures Ltd
Main contractor: Wates Construction
Client: M&G Real Estate

An emblem of the city's ambition, Central Square in Leeds is a landmark development binding together a dynamic business district to create a vibrant new destination for the public and tenants.

Situated within a stone's throw from Leeds railway station, Central Square has risen up on the plot previously earmarked for the Lumiere, a 54-storey tower that would have been the tallest residential building outside of London.

Set in the city's business district, Central Square is a 20,400m² development, providing 18,700m² of Grade 'A' office space with 1,700m² of retail, leisure and health/fitness.

It provides office accommodation on 10 floor levels and these are said to be the largest floorplates available in the city. They have been designed so that they can be subdivided, providing the occupier with both flexible and highly efficient floor space.

"Steel was chosen for the superstructure of Central Square for a number of reasons, but chief among those reasons was the ability to achieve the clear spans that the architect desired, within the main office floorplates, while maintaining a lightweight and efficient structure," says WSP Technical Director Building Structures David Hill.

"This allowed us to minimise the foundations required which, given the congested nature of the ground beneath the site and the presence of numerous existing piles, was extremely beneficial."

The development also offers an outdoor Sky Garden on the ninth floor, providing entertainment opportunities and views across the city.

In addition, a stunning seven-storey, fully glazed atrium houses Central Square's Winter Garden, where a contemporary square offers a mixed-use destination for members of the public throughout the day and evening.

Sitting above a two-level concrete basement, the steel frame forms a U-shaped structure with the central void occupied by the fully-glazed Winter Garden. This feature element has been created by glazing that slopes down from the underside of level eight within this central void.

In total, five 27m-long tubular 'vertical' bowstring trusses, which were delivered to site in two pieces, form this indoor zone.

The heaviest steel assembly on the project was a 43t storey-high Vierendeel truss that supports level eight's balcony that overlooks the Winter Garden.

"The most challenging aspects of the steelwork design for Central Square involved the trusses," says Mr Hill. "The two-storey deep Vierendeel truss spans across the width of the Winter Garden supporting two levels of office space as well as the head of the bowstring truss frames and an external terrace space.

"The truss spans approximately 25m and at one end spans on to a secondary Vierendeel (over three storeys) to achieve the desired spans without the incorporation of any diagonal elements.

The Vierendeel truss comprising heavy UC members was brought to site in individual sections that were then assembled on the ground before being lifted into place by a 300t-capacity mobile crane.

The majority of the steelwork was erected using the site's tower cranes, with Elland Steel Structures employing two erection teams that divided the structure in half and erected the frame three floors at time, while also placing and fixing the metal deck flooring.

The judges say, Central Square is a landmark office and leisure complex within two minutes of Leeds City Station. In this BREEAM 'Outstanding' development, the floors are supported on long-span beams enabling 25,000ft² floorplates, the largest in the city.

The ground and first floors are accessed through a large atrium 'winter garden', forming a new and exciting part of the public realm in the area.

STIHL Treetop Walkway, Westonbirt, the National Arboretum

At 300m-long the walkway is the longest structure of its kind in the UK; set in the beautiful Grade 1 historic Victorian landscape, it provides visitors with a chance to walk through the tree canopy providing a new perspective and stunning views.

FACT FILE
Architect:
Glenn Howells Architects
Structural engineer:
BuroHappold Engineering
Steelwork contractor:
S H Structures Ltd
Main contractor:
Speller Metcalfe
Client:
Forestry Commission, Westonbirt, the National Arboretum

Reaching heights of up to 13m the walkway provides easy level access to all visitors, creating a new way to access Silk Wood, a semi-natural ancient woodland.

The walkway project has a history that goes back nine years when a concept design first came to light following a design competition. However, it was put on hold while the arboretum focused on fundraising and completing Phase One, a new Welcome Building and car park.

After a three-year fundraising campaign by the arboretum's partner charity Friends of Westonbirt Arboretum and a refined design in place, the project was able to start on-site.

"We made a few tweaks to the design, such as changing the walkway support spine from timber to steel," says BuroHappold Project Engineer Joe Darcy.

"Steel was chosen as it is more durable and will give the walkway a longer lifespan, while we also needed a material to give us a stiffer deck to provide lateral stability," adds Westonbirt Arboretum Project Manager Sophie Nash.

"We have used two primary materials to construct the walkway, steel and timber. Steel has been used to support the deck of the walkway, which enabled us to slim down its profile, reducing the visual impact on the landscape. Using steel also allowed us to create gentle, sweeping curves."

The basic structure is a simple arrangement of two perimeter beams supporting the 1.8m wide deck and the balustrades. These beams are formed from curved galvanized steel RHS sections which, with the CHS cross beam, create a laterally stiff structure to transfer loads back to the supports.

A galvanized finish was chosen for all the steel components to achieve the required design life with limited need for ongoing maintenance. Sustainability was also an aspect of the design when it came to the construction. Building the walkway using small assemblies and single elements enabled the size of the construction equipment to be reduced, and the use of bolted connections throughout means that future dismantling will be straightforward.

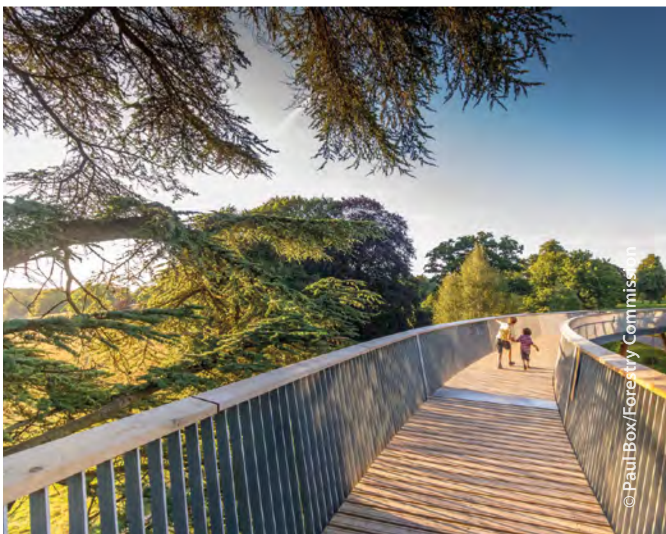
Various support solutions were considered due to the unique constraints of the site. The chosen route of the walkway had to have the minimum impact on the root profile of the surrounding trees and there could also be no direct fixing to any of the trees.

The solution was to use shallow reinforced concrete pads supporting pairs of inclined timber legs at 10.5m centres. The inclined columns provided a more natural feel and allowed the base positions to be easily moved in plan to avoid areas of heavy root coverage.

At four points along the route the walkway widens providing spaces for pausing and interpretation of the surrounding woodland and interesting facts about trees and timber.

The judges say, owing much to the romantic tradition of great English landscapes this sinuous walkway carefully winds through the canopy of ancient working woodland, whilst avoiding the precious root zones. A 'tuneable' structural system addresses the varying dynamics and geometrical restraints.

The curvilinear route, which heightens the sense of drama and discovery, was facilitated by the use of steel. Apparent simplicity conceals sophistication in this project.



The Hurlingham Club Racquet Centre

The Racquet Centre is a new sporting facility set in 42-acres of pastoral landscape at the prestigious Hurlingham Club in Fulham, London.

FACT FILE
Architect:
David Morley Architects
Structural engineer:
Price & Myers
Steelwork contractor:
Tubecon
Main contractor:
ISG
Client:
The Hurlingham Club

The Hurlingham private-members club is recognised throughout the world, and aims to provide modern social and sporting facilities, while retaining a traditional British charm and elegance.

The new state-of-the-art Racquet Centre replaces an existing structure and has been designed to meet high standards of sustainability.

The centre is home to four indoor and two outdoor tennis courts, four squash courts, a multi-use games area (MUGA) and changing facilities. The courts have been designed to meet the international standards of the Lawn Tennis Association and World Squash Federation.

The aspiration was to develop a sustainable, low energy building with a comfortable internal environment. Set in the well-established foliage of Ranleagh Gardens, it was important to keep ecological impact to a minimum, therefore the new site allows for the preservation of existing trees.

The new courts are set into the ground reducing the overall mass of the building. A discreet low-impact insulated barrel vaulted roof with a sedum grass finish is sympathetic with the park setting.

Materials were carefully selected to integrate seamlessly into the surrounding grounds: on the South West façade a glazed green brick is used for the lower level and the curtain walling reduces solar gain and glare using brise soleil, which is mechanised to track the sun.

