www.newsteelconstruction.com

NSC

Annual Review

Cover Image
52 Lime Street, London
Main client: W.R Berkley Corporation
Architect: Kohn Pedersen Fox
Main contractor: Skanska
Structural engineer: Arup
Steelwork contractor: William Hare
Steel tonnage: 10,500t

NSC Annual Review

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

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

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

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

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

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

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

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

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

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

These and other steelwork articles can be downloaded from the New Steel Construction Website at *www.newsteelconstruction.com*

Steel still the dominant force in key markets

Sarah McCann-Bartlett, Director General of the British Constructional Steelwork Association, introduces the Annual Review of NSC in 2017.

Welcome to our Annual Review of highlights from New Steel Construction during 2017. I'm sure you'll agree that it provides a highly deserved showcase for the astonishing depth of UK design, fabrication and construction skills used on steel projects of all types and sizes throughout the UK.

The latest market survey figures from Construction Markets show that steel is still the dominant force in the major markets that it serves. For multi storey buildings of six storeys and over, steel is overwhelmingly the preferred framing choice, with a near 75% share of the market. Steel also remains the preferred choice for almost all single storey industrial buildings.

Competition from other materials intensified during the year but market share was gained in several areas including multi-storey leisure buildings, which includes hotels.

At the time of writing, the construction industry, at least the buildings part of it, seemed to be undergoing one of its periodic downturns. If the focus of developers on cost intensifies as a result of economic or financial concerns, then the cost advantages of building in steel can be expected to become even more important. Other steel advantages like speed of construction, quality, flexibility and sustainability all have cost benefits that will also come to the fore.

The diverse range of projects featured in this Annual Review all have high quality of design and construction in common. Another important factor they have in common is that their steelwork was fabricated by BCSA members.

The best way of ensuring that a quality steelwork contractor is selected for any project is to insist on selecting a BCSA member. They are recognised worldwide as the leading force in steelwork construction, using the most sophisticated software and fabrication equipment available, backed by the most sophisticated supply chain in the world's constructional steelwork industry.

NSC is brought to you by Steel for Life, which is supported by BCSA's members. For the coming year we have several initiatives planned that will develop the BCSA's and Steel for Life's support for all those who design in steel. We look forward to seeing this result in a steady stream of great steel successes to write about in NSC.

SCCS achieves revised standards

Following separate UKAS assessments, the Steel Construction Certification Scheme (SCCS) has successfully transitioned to the revised BS EN ISO 9001:2015 and BS EN ISO 14001:2015 standards.

These standards have been updated from the previous 2008 and 2004 versions, respectively, because it is recognised that business has changed radically. Geographical boundaries are almost insignificant in today's global economy, supply chains are increasingly complex and the information companies have to manage has multiplied exponentially.

To ensure that ISO 9001 and ISO 14001 continue to serve the business community and maintain their relevance in today's market place, both standards have been revised to address these changes.

"For the SCCS to achieve these transitions is a significant milestone," said SCCS Certification Scheme Manager Stephen Blackman.

"William Hare is the first of our ISO 9001 clients, and Severfield is the first of our ISO 14001 clients, to achieve certification to the revised standard through SCCS.

Companies have until September 2018 to achieve certification to the revised standards.

The SCCS is a wholly-owned subsidiary of the British Constructional Steelwork Association. It was established in the early 1980s to provide a Quality Management Systems certification service for steelwork contracting organisations.

SCCS now offers additional certification and monitoring services for the structural steelwork sector, including integrated or separate Environmental and Health & Safety management systems, Factory Production Control systems and selected National Highways Sector Schemes.

For more information about SCCS go to *www.steelcertification.co.uk*

Steel wins at BCO awards 2017

Steel-framed projects have been named as regional winners of the British Council for Offices (BCO) awards 2017.

The new headquarters building in Wrexham for UK telephone answering service and outsourced switchboard company, Moneypenny (pictured), won the Corporate Workplace award for the North of England, North Wales and Northern Ireland region.

Working on behalf of main contractor Pochin Construction, EvadX erected more than 700t of steel for this project.

Chemical giants INEOS Olefins & Polymers' new steel-framed Grangemouth headquarters won the Scotland region's Corporate Workplace award.

Utilising 950t of structural steelwork supplied and erected by BHC, the 6,500m^2 building provides high quality open-plan office space over four floors and includes meeting rooms, conference facilities and kitchens located on the ground floor.

The Commercial Workspace award for London went to 8 Finsbury Circus. William Hare erected 2,000t of steelwork for this job.

The development was praised by the judges as a delightful new office building, which maximises the development potential of a very difficult site, while respecting the surrounding heritage.

The BCO's mission is to research, develop and communicate best practice in all aspects of the office sector. It delivers this by providing a forum for the discussion and debate of relevant issues.

Established in 1990, the BCO is Britain's leading forum for the discussion and debate of issues affecting the office sector.

Contractor starts long-span corrugated web beam production

Ireland-based Kiernan Structural Steel (KSS) has installed a fully automated production facility for welded plate girders with sinusoidal corrugated webs.

Known as the SIN system, the production technology has been imported from Austria. The product, SIN beams, are said to combine large spans with a very low weight.

Having started production, KSS said it is now able to supply the beams to customers in the UK and Ireland.

Dimensions, material thickness and material quality of the upper and lower flange as well as the web are precisely adapted to the customer's respective requirements.

KSS Structural Engineer John Kiernan said: "SIN beams can be used for long-span portal frames, long-span roof structures – replacing trusses – open-sided multi-storey car parks, and pedestrian footbridges.

"The maximum length of a manufactured beam is 16m, but the beams can be spliced to make longer sections. An open span portal frame has been made in Austria spanning 56m."

The depth of sections varies from 350mm up to a maximum of 1,580mm, with a 400mm maximum width of flange. Sinusoidal corrugation of the web is standard no matter the depth or the width of the beam.

BCSA publishes NSSS 6th edition

The British Constructional Steelwork Association (BCSA) has published the 6th Edition of the National Structural Steelwork Specification (NSSS) for Building Construction (BCSA Publication No. 57/17).

The 6th edition can be used for all types of building construction designed for static loading and is based on Execution Class 2 structural steelwork designed in accordance with BS 5950-1 or BS EN 1993-1-1 (including BS EN 1993-1-8 and BS EN 1993-1-10) and executed in accordance with BS EN 1090-1 and BS EN 1090-2.

BCSA Director of Engineering Dr David Moore said: "The NSSS clarifies and aids the process of translating designers' requirements into specific work instructions for execution. Specifiers are encouraged to use this latest NSSS as the default specification for all steel building structures."

Copies of the National Structural Steelwork Specification for Building Construction 6th Edition (BCSA Publication No. 57/17) can be obtained from BCSA's web site (*www.steelconstruction.org/shop*) at a cost of £20 for Non-members and £15 for BCSA members. This book is only available in PDF format.

Steel delivers Oxford chemistry laboratories

Structural steelwork has been completed on main contractor ISG's contract to create new chemistry teaching labs for Oxford University.

Steelwork contractor Four Bay Structures erected 150t of steel for the project.

Although the braced steel frame is structurally independent, it is linked into the existing building on two levels.

Work on the project is scheduled to be completed in Spring 2018.

Bridge opens up King's Cross development

Photo: John Sturrock

A new pedestrian and cycle bridge that spans the Regent's Canal in the heart of London's King's Cross development has been officially opened.

Designed by Moxon Architects, the 38m-span bridge forms a vital link between Camley Street and an area of retail, residential and office schemes.

Working on behalf of main contractor Carillion, S H Structures fabricated the bridge structure from 15mm steel plate at its works in North Yorkshire.

Once fabricated, the bridge was trial assembled before being sent to site in four individual sections.

Assembled on-site, the completed 55t bridge was lifted into place using a 750t-capacity mobile crane.

The bridge was installed on 4 May and officially opened to the public on 5 July.

NEWS IN BRIEF

Kloeckner Metals UK/Westok has released version 10.3 of its cellbeam software package. New features include Eurocode design to EN 1993 and 1994 and enhanced deflection analysis using the stiffness matrix method. The company recommends all users of cellbeam to upgrade to V10.3.