The external walls of the squash, MUGA and support spaces adopt a garden wall vernacular inspired from the walled features found within the grounds. A green roof helps to attenuate rainwater, protect the building from the sun and promote biodiversity.

This multi-million pound project was awarded to ISG, with Tubecon contracted to provide its expertise in connection design for the complex 38m span steel frame, using curved Vierendeel trusses with integrated timber roof cassettes.

"Steelwork was the natural and most cost-effective material, due to the long spans required by the large 38m × 70m column-free tennis hall," says ISG Regional Engineering Director Tim Sullivan.

A series of tied-arched steel frames, tied with large diameter bespoke tension bars at 16.5m centres, form the primary roof structure.

These purpose-engineered welded box sections were paired together to also act as Vierendeel trusses, which helped distribute horizontal forces back to vertical bracing systems.

Further efficiencies of the arch were gained by portalising the structure and providing raking ties at the roof ends, which help minimise the depth and weight of the box sections.

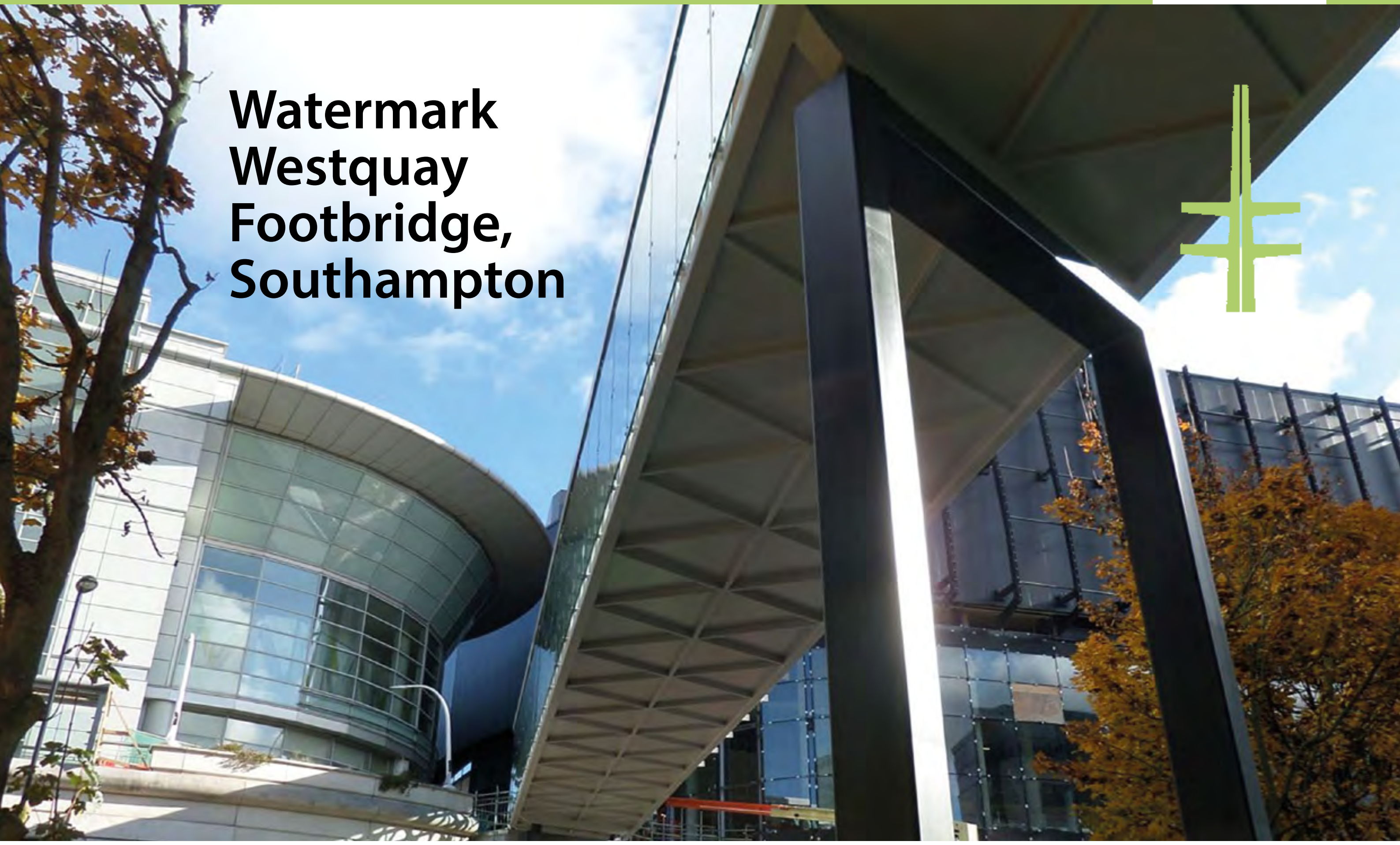
Transfer structures support the vertical load of the arched frames and distribute the residual thrusts, providing resistance to the lateral wind loads that act on the building.

Logistically the project wasn't without challenges. Designed to be transportable, the trusses had to be fabricated in three sections with bolted splices connected on-site using a seating jig. Once connected, a tandem lift with two cranes then lifted the 45t trusses into place.

"The transportation of the fully fabricated Vierendeel third sections to site was particularly challenging as we only had 100mm clearance between the steelwork and the site's brick gate posts," says Tubecon Project Manager Stuart Cree.

In summary, the judges say a detailed, yet compact, building adds generous new indoor play areas, while meeting the requirement for a low profile at the edge of the Club grounds. Steelwork again enables elegance and efficiency in modern sports facilities.

© Metsä Wood



Watermark Westquay Footbridge, Southampton

Spanning a busy road, this landmark footbridge connects the new Watermark retail centre with an existing car park.

Having rejected earlier design options, Sir Robert McAlpine approached S H Structures to work with the team to develop a footbridge of quality and interest within the tight budget available.

A number of potential options were explored before the team arrived at the solution of a box truss structure incorporating a pattern in the side bracing. This provided the attractive combination of structural efficiency together with the opportunity for some architectural expression and a strong visual identity.

Steel was chosen as the preferred material for the bridge superstructure as it provided the opportunity to have a visually and physically lightweight structure that could be quickly erected from prefabricated component parts, minimising the need for temporary works and road closures," says James Packer, Associate at David Dexter Associates.

"The use of a steel box truss for the bridge deck resulted in the most cost-effective approach to both achieving the required spans over the carriageway, and generating a covered internal access route from the car park to the Watermark Westquay retail centre."

The challenge with the overall design was to avoid a heavy over structured appearance to the box truss due to the relatively dense pattern for the sidewall bracing.

The approach taken to avoid this was to employ a modern version of a traditional approach to bridge construction. For the truss sidewall bracing, RHS diagonal bracing elements are used in the idealised compression direction with paired plates lapping these in the idealised tension direction.

Whereas in the past these elements would have been riveted together, in this modern version welds are used. This combination of box sections and plates provides a striking layered visual effect and dynamic views as you move through the bridge.

"The bridge arrived on-site towards the end of our works on this project when programme constraints were at their tightest. The amount of prefabrication that was achievable with steel frame construction, and delivery of the bridge truss in just two parts, proved invaluable in keeping on track and minimising disruption to road traffic, other site works and the day-to-day running of the Westquay shopping centre," says Sir Robert McAlpine Construction Manager Phil Ball.

The challenge with the detailing was to achieve a uniform appearance throughout the length of the bridge. Thicker RHS bracing elements are used at the support locations with subtle local stiffening. Narrow and thick walled chords (200mm × 200mm SHS) provide good punching shear resistance, minimising local stiffening and giving a visually shallow profile.

The horizontal bracing to the box truss' roof and floor is in a similar, but less dense, pattern to the sidewalls and is formed with RHS elements of equal size to the RHS wall bracing.

Various forms of steel frames were considered for the supports but the preferred option was to use 500mm × 250mm RHS steel hoop frames oriented with the shallower profile in the plane of the hoop – this seemed to work best with the overall form.

Hammerson Development Executive Ceara Byrne says: "As the overall client we were looking for a lightweight bridge solution that enabled good visibility of the new Westquay development from the car park, and in terms of design contributed positively to the customer experience upon arrival at the new centre – we are happy that this bridge delivers on both fronts!"

Summing up, the judges say the pedestrian link from parking into the shopping centre was necessarily economical. This latticed box girder bridge does the job without fuss. A simple and economical concept has been beautifully executed.

FACT FILE
Architect: ACME
Structural Engineer: David Dexter Associates
Steelwork contractor: S H Structures Ltd
Main contractor: Sir Robert McAlpine Ltd
Client: Hammerson plc

A400M MRO Facility, RAF Brize Norton

The 22,000m^2, three-bay maintenance hangar at RAF Brize Norton in Oxfordshire was built to service A400M and C17 military transport aircraft.

© Balfour Beatty

In addition to housing three aircraft in hangars equipped with overhead cranes, the building contains specialist workshops together with parts stores, offices, welfare and mission planning functions.

The design and build was heavily constrained by the demands of the airbase, in particular the need to avoid interference with radar and aircraft guidance systems, clearances around runways and taxiways, and the operational requirements of the aircraft

"Structural steel was chosen for its versatility and sustainability: it is the only practical solution for a building of this type," explains AWW Architects Associate Ian Hunt.

In section, the shape of the building follows the shape of the aircraft. Space is allowed above the aircraft for craneage and maintenance access, and in essence the hangar section consists of a high section located over the tail of the aircraft and a lower section over the fuselage.

In the fourth quadrant of the building, where there are stores and workshops, the roof is brought down lower; this creates an interesting sweeping roof shape which is also reflected in the roof of the office accommodation beside the hangars.

The building is approximately 27m-high, 143m-long × 146m-wide and is located on a military air base on the edge of the Cotswolds countryside. Project architect AWW has incorporated a number of design initiatives in order to minimise the visual impact of the building.

The shape of the building has been softened by incorporating sweeping curves into the design where possible. This has the two main benefits of reducing the volume of the building by lowering it in the centre, where height is not necessary, and softening the shape of the building by avoiding a more aggressive shape which would result if the building was rectangular.

The curves give a more natural shape that fits in better within the context of the landscape.

The colours of the wall cladding of the building are a light metallic blue. It was chosen as it is a very natural colour, reflecting both the sky and the fact that landscapes in the distance tend towards the blue end of the spectrum.

Where necessary to control radar reflection off the building, there is an additional layer of profiled steel cladding on the building's walls, which also helps to further soften the top edge.

"This is a functional building built to a very tight budget and the nature of its purpose means that there was very little scope for flexibility: the height and position of the building was determined by strict requirements for the aircraft and the airbase.

"Hangars generally are not known for their design qualities: what makes this building special is its pleasing and successful appearance and the way it fits well into its countryside context," says Mr Hunt.

Summing up, the judges say the design and construction were heavily constrained by the operational demands of the airbase. Satisfying the constraints and the client was a noteworthy success for large steelwork.

© Balfour Beatty

FACT FILE
Architect: AWW Architects
Structural engineer: Arup
Steelwork contractor: Billington Structures Ltd
Main contractor: Balfour Beatty
Client: Defence Infrastructure Organisation

Wellcome Collection Dynamic Stair, London

A key feature of the Wellcome Collection's development project, the Dynamic Stair is a free-flowing form, travelling from floor-to-floor without any visually intrusive supports.

The Wellcome Collection was launched in 2007 and is based in the Trust's former headquarters on the Euston Road. The venue enables the public to explore connections between medicine, life and art, offering exhibitions, lively public events and debates, and access to the world-renowned Wellcome Library.

The project team's brief was to expand and enrich the main visitor offer, while easing congestion and improving customer facilities to accommodate increasing demand.

Originally Wellcome Collection predicted visitor numbers of around 100,000 a year, but by 2013 the venue welcomed more than 550,000 people a year. Studies revealed that less than 40% of these visitors ventured upstairs from the ground floor.

As part of the analysis of vertical circulation and building usability undertaken by WilkinsonEyre, a new staircase was proposed in order to improve visitor circulation and open up the upper floors to the public. The new Dynamic Stair incorporates sculpted steel into a flowing, swirling form to entice the eye and draw people up through the building.

Building the stair within the confines of an existing building presented a series of constraints in terms of capacity and accessibility.

To install the stair the team was required to make significant alterations to the first and second floors, firstly introducing an opening to facilitate the stair's insertion and then to provide the supporting steelwork to carry the stair loading back to the historic primary structure.

Access below ground floor was not possible and so the strengthening of this floor or the vertical structure was not possible. It became clear that steel was the only realistic option for the stair, exploiting the strength and stiffness of this material and its readiness to be worked into complex forms.

For the stair itself, the chosen solution uses the inner balustrade and floor components as a structural monocoque that exploits every part of the stair as part of the structural system.

This provides the vertical and torsional stiffness necessary to deliver the desired vibrational characteristics, and architectural aesthetic in an efficient and lightweight manner.

Each of the 18 sections was made up of 8mm thick steel plates, which were formed by a mixture of pressing or cold rolling and then welded together. The heaviest of the sections weighed 3.5t and was lifted in to position via a bespoke temporary structure and lifting strategy.

The aspiration for the finish of the stair was to exploit the natural steelwork as much as possible. The final solution was for the outside face to be shot blasted and sealed with clear lacquer. The inside faces were sprayed with a cold zinc and hot stainless steel solution. The inside surfaces were then hand polished.

The Dynamic Stair now provides the renovated Wellcome Collection with a strong central visual statement. The simplicity and tactile nature of the polished whirling form allows the crafted steel of the stair to be displayed and celebrated.

The outer balustrade glass accentuates the movement of visitors around the staircase and up through the building, allowing visibility throughout the floors. Generous breakout spaces surrounding the stair give it room to breathe as a sculptural object in its own right.

This finely crafted staircase winds its way through two floors, with a changing geometry to fit the tight constraints of the existing floor structures. The combination of galvanizing and hot-applied stainless steel spray, which was hand-buffed, creates a most attractive finish, say the judges.

FACT FILE
Architect: WilkinsonEyre
Structural Engineer: AKT II
Architectural Metalworker: Clifford Chapman Staircases Ltd
Main Contractor: Overbury
Client: Wellcome Trust

Market Place Shopping Centre Redevelopment, Bolton

An historic shopping centre has undergone a major transformation with the addition of a cinema complex along with the internal re-structuring of the central atrium.

Bolton's Grade II listed Market Place Shopping Centre was originally constructed in 1851 utilising a cast iron framework. The centre was later extended in the 1980s with the introduction of additional steel-framed two-storey shopping facilities and a multi-storey car park.

The overall concept for the redevelopment was to provide further restaurants, bars and cafés in the re-structured underground Victorian arched vaults, enlarging the central feature atrium and the addition of a steel-framed cinema extension on the roof.

"A steel-framed solution was essential to facilitate the continued operation of the shopping centre," says Shipley Structures Director Glynn Shepperson.

"The steel frame also provided a slim skeleton for the upper cinema extension, which maximised the internal auditoria and general amenity areas."

Grade S355 steel sections were used throughout in order to minimise the steel weight, which was transferred through the existing structure to basement level.

The transfer of the increased dead and imposed loads from the new 10m-high upper cinema extension through the existing steel-framed structure below necessitated the adaption and strengthening of the existing steelwork components.

"The big challenge from an architectural perspective was how to squeeze auditoria spaces into a restricted space. In the design of auditoria, height is of fundamental importance and at Bolton we designed screens that maximised both the viewable area and the maximum possible seating numbers for nine screens," explains Wren Architecture and Design Associate Lee Dyball.

The re-structuring of the central atrium area included the provision of a fully welded 21m-high exposed feature steel liftshaft, infill link bridges and the creation of new escalator floor openings.

The remodelling works unite all four main components of the building; the Grade II listed Market Hall to the south, the 1980s Shopping Centre extension to the north, the Victorian basement vaults and the newly created roof-mounted cinema.

The completed building is now a key focal point in the town centre and a testament to all parties involved.

"Steel was selected as it offered the most flexibility for the desired extension and because the existing structure was a steel frame," says McLaren Construction Senior Planner Jamie Heptonstall.

"The transfer of loads to the existing foundations without unnecessarily disrupting shopping centre operations naturally led to the continuation of this mode of structure."

Survey works to establish existing connections were undertaken and connections made back to the existing frame. However one of the challenges was that, despite being constructed in the 1980s, the information was not accurate and sections of the frame were found to be as much as 30mm out of position.

Due to the flexibility of the steel frame, baseplate design was adapted and members lengthened or shortened to suit the new structure.

Construction was particularly demanding because the Centre was required to function throughout the contract period. The tower crane reached only 60% of the works, so many components had to be manhandled into position. The tough logistical challenge was met in a meritorious way, say the judges.

FACT FILE
Architect: Wren Architecture and Design
Structural engineer: Ramboll
Steelwork contractor: Shipley Structures Ltd
Main contractor: McLaren Construction Ltd
Client: Moorgarth Properties Ltd

Waterford Fire Station

The new Waterford Fire Station's form derives from tracking movements of fire tenders leaving the appliance bays at speed and returning after firefighting.