Italian steel processing equipment manufacturer **FICEP** has launched the Tipo G31 CNC machining centre. It is said to be ideal for drilling, milling, marking, scribing, tapping, chamfering and cutting of heavy steel plates up to 100mm thick × 3,100mm in width.

Lindapter's Type HD clips have been chosen to secure low speed rails at Hitachi's Train Manufacturing and Assembly Plant in Newton Aycliffe, where the new InterCity Express (IEP) trains and AT200 commuter trains are being made.

ParkerSteel has taken delivery of two heavy-duty Vernet Behringer plate processing machines and two high performance Esprit plasma profiling systems. Dylan Alexander, Managing Director of ParkerSteel said: "We are very happy with our investment and are particularly impressed with the build quality and performance of the machines."

voestalphine Metsec has launched the wide flange purlin, claiming it had identified a need in the claddings market for a flange with a wider surface for fixing to. The company said the introduction of this product means that a roofing contractor now has an on-hand, bespoke, engineered solution which reduces the amount of materials and labour needed, as well as providing a cost saving.

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

Steel rises on Oxfordshire science project

The latest project at the prestigious Harwell Science Campus in Oxfordshire has started to take shape.

Known as the Harwell Facilities Building, it will provide specialist support space allowing researchers to test and commission new scientific equipment for use on the campus and around the world.

Steelwork is being fabricated, supplied and erected by Hambleton Steel, working on behalf of main contractor Willmott Dixon.

A total of 900t of steel is required for the project and this includes a series of large toblerone-shaped tubular cambered roof trusses, fabricated and delivered in three sections.

Procured through Scape Group's major works framework, Willmott Dixon is working with Oxford architects, Clarke Nicholls Marcel and AECOM to complete the facility by spring 2018.

Willmott Dixon was appointed by the Science & Technology Facilities Council (STFC) for a £23.7M contract to build the Harwell Facilities Building.

Peter Owen, Managing Director of Willmott Dixon in the Midlands said: "It's less than two years after the company completed the RAL Space facility for STFC, also a steel-framed structure at the Harwell Science Campus. We are delighted to be back working with STFC."

Whitehaven school completes 11-week steel programme

Working on behalf of Wates Construction, Border Steelwork Structures (BSS) has completed its 700t steelwork package on Whitehaven Campus.

The project will bring together St Benedict's Catholic High School and special education needs (SEN) school, Mayfield, into two brand new buildings at the former's existing site in Hensingham, Whitehaven.

The project, which is due for completion in August 2019, has a £28M value and has been funded by investment from a range of partners, including Copeland Community Fund, Cumbria County Council, the Nuclear Decommissioning Authority and Sellafield Ltd.

As well as an indoor sports hall, fitness suite and a hydrotherapy pool, a range of outdoor facilities will be available to the local community during non-school hours.

These include multi-use sports pitches, one of which will have an all-weather 4G surface.

"We erected the entire steel frame in 11 weeks, which amounted to some 3,500 individual pieces," said BSS Contracts Director Stuart Airey.

"That's one of the advantages of steel, it is quick to erect and only high winds, which we didn't really get, will halt its progress," added Wates Senior Project Manager Simon Humphrey.

"I've been involved in a number of steel construction jobs in the past and this one has been one of the most well organised. The trick is to order the steel early and get the fabrication started as soon as possible to iron out any snags, and this is precisely what we did."

Revised plans for City 50-storey tower approved

The City of London Corporation has granted planning permission for WilkinsonEyre's revised 6-8 Bishopsgate/150 Leadenhall Street tower, which includes 10 more floors.

Approval has now been secured for the 50-storey office tower which will sit at the corner of Leadenhall Street and Bishopsgate. The development will encompass a distinctive 'stacked blocks' design, with retail units on the ground floor and a viewing gallery at its summit. The scheme will now provide over 52,900m^2 of space to let.

Developers for the scheme are Mitsubishi Estate London and Stanhope.

Stanhope Chief Executive David Camp said: "We are delighted to be continuing our partnership with Mitsubishi Estates on this striking landmark building for London that will further enhance its global appeal and its ability to attract high quality international businesses to locate in the City."

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 answers, 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 three model answers, which are to Question 1 from 2013, Question 2 from 2015 and Question 1 in 2016, are now available at: *www.steelconstruction.info/Continuing_Professional_Development#Model_answers_to_IStructE_exam*

Steel completes at west London school

Elland Steel Structures has completed the steel erection for the £25M Nishkam School in west London.

Working on behalf of main contractor BAM Construction, Elland Steel has installed precast staircases, 7,500m² of 200mm-deep precast flooring, structural roof decking and 570t of structural steelwork.

The new school, which will include a sixth form, will provide places for 1,400 pupils.

Architecturally, the school is set over two and three-storeys, with four wings radiating from a central hub.

The project also includes a four-court sports hall, two dining halls, main assembly hall, and a central faith area with an ETFE dome.

An extensive solar array on the roof will allow it to meet the requirements of the London Plan, which is a strategic plan for the capital setting out an integrated economic, environmental, transport and social framework.

There will be electric charging points in the car park, and the football field will be used for storm attenuation.

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.

Once ISG has completed the construction programme, fit-out is due to commence early this year with the opening of the outlet scheduled for the summer.

NEWS IN BRIEF

Trimble has released a variety of new tools for Tekla Structures, which it said will enable customers to detail miscellaneous steelwork easily and quickly. Expanding upon the group of default components already available in Tekla Structures, Trimble has added new components to address more complex situations. The new tools, which can be used for a multitude of projects, whether it's residential, industrial or architectural, are said to allow detailers to create curved platforms, spiral staircases and mezzanine floor systems.

British Steel has reported a profit for the first year as an independent business since being sold by Tata Steel. The company, which is primarily based at the Scunthorpe steelworks posted £47M in earnings before interest, tax, depreciation and amortisation in the 12 months ending 31 March. Executive Chairman Roland Junck said: "In 12 months we have started transforming from an inward-looking production hub into a profitable, more agile business by controlling costs, improving our product range and quality, and through strategic investments."

Coatings manufacturer **Hempel** has introduced Hempaprime Multi 500, a new epoxy intermediate coating that is said to offer a longer service life for industrial assets and steelwork.

ArcelorMittal has a new publication focusing on high-rise buildings that was produced with the assistance and guidance of the Council on Tall Buildings and Urban Habitat. The guide highlights how structural steel can be used effectively in tall buildings and includes various effective structural options such as: use of S460, stiffness considerations including outrigger design, recommendations for seismic design, life cycle assessment and composite mega-columns. It can be downloaded from: *http://sections.arcelormittal.com/library/technical-brochures.html*

Steel sector's professionalism highlighted at Awards

The Structural Steel Design Awards (SSDA) scheme was instituted in 1969 to recognise the high standards of structural and architectural design attainable in the use of steel.

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

Chairman of the Judges, David Lazenby

BCSA President, Tim Outteridge

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.