FACT FILE
Architect: McCullough Mulvin Architects
Structural engineer: O'Connor Sutton Cronin
Steelwork contractor: Steel & Roofing Systems
Main contractor: Duggan Brothers Contractors Ltd
Client: Waterford City & County Council

The design of the new fire station in the Irish city of Waterford consists of a strong form, wrapped in zinc, which is folded - origami-like - to enclose a drill yard with different training zones.

Organised in a spiral, rising from single storey vehicle parking, workshops and dormitories to first floor offices, canteen, leisure and study facilities and terminating at a second floor lecture theatre, the zinc roof is angled and cut away to provide sheltered inside-outside spaces overlooking the yard, where the drill tower acts as an urban beacon in a new public space.

Founded on strip foundations, the steel structure supports precast concrete planks, which form the floor slab. The building is formed from inclined planes and folded volumes, and the flexibility in design of the steelwork facilitated the complex geometries of the structure, while expediting the follow-on trades; zinc, drywall, blockwork, mechanical and electrical services. This allowed a shorter and simpler build programme.

Steel trusses are utilised to give wide spans in the appliance bay and facilitate the appliances driving to and from the drill yard to outside active duty.

"The use of steel to form the structural skeleton provided a quick and cost-effective solution for this relatively low budget facility," says McCullough Mulvin Architects Associate Coran O'Connor.

"The vehicular trafficked areas of the ground floor required large spans and integration of mechanical ventilation systems. The large span trussed structures provide efficient floor constructions that also allow future flexible floorplates for the building users."

Steel also provided a high-quality aesthetic for exposed frames in both the working areas of the ground floor and in the offices and socials areas of the upper floors.

The building brings together many differing uses, requiring a variety of structural solutions to achieve the desired functionality for the client.

The large open-plan appliance bay, with sufficient space for 10 appliances, is achieved using long span steel trusses. Above this open space, a mixture of blockwork and steel provides the structure to the office area.

A second wing, consisting of load bearing blockwork and precast hollowcore slabs, provides training facilities and living quarters over two storeys.

Both wings of the building, together with a covered car parking area to the rear, serve to enclose the large central training yard. The roof to all covered areas consists of a steel frame sloped to suit the profile of the roof and supporting a timber build-up underlying the finished sheeting.

"All of the team members worked closely with the building contractors to achieve the precise geometries set out in the contract. The steelwork contractor needed to resolve a number of bespoke steel connections to comply with the design and achieve the architectural intent," says Mr O'Connor.

Summing up, the judges say the scheme is characterised by the architectural concept of a ribbon of accommodation wrapping around a courtyard in which emergency vehicles circulate and drills are carried out. The distinctive 'origami-folded' roof, formed from cranked steel beams, twists and rises over the different levels of accommodation. A most interesting addition to the town.

© Gianni Botsford Architects

Layered Gallery, London

A steel-framed extension to a private residence houses the owner's collection of photographs, prints, pastels and lithographs.

FACT FILE
Architect: Gianni Botsford Architects
Structural engineer: Entuitive
Steelwork contractor: Trescher Fabrication Ltd
Main contractor: Verona Construction

The Layered Gallery adjoins a five-storey, Grade II listed terraced house that dates back to 1770 and replaces a modern extension of similar volume in the courtyard to the rear of the building.

The client's basic brief – a new rear extension housing art storage and display space as well as a new toilet – led the architect to devise an enclosed courtyard structure that provided a retreat and place to contemplate art.

Showcasing the aesthetic qualities and structural capabilities of weathering steel, the Layered Gallery adds a contemporary, flexible extension to the more traditional spaces of the residence.

Gianni Botsford Architects' design concept was based on a series of superimposed screens, creating a layered effect against the blank brick wall vacated by the previous extension.

The outermost layer is a structural gridded screen made of weathering steel. The second is a weathering steel-framed glazed façade of museum quality UV-treated glass, which opens to allow natural ventilation.

"We like to work with one material and make it work really hard on every project we do. Here weathering steel was chosen due to its structural and self-maintaining properties, and was used not only for all structural and external elements, but also for most of the internal furniture and fittings," says Architect Gianni Botsford.

Inside the extension, two additional layers hang from each storey's ceiling: red blinds, which protect the collection of artworks and provide privacy for the new toilet; and the weathering steel display screens that display the collection.

The lower storey of the extension houses the gallery's main display area where moveable weathering-steel mesh screens, on which artworks can be easily stored and rotated for display, are hung from ceiling rails.

This storey also houses a specially fabricated weathering steel toilet cabinet designed by the architects and from which a toilet and basin emerge when needed, adding an element of surprise and transformation.

The upper storey houses a sun-filled open gallery space topped with a glazed roof. A single weathering steel display shelf is attached to the existing brick wall, and the surrounding rooftops of Fitzrovia are framed by the patinated window frames and the structural screen beyond.

Cranage at the site was impossible due to the constricted space and protected surroundings, and so all structural components were sized to be carried into the courtyard through the house, drawing on weathering steel's suitability for plate fabrication and optimised sizes rather than rolled sections.

Erection was aided by the use of bolted connections of the steel plates throughout, and the relative light weight of the individual members reduced construction costs associated with cranage.

One of the greatest challenges for this project was the numerous connections in the façade, which were carefully detailed and coordinated with the architect and steelwork contractor" says Entuitive Principal Toby Maclean.

"We needed to design thermally broken connections between the façade and the internal steelwork since the structure was left uninsulated outside the building's envelope."

In effect, the main floor beam stops at the glazing line and is supported off weathering steel plates cantilevered from the façade members. This allows the structural frame to remain entirely uninsulated on the exterior.

"A large number of elements make up the final structure that were all carefully co-ordinated between the structural engineer, the steelwork contractor and ourselves, and all erected without cranage in this tight site. This was achieved through careful modelling of all the elements to ensure they came together as planned and worked around the existing structures that were invariably out of plumb or level," says Mr Botsford.

Summing up, the judges say this delightful filigree extension has completely transformed this historic house for its art-collector owner. Forming the backdrop to a new oasis of calm in a frenetic area of London, the building draws inspiration from organic forms of courtyard planting. Exposed weathering steel and external glazing systems are cleverly integrated.

Maxwell Centre, Cambridge

Part of Cavendish Laboratory's long-term development programme at the University of Cambridge, the £26M science facility has been developed to foster advanced research in several scientific fields and is set to provide a new home for collaborative research.

The new four-storey Maxwell Centre contains research laboratories and offices complemented by seminar rooms, interactive spaces and dedicated hubs.

The desire was to create an inspiring and iconic structure to bring together academia and industry. This idea demanded a solution which would be architecturally striking, while satisfying the various needs of the users with flexible research laboratories, high specification meeting rooms and offices on the upper levels.

During the early stages of the project the design team investigated a number of different structural schemes. As the design developed, it became clear that a steel frame with precast planks was the only solution that could deliver the architectural aspirations within typical structural zones of just 350mm within 13m-long spans.

Steelwork was also the obvious choice to realise the architectural intent, which features a double curved roof, as well as curved meeting rooms which reach out from the south elevation.

The complex and challenging double curved roof was designed to reflect the curved roof of the adjacent Physics of Medicine Building. The roof was created using a series of curved steel beams, each with a slightly different radius.

Ramboll Project Engineer Paul Astle says the company worked closely with the steelwork contractor and the specialist bending contractor to ensure that the member sizes used were readily available and were able to be curved to the necessary radii.

The different uses of space between lower ground and the upper floors meant that there were many constraints on the structural layout. To avoid columns disrupting the seminar room, the business lounge above is partly hung from the main roof beams. An 18m-long truss, made up of open sections, was used suspended from three points in the roof.

The centre of the building boasts a three-storey central courtyard covered with an ETFE roof. Within this courtyard two meeting pods cantilever out within the space, as well as an open balcony suspended from the frame.

Exposed precast plank soffits are an important visual element in the building and they are also utilised for thermal mass in the naturally ventilated upper levels.

The coordination of the steelwork support details was therefore of great importance particularly at the column-to-soffit junctions, which included support plates for the planks, substantial torsional connections for the beams, and a connection for an inverted tee beam which acts as a frame tie.

The steelwork is both internal and external, and in some areas it is concealed while exposed in other areas. The use of parts of the roof structure to support floors below also meant that appropriate fire protection was required for some of these elements.

The protection systems were set out in the steelwork specification, using the 3D Revit model. Members were then colour coded to identify their respective systems. This colour coded model was issued to the construction team to allow them to understand the protection requirements of each element.

Summing up, the judges say flexibility and efficient distribution of services were critical to this project. The solution was to use long-span floors supported on steel slimfloor beams, which also enabled natural ventilation. Four storeys are arranged under a doubly-curved roof, reflecting the adjacent building to which it neatly links.

The result is an efficiently elegant building.

FACT FILE
Architect: BDP
Structural Engineer: Ramboll
Steelwork Contractor: The Wall Engineering Co Ltd
Main Contractor: SDC
Client: University of Cambridge Estate Management

Cast-in plates

Richard Henderson of the SCI discusses the design of plates cast into concrete to connect to steel beams and the forthcoming SCI design guide.

No 1 Spinningfields Manchester

Introduction

It is a truth universally acknowledged, that a simple beam in proximity to a concrete wall, must be in want of a cast-in plate… Wandering around cities examining construction activity, one cannot but be struck by the number of buildings in which the lateral stability system is provided by concrete cores and the floor beams and columns are structural steel. It is perhaps surprising that until now there has been no design guide for cast-in plates available in the UK.

What do cast-in plates do?

The floors that surround concrete cores are supported on steel beams that in turn are supported by the core walls. Steel plates are cast into the wall during construction and subsequently, as the steelwork is erected, connections are made to the cast-in plates. The connections carry the design loads from the beams: the vertical reaction at the end of the beam and possibly a horizontal force (e.g. from wind loads on the façade and a separate tie force for robustness). The cast-in plates must therefore transmit these forces into the concrete walls through shear studs, reinforcing bars, anchor plates and the like, fixed to the back of the plate and embedded in the concrete.

Simple Connections

Many steel buildings in the UK have been designed with braced frames providing lateral stability and simply supported beams carried by the steel columns. Standard connections have been developed which are able to resist the vertical reaction at the end of the beam but are sufficiently flexible to allow the beam to take up the end slope corresponding to a simple support. The connections are also capable of resisting the horizontal tie force required to provide adequate robustness, in a separate load case. The details are published in the SCI 'Green book', publication P358 . Various types of connections are included: partial and full-depth end plates and fin plates. Tests on connections to beams up to 610 serial size have been carried out to demonstrate the behaviour of the connections.

Coexistent shear and tension

Connections may be required to carry shear and axial force in the same load case. Where beams are supported on inclined columns, significant horizontal forces may be developed. If risers for building services are grouped round a concrete core, the floor slab may stop short, leaving no opportunity to transfer horizontal forces through the floor slab. In such cases, the connection falls

▶38

▶36 outside the details in the 'Green Book' and the connection must be designed from first principles. The ability of such a connection to rotate to relieve a fixed-end moment while carrying a significant horizontal force must be carefully considered.

Connections to cast-in plates

Where a building has been designed with simply supported beams carrying shear and no horizontal forces and with tying forces in a separate load case, connections can be taken from the 'Green Book'. A common form of connection is a fin plate welded to a cast-in plate. An end-plate connection could be formed by welding a Tee to the cast-in plate, but such an arrangement where a beam has to be erected between two vertical surfaces may make the steelwork less easy to erect than with a fin plate. If at all possible, it is preferable to transfer the horizontal tie force through the concrete floor slab into the concrete core, to avoid the need to design the core to resist a local tension delivered through the cast-in plate and provide any necessary shear reinforcement.

Photo courtesy of William Hare Ltd

Issues to consider

Split of responsibility

The design of concrete cores usually belongs to the building structural engineer. In most contractual arrangements, the required performance of the connections and the forces they are to resist are also determined by the structural engineer. The design of connections between steel elements are usually the responsibility of the steelwork contractor because they can be detailed to suit the production process. The work of these two parties comes together at the face of the cast-in plate. For the smooth progression of the construction process, it is necessary for each party to know the assumptions, behaviours and limitations of the structural components that come together at this point.

The design responsibilities of the different parties must be clearly defined and understood. It is logical for the split of design responsibilities to lie on the face of the cast-in plate. The design of the plate and the embedded elements fall to the structural engineer, who is in control of all the details of the concrete core wall, including geometry, strength of concrete and reinforcement details. The steelwork contractor selects and details the element welded to the cast-in plate and must also be satisfied that the element chosen (e.g. a fin plate) working together with the cast-in plate will perform as required.

The work of the structural engineer is in advance of the steelwork contractor and therefore it is necessary for the engineer to be aware of the impact of decisions on the steelwork contractor's subsequent activities. For example, assuming beams are simply supported and specifying shear and axial forces in the same load case means that connections cannot be selected from the standard details in the 'Green Book' and must be designed from first principles.

Accuracy of construction and agreed deviations

Concrete cores or shear walls are likely to be specified and built using the National Structural Concrete Specification and structural steelwork fabricated and erected using the National Structural Steelwork Specification. These documents have different requirements for the accuracy of erected elements which must be reconciled where the different elements come together, notable at the cast-in plates. A set of deviations must be agreed by the appropriate parties early in the project to avoid problems later.

Adjustments to allow for the connections between the steel and concrete elements to be made are often arranged as follows. After the concrete core is constructed, the positions of the cast-in plates are surveyed and a fin plate cut to suit the as-built position and site-welded to the plate. A similar process would be used if a Tee stub were to be preferred. The steelwork must be detailed to allow for a longer or shorter fin plate, depending on the results of the survey. The resistance of the cast-in plate must be such as to carry the loads resulting from a connection anywhere within the agreed positional deviations. Maximum values of ± 35 mm in plan position are typical.

Design Guide

The forthcoming design guide is going through its final checks before publication. It has been funded by BCSA and Steel for Life and a working party with members drawn from various parts of the construction industry has made contributions and made comments on drafts of the guide.

The guide proposes a design model for the design of cast-in plates which is based on design codes. As might be expected, these are Eurocodes 2, 3 and 4, dealing with concrete, steel and composite construction respectively. A consequence of this approach is that the design model uses shear studs to resist shear forces and steel reinforcement to resist tension. The tension is transferred into the concrete via bond with the reinforcement. Eurocode 4 considers shear studs in combined shear and tension but states that tensions greater than one tenth of the stud shear resistance are outside the scope of the code. There is also at present no code-based interaction formula for assessing combined shear and tension on shear studs.

The guide discusses the issues outlined above in more depth and addresses other issues such as weld details for reinforcement, the potential for thermal expansion of the cast-in plate during welding and handling of the cast-in plate during construction. The guide also presents a design example of a cast-in plate to receive a simple connection from a 610 serial size UB.

It is intended that the guide will identify many of the issues which are relevant to this form of construction for structural engineers who are embarking on such a project for the first time. The guide will also provide a starting point for discussions between the different parties involved.

References

1 Joints in steel construction Simple joints to Eurocode 3, (P358), SCI, 2014
2 National Structural Concrete Specification, 4th Edition, Concrete Centre, 2010
3 National Structural Steelwork Specification, 5th Edition CE Marking version, (52/10) BCSA, October 2010

Southbank Place

AD 411:
Design of web to flange welds in plate girders

The SCI Advisory Desk is frequently asked how to design the welds between the flange and web of a plate girder. The following note discusses the standard formula for the shear flow between web and flanges of a doubly symmetric beam which is used for weld design and gives the background to the formula in Eurocode 3 Part 5[1]. An example is also presented.

The design of a plate girder element is the responsibility of the building structural engineer just as is the design of a rolled section beam. The difference is that plate girder design involves choosing explicitly the width and depth of the beam and also the thicknesses and arrangement of the constituent plates, including the connection between them. The web to flange welds are not connections between elements so in the contractual arrangement usually adopted on projects, their design is not in the steelwork contractor's scope of work.

The relevant stresses in the beam which are carried by the web to flange welds are the shear stresses which act on planes parallel to the longitudinal axis of the element and are the result of the change in bending moment over an incremental length of the beam. Shear stresses which are equal and perpendicular to the longitudinal stresses are developed in the plane of the cross section and are termed "complementary" shear stresses. The sum of these stresses over the area of the cross section equals the applied shear force. The stresses are determined using the standard formula for calculating the shear stress distribution over the cross section which is found in strength of materials text books:

$$\tau = \frac{V_{Ed} A \bar{z}}{I_z b} \qquad \text{equation 1}$$

where:

- τ is the shear stress at a point in the cross section a distance z from the neutral axis of the section;
- V_{Ed} is the design shear force on the section;
- A is the area of the cross section further from the neutral axis than z;
- z is the distance from the neutral axis to the centroid of area A;
- I_z is the second moment of area of the whole cross section;
- b is the width of the section at the point considered.