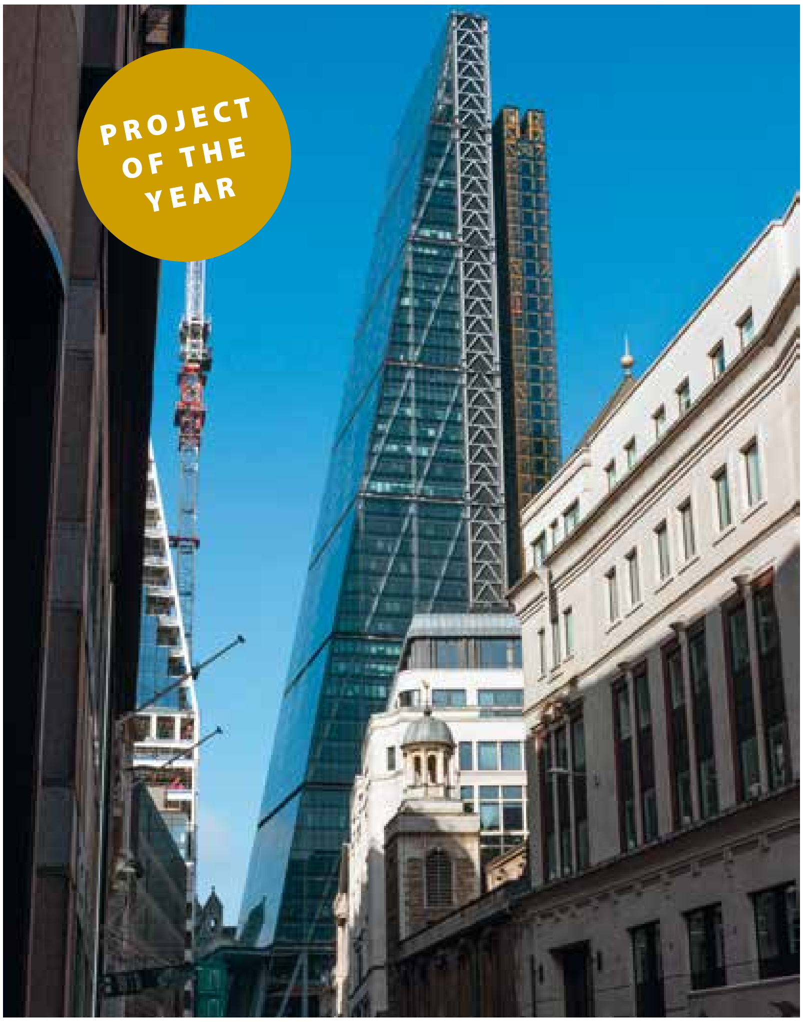
"This expertise shines through the entire shortlist, and I would like to congratulate every one of you for your outstanding achievements.

"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."

The Leadenhall Building, London



© 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 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 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," says Arup Director Nigel Annereau.

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.

Summing up, the judges say this project had a committed client, architectural and engineering excellence, fabrication precision and construction ingenuity and innovation.

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

FACT FILE
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

T-Pylon

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.

In summary, the judges say the T-Pylon represents a generational step change in power transmission hardware. This is a steelwork design classic.

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

LSQ London

FACT FILE
LSQ London
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 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," says make Lead Architect Frank Filskow.

"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."

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 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.

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.

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.

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

HGV Egress Ramp, Selfridges, London

FACT FILE
HGV Egress Ramp, Selfridges, London
Architect: Gensler
Structural engineer: Expedition Engineering
Steelwork contractor: William Hare
Main contractor: Blue Sky Building and SRM JV
Client: Selfridges

In 2012, a master plan feasibility report was prepared for Selfridges that explored redevelopment opportunities across its store in 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 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

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.

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.

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

The project is located in the heart of Romford town centre

Hot and cold

A swimming pool and an ice rink are being built within one large steel-framed structure in Romford, presenting several challenges.

FACT FILE
Romford Ice Rink and Swimming Pool
Main client: London Borough of Havering
Architect: Saunders Boston
Main contractor: Willmott Dixon
Structural engineer: AKS Ward
Steelwork contractor: Billington Structures
Steel tonnage: 1,200t

Constructing two large column-free spaces stacked on top of each other may be a challenge in itself, but if one contains a heated swimming pool and the other an ice rink, all of a sudden a whole host of unique issues concerning temperature and isolation arise.

This is precisely what Willmott Dixon is facing at Romford where, in order to fit all of the required amenities into a tight footprint, an ice rink is being built above a swimming pool at a new leisure centre, something that is said to have only been done once before in the UK.

Working on behalf of the London Borough of Havering, the £28M flagship Romford Ice Rink and Swimming Pool complex will deliver an eight-lane competition swimming pool, fitness suite and 56m x 26m ice rink in the heart of the town centre.

The council says the long-planned development will assist the cultural renewal of Romford and will make a huge impact on the local economy by attracting new inward investment.

The new rink will also provide a home for the local ice hockey team, London Raiders, who relocated to Lea Valley when Romford's former ice rink closed in 2013. The team plans to take up residence in time for the 2018/19 season.

Commenting on the project's unique features, Willmott Dixon Project Manager Simon Cook says: "The temperature differential between a hot pool and a freezing ice rink has made this building particularly challenging to design and build."

The difference in temperature creates the potential for surface condensation due to warm, moist air hitting a very cold slab above the pool.

As most ice rinks are built on the ground this is not an everyday problem, but the solution was relatively straightforward. A thick layer of carefully detailed insulation was installed below the 200mm thick composite slab.

This protected the network of ice rink cooling pipes encased in the super-flat concrete slab which had to be constructed to a surface tolerance of +/- 3mm. Below this, steelwork supporting metal decking was punctured with 300mm diameter holes through the webs to increase air circulation.

As well as isolating the ice rink from the pool, the other big challenge was creating the large spans for each of these two distinct facilities.

"Due to the extensive spans we required, and because of the unique challenges of constructing an ice rink over a swimming pool, our preferred approach was to use a steel frame solution," explains Saunders Boston Architects Director Nathan Swift.

"Steel was the obvious choice to accommodate the 25m-long span competition pool, an array of water balancing tanks, a learner pool and the ice rink's 42m-long span," agrees AKS Ward Engineer Sophie Onoufriou.

"Both vertical and horizontal deflections of the structure were also very tight and difficult to achieve due to the large open spaces and double-height voids. Locating steel cross bracing at the right places was a challenge."

Spanning the ground floor swimming pool is a series of 35m-long by 1.55m-deep plate girders. Supported by perimeter columns and one internal column line, the girders create two spans, one 25m-wide zone for the pool and another 10m-wide zone primarily taken up by changing rooms.

Because of the high humidity levels expected inside the pool area, the girders and their supporting columns are protected for the chlorinated environment by means of a high quality paint system suitable for a C4 environment.

The structure's main columns are spaced at 6m centres. However, due to the length of the required span and the loads from the ice rink, the plate girders are spaced at 3m centres with intermediate girders located in between each column spacing.

Steelwork contractor Billington Structures delivered these 35m-long girders to site in three sections. Two sections were bolted together on the ground to form one long member, which was then lifted into place using a mobile crane. The third section was lifted separately and the final splice completed mid-air.

Creating the roof of the leisure centre and the large 42m-long span over the ice rink is a series of trusses. These were also brought to site in three sections and erected in a similar fashion.

The ice rink will have spectator terrace seating on either side, with the highest bank of eight tiers on the western elevation of the facility formed with steel rakers bolted to the main steel frame supporting precast seating units.

Exerting more loads on to the project's steelwork, and another reason why the plate girders are spaced at 3m centres, the ice rink's floor will also have to support an 8t ice surfacing machine.

This vehicle cleans and smooths the surface of the ice sheet and a rink operator will generally use its machine a couple of times a day.

A steel-framed storage space beside the terrace seating has been erected, as well as a large ice pit where ice shavings are dropped into warm water before being drained away.

Summing up, Mr Cook says the project's other main challenge has been the logistics of working on such a tight site.