Applying the formula to a rectangular cross section with the long dimension vertical carrying a vertical shear force produces a parabolic distribution of shear stress over the section which is a maximum at the neutral axis and zero at the top and bottom. When applied to an I section it produces the familiar distribution showing that most of the shear force is carried by the web of the beam.

When considering weld design, equation 1 can be written in terms of shear flow s between the flange and web by substituting $s = \tau b$ as shown:

$$s = \frac{V_{Ed} A_f \bar{z}}{I_z} \qquad \text{equation 2}$$

where A_f is the area of the flange. The shear flow is the shear force per unit length which is to be carried by the weld.

Part 5 of Eurocode 3 gives conservative and simplified formulae for sizing web to flange welds in clause 9.3.5(1) as follows:

$$s = \frac{V_{Ed}}{h_w} \text{ if } V_{Ed} \le \chi_w f_{yw} h_w t / \sqrt{3}\gamma_{M1} \qquad \text{equation 3}$$

where h_w is the depth of the web. For larger values of V_{Ed} the weld should be designed for

$$s = \eta f_{yw} t / \sqrt{3}\gamma_{M1}$$

Equation 3 is used if the shear force on the web is less than the shear buckling resistance of the web which is given by the expression on the RHS of the inequality. Clause 5.1(2), gives a value of slenderness for an unstiffened web where shear buckling does not arise:

$$\frac{h_w}{t} < \frac{72}{\eta}\varepsilon \text{ where } \varepsilon = \sqrt{\frac{235}{f_y}}$$

Tests have shown that the shear resistance of a stocky web exceeds the resistance predicted by the Von Mises yield criterion due to strain hardening. This effect is allowed for by including the factor η, the value of which is subject to national choice. According to the UK National Annex, η should be taken as equal to 1.0, ie the effect of strain hardening is ignored.

The simple formula for shear flow in equation 3 can be shown to be a conservative approximation if the second moment of area of the plate girder is based on the second moment of the flanges with respect to the neutral axis (ie neglecting the web and the second moments of the flanges about their own centre-line). The $A_f z$ term is the first moment of the flange about the neutral axis of the beam. Substituting these values in equation 2 gives:

$$s = \frac{V_{Ed} A_f (h_w + t_f)/2}{A_f (h_w + t_f)^2/2} = \frac{V_{Ed}}{(h_w + t_f)} \approx \frac{V_{Ed}}{h_w} \qquad \text{equation 4}$$

Neglecting the thickness of the flange in calculating the shear flow is clearly conservative.

Example

A 10m span plate girder 600 mm deep by 300 mm wide with 30 mm thick flanges and a 10 mm thick web (steel grade S355) carries a central point load of 800 kN. The top flange of the beam is fully restrained. Size the web to flange welds.

$I_z = 1/12(600^3 \times 300 - 540^3 \times 290) = 1.60 \times 10^9$ mm^4.
$W_p = 30 \times 300 \times 285 \times 2 + 270 \times 10 \times (270/2) \times 2$
$= 5.86 \times 10^6$ mm^3.

$M_R = 345 \times 5.86 \times 106/109 = 2.02$ MNm.
$M_{Ed} = 800 \times 10/4 = 2.0$ MNm
ie the beam is sized for bending.

Eurocode 3 Part 5:
Web slenderness: $h_w/t = 540/10 = 54$. The limiting slenderness is $72\varepsilon = 58.6$ so the web is not slender and shear buckling does not arise ie $\chi_w = 1.0$.

The limiting value of design shear force:
$V_{Ed} = 1.0 \times 355 \times 40 \times 10 / \sqrt{3} \times 1.0 = 1106 > 400$kN

The simple formula can be used:
$s = 400 / 540 = 0.74$ kN/mm. For two welds, this is 0.37 kN/mm per weld. The 6mm leg fillet weld length required (longitudinal resistance, 1.01 kN/mm) over 200 mm = (200 × 0.37)/1.01 = 73 mm. Adding twice the leg length for stops and starts gives 85 mm: use 90 mm. Provide an intermittent 6mm fillet weld on both sides of the web, 90 mm hit and 110 mm miss. The average shear resistance per mm is (90–12)/200 × 1.01 = 0.39 > 0.37 kN/mm – OK.

Apply the standard formula:
$s = 400 \times 9000 \times 285 / 1.6 \times 109 = 0.64$ kN/mm. For two welds this is 0.32 kN/mm per weld. The 6mm fillet weld leg length required over 200 mm = 200 × 0.32/1.01 = 63 mm. Adding twice the leg length for stops and starts gives 75 mm: use 80 mm. Provide an intermittent 6 mm fillet weld on both sides of the web 80 mm hit and 120 mm miss. The average shear resistance per mm is (80 – 2)/200 × 1.01 = 0.34 > 0.32 kN/mm – OK.

The simple formula in Eurocode 3 is more conservative.

The size of the smallest continuous fillet weld which is just sufficient to transfer the web to flange shear flow may be impractically small (a 3.0 mm leg fillet weld has a longitudinal shear resistance of 0.51 kN/mm). A larger intermittent fillet weld can be used, as in this example, but is not suitable for elements where corrosion is an issue because the web to flange joint is unsealed where there is no weld. In practice, a steelwork contractor may choose to provide a continuous fillet weld to avoid having to set out all the stops and starts. The works may also have a standard weld procedure for the relevant plate thicknesses with a pre-determined size of fillet weld which is larger than the calculated value.

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1. BS EN 1993-1-5:2006 Eurocode 3 – Design of steel structures – Part 1-5 design of plated elements

New and revised codes & standards

From BSI Updates September 2017

BS EN PUBLICATIONS

BS EN ISO 14555:2017
Welding. Arc stud welding of metallic materials
Supersedes BS EN ISO 14555:2014

BRITISH STANDARDS WITHDRAWN

BS EN ISO 14555:2014
Welding. Arc stud welding of metallic materials
Superseded by BS EN ISO 14555:2017

NEW WORK STARTED

EN ISO 9220
Metallic coatings. Measurement of coating thickness. Scanning electron microscope method

DRAFT BRITISH STANDARDS FOR PUBLIC COMMENT – NATIONAL BRITISH STANDARDS

17/30353759 DC
BS 5427 AMD1 Code of practice for the use of profiled sheet for roof and wall cladding on buildings
Comments for the above document are required by 16 October, 2017

ISO PUBLICATIONS

SO 2082:2017
Metallic and other inorganic coatings. Electroplated coatings of cadmium with supplementary treatments on iron or steel
Will be implemented as an identical British Standard

ISO/TS 7705:2017
Guidelines for specifying Charpy V-notch impact prescriptions in steel specifications
Will be implemented as an identical British Standard

ISO 12354-1:2017
Building acoustics. Estimation of acoustic performance of buildings from the performance of elements. Airborne sound insulation between rooms
Will be implemented as an identical British Standard

ISO 12354-2:2017
Building acoustics. Estimation of acoustic performance of buildings from the performance of elements. Impact sound insulation between rooms
Will be implemented as an identical British Standard

ISO 12354-3:2017
Building acoustics. Estimation of acoustic performance of buildings from the performance of elements. Airborne sound insulation against outdoor sound
Will be implemented as an identical British Standard

ISO 12354-4:2017
Building acoustics. Estimation of acoustic performance of buildings from the performance of elements. Transmission of indoor sound to the outside
Will be implemented as an identical British Standard

ISO 23279:2017
Non-destructive testing of welds. Ultrasonic testing. Characterization of discontinuities in welds
Will be implemented as an identical British Standard

BUILDING WITH STEEL

Reprinted from Volume 4 No. 7
August 1967

1,000,000 tons of steel in America's spaceport

1

The rapid pace of technological development during the past few years is most apparent in space exploration. The tiny bell-shaped Mercury capsules which carried the first American astronauts into space have already been consigned to museums and new generations of spacecraft taken their place.

To send the spacemen off on their long voyages of exploration, the United States has built a new technological wonder – the Spaceport on Merritt Island, adjacent to Cape Kennedy. On what was marshland only three years ago, the biggest construction, Launch Complex 39, has now been completed. To build it the National Aeronautics and Space Administration embarked on the biggest and most expensive (one thousand million dollars) construction project in history.

The Spaceport is a vast complex of outsize buildings and mammoth machines fashioned from a million tons of steel and nearly 17 million tons of concrete. Its 80,000-acre site is criss-crossed with 100 miles of roads and 22 miles of railways. A force of 10,000 works there, each with a part to play in the launching of astronauts to their far-off destinations.