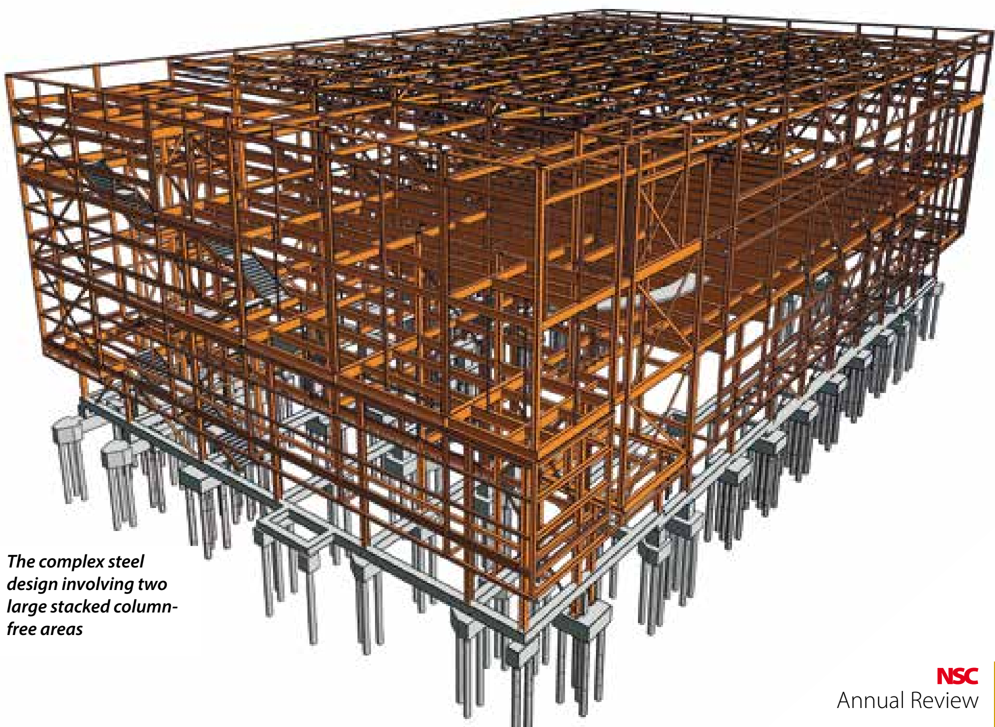
"Prior to steelwork starting on-site we piled the site and then excavated the pool, as this would have been very difficult to do once the frame was up."

"This means once the steelwork programme is nearing completion we can then start concreting the pool and ground floor slabs, working inside the footprint and around the erected columns."

Romford Ice Rink and Swimming Pool is due to complete early this year.

The upper-level ice rink under construction

Roof trusses spanning the ice rink



The complex steel design involving two large stacked column-free areas

Reaching new heights: Steelwork nears completion

The City's dramatic addition

Eventually reaching a height of 190m, 52 Lime Street is the City of London's latest standout commercial development. Martin Cooper reports.

FACT FILE
52 Lime Street, London
Main client: W.R Berkley Corporation
Architect: Kohn Pedersen Fox
Main contractor: Skanska
Structural engineer: Arup
Steelwork contractor: William Hare
Steel tonnage: 10,500t

Featuring a dramatic architectural shape with asymmetric facets and a pointed attic roof structure, 52 Lime Street has from its inception been dubbed the Scalpel, a name that has since been adopted as the official moniker.

Joining a cluster of other prestigious high-rise buildings in the square mile, the project will offer 36,966m^2 of internal floor area over 35 office floors, retail and restaurant areas.

Designed by architects Kohn Pedersen Fox, the project also includes a public square. The realm may also provide space for public art and tables linked to a specialist ground floor coffee shop, designed as a nod to the 17th century establishments that acted as meeting houses for London's fledgling insurance market.

The building has a dramatic inclined northern façade

Setting it apart from its neighbours, the Scalpel features an inclined northern façade, which has a diagonal fold line running from top to bottom giving the building its distinctive look and name.

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

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

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

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

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

Having taken possession of the site once the demolition of the previous building to ground floor level had been completed, Skanska's initial task was to complete the basement works prior to the steelwork erection starting.

A third of the existing basement was partially deepened and, to keep the construction programme on schedule, the ground floor slab was cast early. This allowed the basement construction to be done in a top-down method, while the steel erection was able to carry on above simultaneously.

Early works also included constructing the building's main concrete core. Once this had reached its halfway point at level 17, the steel erection programme was kicking off at ground floor.

Unlike many commercial buildings, the Scalpel's main core is offset and positioned along the south elevation, which provides shade from solar gain. In this way, the structure's available floor space has been maximised and internal spans of up to 20m have been achieved.

A confined site has provided many construction challenges

Visualisation of the completed structure

Wind protection

Because of the building's triangular-like shape and the prevailing south-westerly winds that will hit the structure's narrowest point, a total of seven viscous dampers have been installed within the north elevation steelwork.

Viscous dampers are hydraulic devices that dissipate the kinetic energy of the building and stop the build-up of uncomfortable side to side accelerations in a wind storm.

Because they are built into the stability system of the building they provide damping at a fraction of the cost and take up less space than the more traditional "Tuned Mass Damper" or TMD.

Having an offset core coupled with an inclined north elevation means that the loads on the building are eccentric from the main stability-giving core. To counteract this, the north elevation, as well as the east and west façades, have been designed as large perimeter moment frames to add stiffness to the building.

The core houses three banks of lifts, one for the lower levels (1 to 12), one for the mid-levels (13 to 24), and one for the upper levels (25 to 35). This means the core decreases in size towards the top as only one bank of lifts is accommodated at the upper levels. Again, this has helped the project further maximise the available floor space.

Because of the building's inclined northern elevation, floor areas decrease from 1,466m^2 on the second floor to 614m2 on level 35, the uppermost office floor. Up to level 21 the building has one row of internal columns, but as the floorplates decrease these are no longer needed and by level 24 there are none.

Topping the building is a 10-storey triangular attic that will house plant and maintenance walkways.

A high piece count would have ordinarily been expected for this structure so, in order to make the erection process as easy as possible and iron-out any snags, William Hare trial erected this portion of the building at its fabrication yard.

"Once it had been trial erected the attic structure was dismantled and then brought to site in the largest pieces that could be transported and was erected by the on-site tower cranes," explains Mr Perry.

The attic is a complex steel structure designed to be erected floor level by floor level, with each level immediately stable upon erection. Designing the attic in this way was vital as there is no core this high up the building to give stability and no internal floors to provide any diaphragm action.

No time to take in the view as steel erectors complete a bolted connection

Warehouse opts for a range of steel options

Work is progressing on a vast regional distribution hub near Bristol for retailer The Range.

False ceilings at either end of the building provide access to the sprinkler system

FACT FILE
The Range distribution centre, Avonmouth
Main client: Stoford, The Range
Architect: AJA Architects
Main contractor: McLaren Construction
Structural engineer: Complete Design Partnership
Steelwork contractor: Caunton Engineering
Steel tonnage: 3,500t

An enormous £90M warehouse at Central Park in Avonmouth, under construction for retailer The Range, will be the largest Birmingham-based commercial property developer Stoford has ever delivered.

Providing more than 111,000m² of space, it will be the biggest single building in the South West and one of the largest in the UK. It is claimed to be the equivalent size of 15 Wembley Stadiums.

With good transportation links and close to the Second Severn Crossing, the hub will bring 1,000 jobs to the region and inject millions of pounds into the local economy.

Stoford Developments Director Tony Nash says: "Central Park is an excellent location with first class infrastructure, including the nearby motorway, on-site direct rail freight services and adjacent sea connections."

Steel erection under way

Chris Dawson, founder of The Range adds: "This distribution centre is a big step in the expansion plans that I have for the business; it's non-stop for us. When the warehouse is up and fully operational, it will act as a training hub for smaller distribution centres around the country."

Main contractor McLaren Construction started work on-site in 2016 with an extensive piling programme kicking off proceedings.

As the site is close to the banks of the River Severn, the ground contains soft alluvial deposits and a total of 16,000 concrete piles have been installed, to a depth of 20m, in order to support the ground slab, the steel-frame of the warehouse and its internal racking system.

To keep the programme on schedule, the construction sequence was arranged so that Caunton Engineering erected the steelwork immediately behind the piling operation.

The sequential operation was then repeated with the cladding and roofing contractors along with the concreting team installing the ground slab following on behind Caunton's steelwork erectors.

Overall, the building measures 480m in length, which equates to 60 × 8m-wide bays. It has six spans of 36.5m giving the warehouse a total width of 220m.

Caunton Engineering Site Manager Dave Chadwick says: "We split the erection programme into eight phases, with each one consisting of up to 10 bays in length and the full width of the building."

The roof was strengthened at either end of the building to support two sprinkler platforms at low level.

Extending for five bays at each end and covering the entire width of the warehouse, the false ceilings are hung from the rafters and provide maintenance access to the low level sprinkler system.

All of the rafters were brought to site in 18.25m lengths. For the erection process two sections were bolted together on the ground to form the entire span, which was then lifted into place using one of Caunton's on-site mobile cranes.

One end of the warehouse contains a single-storey office block, measuring 16m (two bays) × 45m-wide, which equates to about one and half spans.

This internal steel braced frame is attached to the perimeter steelwork and topped with a composite slab. Flexibility has been designed into this part of the steelwork so a second storey could be added in the future.

Another notable feature of the warehouse is the fact that there are 104 loading dock doors within the wall panels, and a couple of external canopies that accommodate 14 goods-in/goods-out level access doors. Adjacent to the canopies, on the inside of the warehouse, are two further transport hub office areas.

The enormous warehouse is said to be the largest building in the South West

A range of big spans

David Brown of the SCI discusses some of the features of large distribution centres.

Apart from the overall size, The Range distribution centre is of conventional portal frame design, illustrating the economic dominance of this form of construction when enclosing large volumes.

The spans of 36.5m and centres of 8m are quite orthodox, and 15m clear to the underside of the haunch is not uncommon for this form of distribution facility.

The sheer size of the structure does bring one rather unusual issue, which is the contribution of drag to the overall wind loads. Clause 2.1.3.8 of BS 6399-2 covers the frictional drag component, which comprises a frictional force from the walls (Clause 2.4.5) and a frictional force from the roof (Clause 2.5.10), both depending on the type of surface and thus the frictional drag coefficient from Table 6.

For walls, the frictional drag is assumed to act over all of zone C (the most downwind zone, away from the turbulence that causes high local suctions at the windward edges). For roofs, when wind is blowing parallel to the ridge(s), frictional drag is again assumed to act over zone D, the most downwind zone.

For small buildings, the effect of drag is often rather insignificant, but for The Range distribution centre, the *unfactored* contribution of drag, from the roof alone, was 1200 kN.

In contrast, the overall load from the pressure and suction on the end elevations was approximately 2800 kN, so the drag from the roof alone increased the overall force by over 40%. With larger plan buildings, the lesson is to never neglect drag – it can be considerable.

Distribution centres, as their name implies, are almost certain to have many openings on the elevations. Depending on the direction of the wind and the location of the openings, much increased pressure or suction inside the building could be the result. This is the effect of a dominant opening, covered in Clause 2.6.2 of BS 6399-2.

The designer must carefully consider if assuming the doors to be shut in the event of a severe storm is realistic. BS EN 1991-1-4 requires that if an opening would be dominant (almost certainly) yet is assumed shut, the accident of the door being open should be considered.

A second challenge with distribution centres is that the large doors can often mean that locating vertical bracing on the elevations can be problematic. This was the case at The Range distribution centre, so portalised bracing was adopted around the door openings and conventional diagonal bracing above.

Steel ticks all the boxes

Steel has many benefits that deliver value to designers, contractors, developers and building users. Most arise automatically once the decision to build in steel is made, and at no extra cost.

Safety

- ✓ Accurate fabrication work takes place offsite under controlled and regulated factory conditions
- ✓ Fabricated steel is only brought to site when needed avoiding potentially dangerous clutter
- ✓ Fewer people are needed on-site, reducing the risk of accidents
- ✓ On-site pre-assembly reduces the number of lifting operations and the need to work at height
- ✓ Steel frames are full strength as soon as they are completed so stairs can be fitted, providing safe access for other trades straightaway
- ✓ Steel decking for composite slabs provides a safe platform after installation and protection to lower storeys

Speed

- ✓ Steel construction is fast with skilled erection teams who have a safety focus
- ✓ Steel gives the earliest start on-site and earliest possible pay back on investments
- ✓ Time related savings can amount to between 3% and 5% of the overall project value
- ✓ Fast and safe erection of steelwork makes way for other critical path operations
- ✓ Accurate offsite fabrication eliminates time-wasting quality issues and reworking on-site
- ✓ Offsite trial erections of complex structures can ensure that everything goes right on the day

Quality

- ✓ Quality assurance runs throughout the steel construction supply chain
- ✓ Steel construction provides the surest guarantee of a high-quality finished building
- ✓ Steel sections are tested, certified, and CE Marked before delivery with inspection certificates
- ✓ Fabrication processes are quality assured and fully CE Marked
- ✓ 3D modelling and numerically controlled fabrication systems deliver precision-engineered components to tight tolerances
- ✓ All BCSA steelwork contractors are regularly checked for their technical capabilities and financial standing

Efficiency

- ✓ Efficient steel designs take advantage of the high strength-to-weight ratio of steel
- ✓ Superior use of space and longer flexible internal column-free spaces can be achieved
- ✓ Lean manufacture within an integrated supply chain gives a more predictable construction programme
- ✓ Just-in-time deliveries can be sequenced and synchronised with the construction programme
- ✓ Steel is fabricated offsite to tight tolerances and brought to site for erection with virtually no waste
- ✓ With 3D modelling as standard practice steelwork contractors have long been delivering the efficiencies of BIM

Cost

- ✓ Steel is the most cost-effective framing material for buildings and structures of all types
- ✓ Steel is cheaper than it was 15 years ago in inflation adjusted terms, and has fallen in price since 1980
- ✓ Cost saving benefits from productivity advances achieved throughout the steel supply chain are shared with customers
- ✓ A competitive sector with a large number of steelwork contractors ensures that customers get value for money
- ✓ Cost savings in steel buildings start at the foundations, where the loads imposed by a steel frame are up to 50% less than those of a concrete alternative
- ✓ In October, an independent study showed that on a typical city centre office building, the frame and upper floors cost of the cellular steel composite beam and slab option was 8% lower than the concrete alternative

Sustainability

- ✓ Steel is the world's most recycled material
- ✓ 99% of structural steel used in the UK is either re-used or recycled, waste is minimal to non-existent
- ✓ Steel is multicycled, meaning that it can be used again and again without any loss of quality
- ✓ Steel buildings are adaptable and flexible offering future-proofed solutions
- ✓ Almost all steel-framed buildings can provide optimal thermal mass
- ✓ Signatory companies to the BCSA's Sustainability Charter agree to their sustainability credentials being assessed and monitored

Acoustics and Vibration

- ✓ Steel-framed buildings easily satisfy the acoustic performance requirements for residential buildings
- ✓ Infill steel-framed external walls provide both acoustic and thermal insulation
- ✓ Conventional steel construction systems meet the required vibration performance criteria without any special measures being adopted
- ✓ Extra stiffening can be applied for extremely vibration sensitive applications like hospital operating theatre floors
- ✓ Even with these additions steel remains the most cost-effective and lightweight solution
- ✓ Long-span applications, for which steel is the only option, have been found to offer excellent vibration damping

Fire Protection

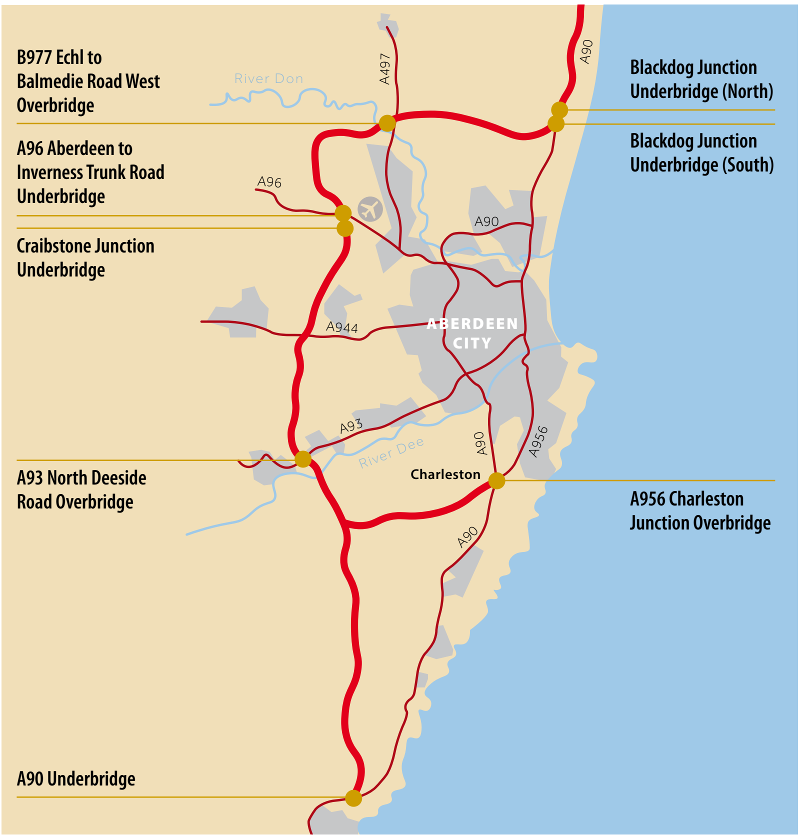
- ✓ More is understood about the behaviour of steel in fire than any other construction material
- ✓ The UK has a competitive and very effective fire protection industry
- ✓ A continuous programme of research means that cost-effective fire protection measures are always being improved
- ✓ Advanced design and analysis techniques avoid over-specification of fire protection requirements
- ✓ The analysis of composite steel deck floors in fire can eliminate fire protection on many secondary beams
- ✓ Offsite application of thin film intumescent coatings shortens construction programmes