The most imposing and unusual feature of launch Complex 39 is the great building where the lunar spaceships are put together and made ready for flight. This is the Vertical Assembly Building, a black and white cube-like structure with three million cubic yards of work space and big enough to house sky scrapers and to breed its own weather. It is nearly 600 ft long, 418 ft high and 410 ft wide and has a volume one and a half times that of the Pentagon, the world's largest office building. A structure of this size, with no obstructions between floor and ceiling could easily create interior conditions leading to the formation of clouds and rainfall. Air conditioning prevents this from happening: the air-conditioning plant is of 10,000 tons capacity and would be adequate for a small town of 3,000 houses.

Because the building resembles a huge box, its designers calculated that it might blow over in a hurricane. Wind tunnel tests confirmed this possibility and the solution was to anchor the structure to bedrock with 4,000 steel piles, which were driven 150 feet into the soil. To shut out the deafening noise of the Saturn V lift-off from the launch pad three miles away, and for protection against shock waves, the building has been designed without conventional windows: instead translucent panels of reinforced translucent plastic were used.

Inside the cavernous building four Saturn V rockets can be assembled vertically at one time. The four assembly bays have work platforms which can be extended vertically and horizontally to give technicians easy access to the rocket at any level. Each Saturn is assembled on

2

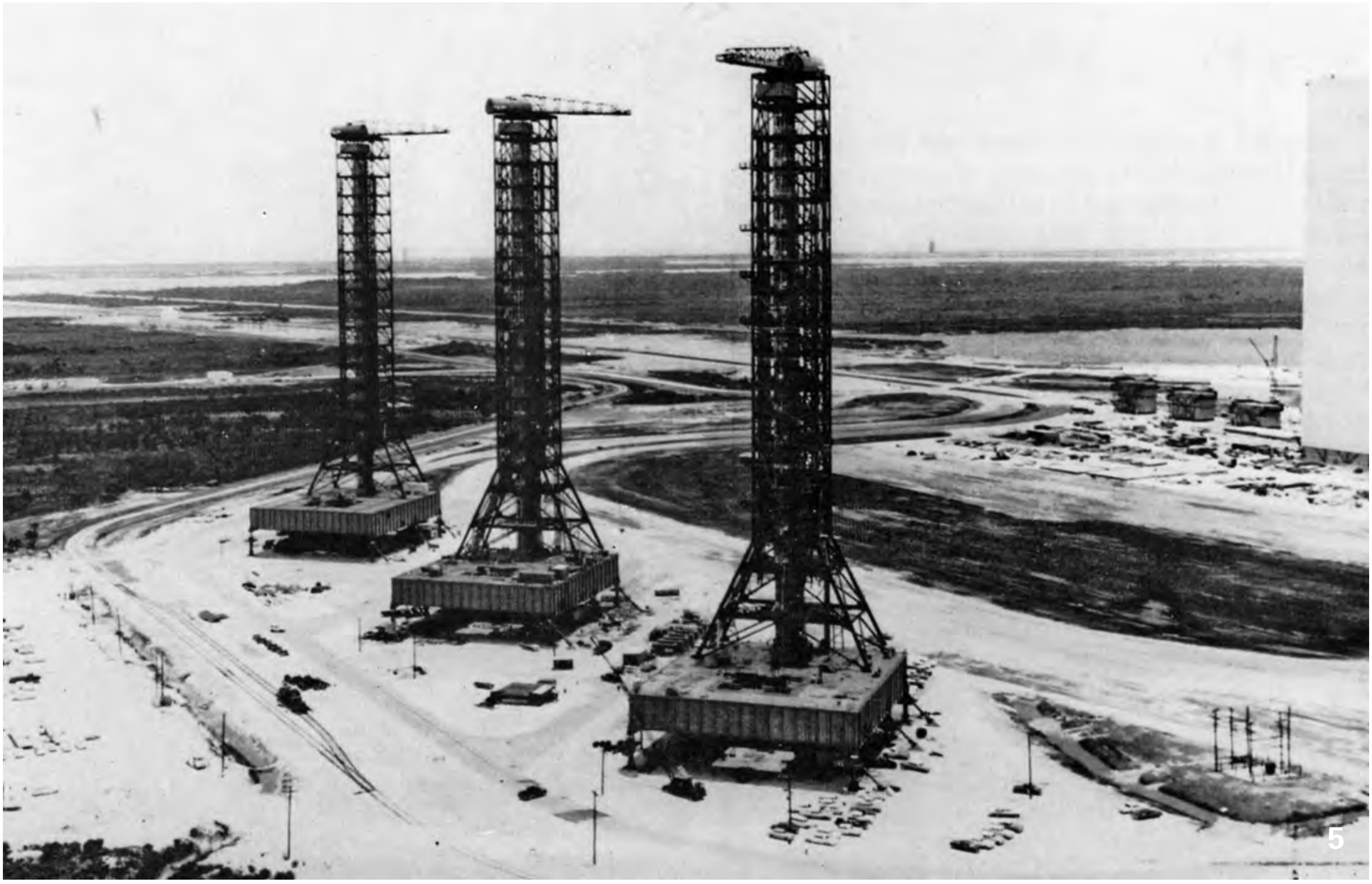
1. The Spaceport at Merritt Island, near Cape Kennedy: the three-mile track to the launching area is seen in the background.
2. The view looking upwards inside one of the work platforms emphasises in a striking manner the vital role of steelwork in this large project. During assembly the semi-circular platforms are moved inwards to grip the rocket tightly so that men can work on many levels simultaneously.
3. Interior of one of the four bays in the vehicle assembly Building.
4. The first Apollo spacecraft ready for transport to the launching area.
5. Giant mobile launch pads in which the rockets are transported to the launching site: complete with rocket each weighs 5,358 tons.

a mobile launch pad inside the Vertical Assembly Building, this pad later serving as the rocket's actual launch platform.

After assembly has been completed and the entire unit checked and rechecked to the stage of a simulated countdown the rocket and the mobile launch pad are transported to the actual launch site. This three-mile journey is an immense undertaking, involving conditions which have never been met before. To cope with it some remarkable equipment has been devised and some strange operations planned.

To lift and carry the 5,358 ton load of the assembled rocket and its mobile launcher in an upright position to the launching area, a giant caterpillar-like machine known as a crawler transporter, of fabricated steel construction, is used. It is powered by two main-drive diesel engines of 5,500 hp and also has diesel generators of 2,130 hp for the levelling, jacking, steering, lighting and electronic systems. Along a concrete runway as wide as an eight-lane highway, this great crawler moves at a snail's pace to the launch area, a journey taking at least three hours.

At the launch area, where only the final preparations will have to be carried out before lift-off, three launch pad sites have been constructed. In the centre of each is an elevated concrete and steelwork structure to anchor support pedestals for the mobile launch pad and arming tower – a 380-ft steel lattice structure designed to give engineers access to all parts of the assembled vehicle at any level. The tower and the mobile launch pad are both placed in position on the support pedestals by the crawler transporter. Then, just before launching, the tower is removed and the rocker left in position.