Girders are lifted in for the A93 North Deeside Overbridge

Bridging the granite city's bypass

A total of eight steel composite bridges have been constructed as a vital component of the Aberdeen Western Peripheral Route.

FACT FILE
Aberdeen Western Peripheral Route/ Balmedie to Tipperty bridges
Main client: Transport Scotland, Aberdeen City Council, Aberdeenshire Council
Main contractor: AWPR Construction Joint Venture
Steelwork contractor: Cleveland Bridge
Steel tonnage: 1,350t



Covering a distance of 58km, the Aberdeen Western Peripheral Route/Balmedie to Tipperty (AWPR/B-T) is the longest road building project currently under way in the UK.

Designed to significantly improve travel in and around Aberdeen and the north east of Scotland, the scheme is being delivered by a joint venture that includes Balfour Beatty, Morrison Construction and Carillion.

One of main reasons for the project is the fact that Aberdeen lies at the intersection of several major roads, including the A90 and A96 trunk roads. Currently traffic has to travel through the city, making journeys difficult and time-consuming.

Meanwhile, the existing Balmedie to Tipperty road is recognised as a bottleneck. The single carriageway, which carries some 22,000 vehicles per day, is heavily affected by peak traffic flow during the morning commute.

Alleviating these problems, the new AWPR/B-T will consist mainly of a new dual two-lane carriageway. However, the carriageway will be dual three-lane for a short section between the North Kingswells and Craibstone Junctions and between Charleston and the next junction to the south at Findon on the existing A90.

The project provides a bypass for long-distance traffic while facilitating peripheral movement for shorter journeys, therefore removing traffic from both the city areas and unsuitable rural and urban local roads.

Constructing such a long highway around a major conurbation brings with it the need for bridges - 75 to be exact on this scheme. Many of these structures are minor, but eight major bridges are steel composite structures fabricated, supplied and erected by Cleveland Bridge.

The bridges vary in length but all have a similar steel composite design. They are constructed with pairs of steel braced girders supporting a concrete deck slab. All of them are single-span bridges with the exception of the two-span A93 North Deeside Road Overbridge.

According to a Transport Scotland spokesperson: "Steel was selected for the structures where the bridge geometry was

One of the 46m-long girders for the North Deeside Overbridge is delivered

too long a span or at too high a skew for concrete, or where steel provided a greater space for fitting major utilities below the bridge deck."

In order to fit in with the overall construction programme, bridge construction has been sequenced with Cleveland Bridge erecting four structures in 2016 and then completing its work in Spring 2017.

During 2016, Cleveland Bridge delivered and installed the steelwork for the following bridges: the A93 North Deeside Road Overbridge, the Craibstone Junction Underbridge, the A96 Aberdeen-Inverness Trunk Road Underbridge and the B977 Echt-Balmedie Road West Overbridge.

Commenting on the work, Cleveland Bridge Head of Projects Dan Banks says: "The delivery of the first four bridges, which had components that were up to 43.5m-long and needed to be transported more than 300 miles, is a demonstration of our manufacturing and logistical capabilities."

Two of the initial bridge structures to be installed, the B977 Echt-Balmedie Overbridge and the A96 Aberdeen-Inverness Underbridge, both required assembly of girders adjacent to their final position.

For the former bridge, the steel was brought to site in four braced pairs of plate girders, each pair being 3.2m wide. They were joined on site, using a 250t-capacity mobile crane to form two 57m-long braced pairs of girders. These were then installed over days using a 500t telescopic crane.

The A96 bridge is a single span structure requiring five pairs of plate girders. The steelwork was taken to site in lengths of 36m and 12m, which were spliced together on two plots adjacent to the bridge's final position. Installation of this bridge required the use of a 800t-capacity lattice boom crane.

The bridges that were installed in 2017 were: the A956 Charleston Overbridge, and the Blackdog Junction North Underbridge and South Underbridge, structures that form both parts of a roundabout junction.

The final bridge structure in Cleveland Bridge's programme was the A90 Aberdeen-Dundee Trunk Road Underbridge at Stonehaven

Steel Bridges - Vital Statistics

A93 North Deeside Road Overbridge – Steel tonnage of 300t and consists of three pairs of two-span plate girders that were installed using a 500t-capacity crane. The fully painted pairs of girders measure 4.8m wide and were delivered to site in 46m and 29m lengths.

Craibstone Junction Underbridge – Steel tonnage of 301t and consists of five pairs of weathering steel plate girders that were taken to site as braced pairs measuring 3.25m wide and 42m long.

A96 Aberdeen-Inverness Trunk Road Underbridge (above) – This is the heaviest structure with a steel tonnage of 811t. It consists of five pairs of weathering steel plate girders 3.2m wide and 48m long.

B977 Echt-Balmedie Road West Overbridge (below) – A fully painted structure with a tonnage of 210t. Consists of two pairs of plate girders measuring 3.2m wide and 57m long.

The A90 Aberdeen-Dundee Trunk Road Underbridge at Stonehaven – Steel tonnage of 312t, this structure consists of five pairs of fully painted plate girders that were brought to site in 3.8m wide × 40m lengths.

The A956 Charleston Junction Overbridge – The second heaviest structure with a 518t tonnage. Consists of seven pairs of weathering steel plate girders brought to site in 3.8m wide × 50m lengths.

The Blackdog Junction Underbridge (North) – Weighing 197t, this structure consists of three pairs of weathering steel plate girders brought to site as 3.8m wide × 44m lengths.

The Blackdog Junction Underbridge (South) – Consists of three pairs of weathering steel plate girders brought to site in 3.8m wide × 46m lengths. Tonnage of 215t.

School goes for steel option

Set to replace an existing school in a nearby village, the West Calder High School has opted for a steel framing solution for cost and efficiency. Martin Cooper reports.

FACT FILE
West Calder High School, West Lothian
Main Client: Hub South East Scotland on behalf of West Lothian Council
Architect: Archial NORR
Main contractor: Morrison Construction
Structural engineer: Arup
Steelwork Contractor: Hescott Engineering
Steel tonnage: 800t

Work is progressing on a new 1,100 capacity secondary school in the West Lothian village of West Calder. The project will replace a nearby existing school and includes a host of amenities such as a swimming pool and other indoor and outdoor sports facilities.

The school is West Lothian Council's largest ever single investment in education. It is being developed through Hub South East Scotland, with Morrison Construction appointed to build the new school.

Due to open later this year, the project architects say the school has been designed with the pupil experience at the core, as well as providing facilities accessible to the local community.

The swimming pool, fitness suite, games hall and outdoor sports pitches will be open to the public at certain times, as will the amphitheatre, which is a feature that forms an integral part of the school's overall design.

The multi-use amphitheatre is positioned in the centre of the school with the classrooms located around the perimeter, while more flexible learning space is located in nearby main circulation areas.