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 £400,000
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	✔	Silver	Up to £2,000,000
Adstone Construction Ltd	01905 794561			●	●	●	●									✔	2	✔	Gold	Up to £3,000,000
Advanced Fabrications Poyle Ltd	01753 653617				●	●	●	●		●	●			●	●	✔	2			Up to £800,000
AJ Engineering & Construction Services Ltd	01309 671919			●	●					●	●			●	●	✔	4			Up to £3,000,000
Angle Ring Company Ltd	0121 557 7241												●			✔	4			Up to £1,400,000
Apex Steel Structures Ltd	01268 660828					●	●			●	●			●	●		2			Up to £2,000,000
Arc Fabrication Services Ltd	01709 557654			●	●	●	●	●	●	●	●			●	●	✔	3			Up to £200,000
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				●	●				●	●			●	●	✔	4		Gold	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 £1,400,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✔	4			Up to £1,400,000
Barnshaw Section Benders Ltd	0121 557 8261												●			✔	4			Up to £2,000,000
BHC Ltd	01555 840006	●	●	●	●	●	●	●			●	●		●	●	✔	4		Silver	Above £6,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●	●	●	●	●		●	●	✔	4	✔	Gold	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●		4			Up to £3,000,000
Bourne Construction Engineering Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●			●	●	✔	4			Up to £6,000,000
Builders Beams Ltd	01227 863770			●	●	●	●			●	●			●	●	✔	3	✔		Up to £3,000,000
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●				●	●	✔	4		Silver	Up to £3,000,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●		●	●	●		●	●	✔	4	✔	Gold	Above £6,000,000
Cementation Fabrications	0300 105 0135	●			●			●			●		●		●	✔	3		Gold	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	●		●		✔	4		Gold	Above £6,000,000
CMF Ltd	020 8844 0940				●		●	●		●	●				●	✔	4			Up to £6,000,000
Cook Fabrications Ltd	01303 893011				●					●	●			●	●		2			Up to £1,400,000
Coventry Construction Ltd	024 7646 4484			●	●	●	●		●	●	●			●	●	✔	4			Up to £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	✔	Gold	Up to £6,000,000
ESL (GB) Ltd	01482 787986	●					●	●	●	●	●	●	●	●	●	✔	4			Up to £400,000
EvadX Ltd	01745 336413			●	●	●	●	●	●	●	●	●				✔	3		Gold	Up to £3,000,000
Four Bay Structures Ltd	01603 758141			●	●	●	●	●		●	●			●	●		2			Up to £1,400,000
Four-Tees Engineers Ltd	01489 885899	●											●	●	●	✔	3		Member	Up to £2,000,000
Fox Bros Engineering Ltd	00 353 53 942 1677			●	●	●	●	●			●				●		2			Up to £2,000,000
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●				●	●	✔	2			Up to £1,400,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
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
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 £1,400,000
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								●		●			●	●	✔	3			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			●	●	●	●		●	●	●			●	●		3			Up to £1,400,000
Rippin Ltd	01383 518610			●	●	●	●	●						●	●		2			Up to £1,400,000
Robinson Structures Ltd	01332 574711			●	●	●	●				●			●	●	✔	2			Up to £3,000,000
S H Structures Ltd	01977 681931	●			●		●	●	●	●	●	●			●	✔	4	✔	●	Up to £2,000,000
SAH Engineering Ltd	01582 584220			●	●	●				●	●			●	●		2			Up to £800,000
SDM Fabrication Ltd	01354 660895	●	●	●	●	●	●				●			●	●	✔	4			Up to £2,000,000
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 £3,000,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●	●	●	●			●				●		2	✔		Up to £1,400,000
South Durham Structures Ltd	01388 777350			●	●	●				●	●	●			●		2			Up to £1,400,000
Southern Fabrications (Sussex) Ltd	01243 649000				●	●				●	●			●	●	✔	2			Up to £800,000
Steel & Roofing Systems	00 353 56 444 1855			●	●	●	●					●		●	●	✔	4			Up to £3,000,000
Taziker Industrial Ltd	01204 468080									●				●	●	✔	3			Above £6,000,000
Temple Mill Fabrications Ltd	01623 741720			●	●	●	●				●			●	●	✔	2			Up to £400,000
Traditional Structures Ltd	01922 414172			●	●	●	●	●	●		●			●	●	✔	3	✔	●	Up to £2,000,000
TSI Structures Ltd	01603 720031			●	●	●	●	●			●			●		✔	2	✔		Up to £1,400,000
Tubecon	01226 345261						●	●	●	●				●	●	✔	4		●	Above £6,000,000*
Underhill Engineering Ltd	01752 752483				●		●	●	●	●	●			●	●	✔	4			Up to £3,000,000
W I G Engineering Ltd	01869 320515				●					●					●	✔	2			Up to £400,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✔	4			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)

BCSA

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
Griffiths & Armour	0151 236 5656
Highways England Company Ltd	08457 504030
Kier Construction Ltd	01767 640111
McGee Group (Holdings) Ltd	020 8998 1101
PTS (TQM) Ltd	01785 250706
Sandberg LLP	020 7565 7000
Structural & Weld Testing Services Ltd	01795 420264
SUM Ltd	0113 242 7390

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	✓		✓	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	✓	4			✓		Up to £6,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●	●		●	●	✓	4			✓	Silver	Up to £3,000,000
Cementation Fabrications	0300 105 0135	●	●						●	✓	3			✓	Gold	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Above £6,000,000
D Hughes Welding & Fabrication Ltd	01248 421104	●		●			●	●	●	✓	4			✓		Up to £800,000
Donyal Engineering Ltd	01207 270909	●						●	●	✓	3			✓	Member	Up to £1,400,000
ECS Engineering Ltd	01773 860001	●	●	●	●		●		●	✓	3					Up to £3,000,000
ESL (GB) Ltd	01428 787986							●	●	✓	4			✓		Up to £400,000
Four-Tees Engineers Ltd	01489 885899	●	●	●	●		●	●	●	✓	3			✓	Member	Up to £2,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●		●				●	●	✓	4			✓	Gold	Up to £6,000,000
Millar Callaghan Engineering Services Ltd	01294 217711	●				●		●	●	✓	4			✓		Up to £1,400,000
Murphy International Ltd	00 353 45 431384	●	●	●	●				●	✓	4			✓		Up to £1,400,000
Nusteel Structures Ltd	01303 268112	●	●	●	●	●		●	●	✓	4		✓	✓	Gold	Up to £4,000,000
S H Structures Ltd	01977 681931	●	●	●	●	●	●		●	✓	4	✓		✓	Silver	Up to £2,000,000
Severfield (UK) Ltd	01204 699999	●	●	●	●	●	●	●	●	✓	4			✓	Gold	Above £6,000,000
Shaun Hodgson Engineering Ltd	01553 766499							●	●	✓	3			✓		Up to £800,000
Taziker Industrial Ltd	01204 468080	●	●	●	●			●	●	✓	3		✓	✓		Above £6,000,000
Underhill Engineering 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 £1,400,000
Cimolai SpA	01223 836299	●	●	●	●	●	●	●	●	✓	4					Above £6,000,000
CTS Bridges Ltd	01484 606416	●	●	●	●	●	●		●	✓	4			✓	Member	Up to £800,000
Francis & Lewis International Ltd	01452 722200							●	●	✓	4			✓	Gold	Up to £2,000,000
Harland & Wolff Heavy Industries Ltd	028 9045 8456	●	●	●	●	●		●	●	✓	3					Up to £2,000,000
Hollandia Infra BV	00 31 180 540 540	●	●	●	●	●	●	●	●	✓	4					Above £6,000,000*
HS Carlsteel Engineering Ltd	020 8312 1879	●	●					●	●	✓	3			✓		Up to £40,000
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		✓	✓	Gold	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		✓	✓	Silver	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		●								N/A		
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		
Cleveland Steel & Tubes Ltd	01845 577789								●		M		
Composite Metal Flooring	01495 761080	●									M		
Composite Profiles UK Ltd	01202 659237	●									D/I		
Cooper & Turner Ltd	0114 256 0057									●	M		
Cutmaster Machines (UK) Ltd	01226 707865					●					N/A		
Daver Steels Ltd	0114 261 1999	●									M		
Daver Steels (Bar & Cable Systems) Ltd	01709 880550	●									M		
Dent Steel Services (Yorkshire) Ltd	01274 607070								●		M		
Duggan Profiles & Steel Service Centre Ltd	00 353 56 7722485	●							●		M		
easi-edge Ltd	01777 870901							●			N/A	Gold	
Fabsec Ltd	01937 840641	●									N/A		
Ficep (UK) Ltd	01924 223530					●					N/A		
FLI Structures	01452 722200	●									M	Gold	
Forward Protective Coatings Ltd	01623 748323						●				N/A		
Graitec UK Ltd	0844 543 8888		●								N/A		
Hadley Group Ltd	0121 555 1342	●									M	Silver	
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	Member	

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM	BIM
International Paint Ltd	0191 469 6111						●				N/A	Gold	
Jack Tighe Ltd	01302 880360						●				N/A		
Jamestown Manufacturing Ltd	00 353 45 434288	●									M		
John Parker & 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	Gold	
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		
Pipe and Piling Supplies Ltd	01592 770312	●									M		
PPG Performance Coatings UK Ltd	01525 375234						●				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	Silver	
Structural Metal Decks Ltd	01202 718898	●									M	Gold	
StruMIS Ltd	01332 545800		●								N/A		
Stud-Deck Services Ltd	01335 390069	●									D/I		
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	01244 892199	●									M		
Tension Control Bolts Ltd	01948 667700						●			●	M		
Trimble Solutions (UK) Ltd	0113 887 9790		●								N/A		
voestalpine Metsec plc	0121 601 6000	●									M	Gold	
Wedge Group Galvanizing Ltd	01909 486384						●				N/A		
Yamazaki Mazak UK Ltd	01905 755755					●					N/A		