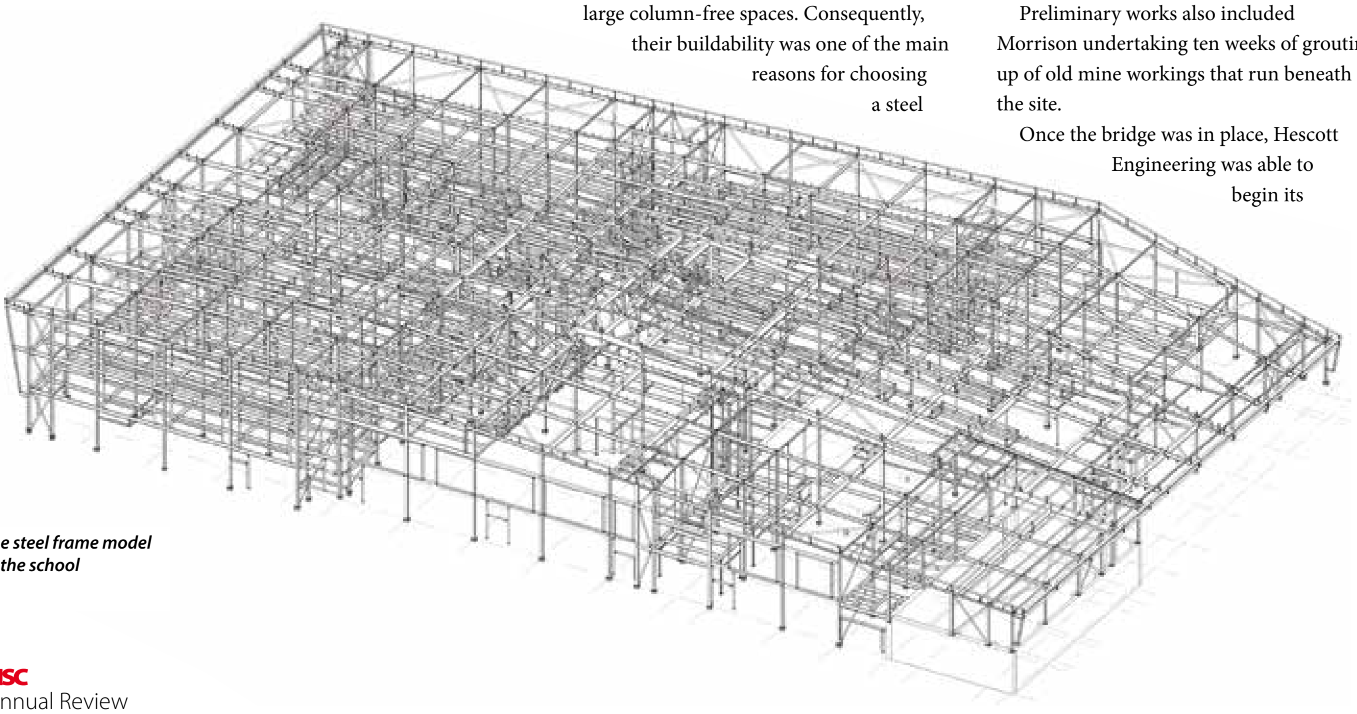
As well as the amphitheatre, most of the school's facilities, such as the pool, games hall and dining area, are all located within large column-free spaces. Consequently, their buildability was one of the main reasons for choosing a steel framing solution for the project.

"Early in the design process we looked at all framing options, weighing up their pros and cons. Ultimately to build the required long spans efficiently and quickly we went with a steel-framed solution," says Arup Lead Project Engineer Ian Miller.

However, before any of the structure could be built, access to the project's site had to be improved. During the early stages of the job's 91-week programme, a narrow local road, passing a number of private properties was used. Construction of a new £5.5M bridge over the A71 and a link road has now provided the site with a haul route for materials.

Preliminary works also included Morrison undertaking ten weeks of grouting up of old mine workings that run beneath the site.

Once the bridge was in place, Hescott Engineering was able to begin its



The steel frame model of the school

The three-storey teaching block

steel erection in February. A cut and fill operation, to form a level base for the school building on this sloping site, was also under way at this time.

Approximately 25,000m³ of overburden has been excavated from the site, with almost 13,000m³ of this spoil re-used. Sitting on concrete pad foundations, the steelwork erection programme has followed on behind the groundworks and earthmoving teams, with all of these trades working in a southerly direction from the lowest end of the site.

In order to integrate the school to the sloping topography, two retaining walls have been constructed across the building's footprint, approximately dividing the building into thirds. The walls form two steps, 3m and 5m-high respectively. Consequently, the 100m-long × 60m-wide building descends from three-storeys down to one storey at the southern end.

Most of the classrooms, as well as the school's main entrance, are located within the three-storey northern end of the building. Because of their different uses, many of the classrooms are of varying sizes. This has resulted in an irregular structural grid and the need for numerous transfer beams to support the irregularly spaced columns.

Overall the school building has a composite design with steelwork supporting metal decking with a concrete topping. Bracing, located in the roof and in stairwells, provides the frame with its stability.

Dominating the central area of the school, the amphitheatre and its adjacent feature staircase are the most complex part of the project's steelwork.

As well as offering access to all of the school's floors, the staircase is 20m-wide and incorporates terraced seating. A series of facetted rakers forms the curved shape of the terrace as it wraps around a portion of the performance space.

Supporting the staircase is a series of girders each weighing in excess of 4t.

As well as erecting the steelwork and installing the metal decking, Hescott Engineering also lifted in the precast terracing units. According to Hescott's Business Development Manager John Dowds, a total of 37 crane lifts were needed to install the precast units.

Three 20m-long × 3.5m-deep trusses form the amphitheatre's open-plan column-free space. One of these trusses is positioned at the north end of the space, where the building steps up from two storeys to three. The other two trusses tie into the first truss and span southwards creating the open void.

Looking at the school from the outside the most striking feature will be the roof. Intended to be a nod to the surrounding countryside, the roof slopes down from the three-storey element towards the single storey area, incorporating three different pitches.

A West Lothian Council spokesperson said: "The modern, high-quality school will be a fantastic resource for local young people, providing an ideal learning environment for them to achieve their full potential. This investment will help ensure that West Lothian continues to have one of the best school estates in Scotland."

Terraced seating for the amphitheatre

A number of varying floor levels have resulted in a complex steel design

Steel promotes South Bank development

Two steel-framed commercial blocks will provide a central element to a prestigious mixed-use development taking shape on London's south bank. Martin Cooper reports.

Raking columns span the Bakerloo Line that runs beneath the site

One of the largest construction projects to be undertaken in central London this century is currently under way on the south bank of the River Thames.

Situated between the London Eye and busy Waterloo Station, Southbank Place covers an area of more than 20,000m^2 and consists of two commercial blocks, and six residential towers along with new retail units, restaurants and cafés, all of which are located around the existing Shell Tower, which will become one of the centerpieces when the project completes in 2019.

The two new commercial office blocks, known as One and Two Southbank Place are both steel-framed structures, containing 11 floors and 17 floors respectively.

Apart from one residential tower, the two commercial structures are the first buildings to take shape on what is already a very busy and logistically challenging site.

Faced with the usual traffic, noise and lack of space all inner-city projects have to cope with, Southbank Place will eventually have a maximum workforce of 1,600 people.

The steel erection has been carried out immediately behind the large-scale groundworks programme, which is currently progressing throughout the site.

Viewed from outside of the hoardings, the project is a forest of tower cranes – there are currently 16 cranes – needed to feed and lift the various materials being used.

"There is very little room on-site and certainly no room for materials to be stored," explains Canary Wharf Contractors Project Manager Sam Hayward. "All of the steelwork has to be delivered on a just-in-time basis and is being offloaded and erected by tower crane."

Severfield began its steel erection programme in January. Work was able to commence once the concrete formed

Visualisation of the completed Building Two

Building One incorporates a series of steps for outdoor terraces

basements were completed, along with the slip-formed cores.

Building One has two cores, a main core that reaches the full height of the structure, and a secondary satellite core that only serves the lowest five levels. Building Two has just the one centrally-positioned core.

"Building One is a fairly straightforward building, based around a repetitive 9m × 12m grid pattern," explains WSP Associate Director Andrew Martin. "Two on the other hand is much more complicated as its design is partially dictated by the Bakerloo underground line that passes beneath its footprint."

The tube line actually passes under the structure's south eastern corner and consequently no piles could be installed in this area. In order to not position columns over this important transport link, this corner, that houses the main entrance of the building, slopes inwards from the sixth floor down with the aid of two raking columns.

These raking columns make the building structurally pull itself towards this corner. To counterbalance this temporary bracing has been installed, which has to remain in position until the structure's floors are complete.

Both buildings have used cellular beams throughout for efficient service integration. However, unlike Building One, which has some internal columns, Building Two has none, with clear uninterrupted spans reaching a maximum length of 17m.

"With such long spans, some of our connections are very big, as the finished main member is up to 30t in weight in places," says Severfield Senior Project Manager Paul Walmsley. "We've also had to use a number of plated sections to achieve these spans and for the supporting columns."

The north and west elevation of Building Two features a series of outdoor spaces accommodated on 2m-wide cantilevers. These spaces extend upwards from level 6, and they are formed by two further raking columns positioned at fourth floor level that extend up to the underside of the sixth floor.

The uppermost floor of Building Two is known as the entertainment area. Formed with 12m-high elliptical members, it is a glazed pavilion that is set back from the floors below and offers access to a rooftop terrace. Adjacent to this feature the structure also has a rooftop two-storey plant enclosure.

Meanwhile, Building One's standout features are the five further outdoor terraces, formed as the structure steps in at levels five, eight and nine, and Level 11 is a plant space.

Both blocks will have different cladding systems, with Building Two finished with curtain walling, and One predominantly clad with large precast panels weighing up to 12 tonnes each.

Both buildings are aiming to achieve a BREEAM "Excellent' rating, and are due to complete towards the end of 2018.

The project is one of the first to be operating as an Ultra Site under the Considerate Constructors Scheme.

Building One (foreground) and Building Two viewed from York Road

FACT FILE
One & Two Southbank Place, London
Main client: Braeburn Estates
Architects: Squire and Partners, Adamson Associates, Kohn Pederson Fox
Main contractor: Canary Wharf Contractors
Structural engineer: WSP
Steelwork contractor: Severfield
Steel tonnage: 6,300t

Steel model of Building Two

Complex frame accommodated by steel

FACT FILE
Richmond Wood Norton retirement village, Evesham, Worcestershire
Main Client: Richmond Care Villages
Architect: BAM Design
Main contractor: BAM Construction
Structural engineer: Rodgers Leask
Steel contractor: Adstone Construction
Steel tonnage: 1,080t

A steel-framed solution was the answer for a retirement village containing numerous room configurations, spread over seven different floor levels. Martin Cooper reports.

As the UK has an ageing population, it is no surprise that the construction of retirement accommodation is on the increase.

One of the country's leading providers is BUPA-owned client Richmond Care Villages, who are currently providing a retirement village at Wood Norton near Evesham, Worcestershire.

The £40M development, being built by BAM Construction, will create 61 village apartments for independent living, 46 suites for assisted living, and a 60-bed care home providing nursing and dementia care.

In addition, there will be a wellness spa, lounges, library, terrace café, restaurant and garden bar.

The project is located adjacent to an exclusive hotel and BBC technical and training facility. The retirement village's footprint was previously occupied by a BBC-owned training and conference centre, which was demolished as part of the project's early works.

Work initially included the team removing roof tiles and felt from pitched roofs to prevent bats from roosting, and then stripping out asbestos from the existing buildings prior to demolition. The team then undertook groundworks that consisted of 26,000m^3 of overburden being removed from site.

Most of the accommodation is within one large building, with the exception of 13 individual apartments which are housed within a separate three-storey steel-framed building.

The footprint for the main building has a serious slope, with an 8m difference from the top end to the bottom end. Two 5m-high retaining walls were installed to form two steps for the building.

The walls split the building roughly into thirds, with the top portion consisting of four levels (0, 2, 3 and 4) and the bottom third also consisting of four floors, but these are at -2, -1, 0 and level 2. Incidentally floor 1 only exists in the middle portion, which also includes -1, 2 and 3. The entrance to the village is at the top end and at level 0.

Having such a complicated floor set-up had a huge impact on the initial design of the project as BAM Construction Project Manager Paul Hayfield explains: "The design intent was originally for a load-bearing masonry frame, but we changed it to a steel frame as masonry would have been impractical for this form of construction. The steel frame construction has certainly given us a programme betterment."

A steel-braced composite solution using structural steelwork supporting metal decking was the final design decision.

Consequently 1,080t of structural steelwork, fabricated, supplied and erected by Adstone Construction was used, along with 14,347m^2 of metal decking supplied and installed by Structural Metal Decks (SMD).

As well as a sloping site and the subsequent floor level changes, most of the building's floors have different uses, which adds to the complicated design as room sizes and column locations change for each floor.

"The design has to incorporate numerous transfer beams to accommodate column line changes and this is much easier to do with a steel frame," says Rodgers Leask Project Engineer Craig Wynne.

With different room sizes and facilities on most floors the retirement village also requires numerous services, such as heating and power, which have had to be integrated within the structural floor zone.

BAM Design says its expertise in 3D co-ordinated design, and working with steelwork contractor Adstone Construction as well as the structural engineer and M&E subcontractor in a collaborative manner, was fundamental to the integration of over 400 services holes through the steel frame.

"We have fabricated and installed a series of universal beams, each with individual holes formed within them to accommodate the services," says Adstone Construction Contracts Director Gary Howson. "It was important to have the services within the beam's depth as this kept the building height down."

The beams spanning the corridors have to accommodate the most services. In order to create enough space, the design team had to change the support level for the metal decking in some locations.

With a total steel tonnage of just over 1,000t, the project has required an unusually large number of individual steel members.

With little repetition, as very few columns reach the full height of the building, the frame also has to incorporate step changes to the layout. Adstone estimates that the project has required 50% more steel members than would ordinarily be needed for a scheme of this size.

During the steel erection programme Adstone delivered 47 loads of steel, with some loads consisting of up to 270 individual members.

"There are a lot of small pieces due to the complex nature of the structure and the requirements of the frame with every connection being bolted. We've calculated there are approximately 53,000 bolts on this complex job," adds Mr Howson.

Because most of the steel frame consists of small light pieces, Adstone was able to use a 40t-capacity mobile crane for the steel erection. The only exception being some large 10t beams spanning the pool, which required a large crane to be brought to site.

The large piece-count of steel also made the erection process quite complicated.

"We couldn't just erect the building sequentially from one end to the other, as the column lines change so frequently and many parts of the building are reliant on adjacent areas for their stability," says BAM Construction Senior Site Manager Alan Whyte. "Consequently, the erection sequence had to jump around a bit, which made it more challenging when organising where the follow-on trades could begin their work."

Completion of the retirement village is scheduled for September 2018.

Room sizes and uses change for each floor

The complex steel frame

The project incorporates an 8m slope from one end of the site to the other

The distinctive rounded shape of the hospital presented a number of construction challenges

Healthcare in the frame

FACT FILE
New Orkney Hospital and Healthcare Facility, Kirkwall
Main Client: NHS Orkney
Architect: Keppie
Main contractor: Robertson Major Projects
Structural engineer: AECOM
Steelwork contractor: BHC
Steel tonnage: 1,200t

A number of challenges have had to be overcome during the construction of a new hospital in the Orkney Islands. Martin Cooper reports from a project where steel has ticked all the boxes.

Healthcare in the Orkney Islands is set to be transformed by a new £64M hospital and healthcare facility which will provide a state-of-the-art clinical environment for the delivery of health services, and with the introduction of new technologies and facilities will reduce the number of people having to travel to the Scottish mainland for routine care.

Replacing the existing Balfour Hospital, the new facility, which opens in 2019, is currently being built on a greenfield site on the outskirts of Kirkwall, the Island's largest settlement and capital.

The hospital is due to open in 2019

The project is said to be the biggest construction job on the Orkney Islands since St Magnus Cathedral was completed in the 12th Century. In recent times, it is certainly the largest project since the Kirkwall Grammar School and Pickaquoy Leisure Centre were completed a few years ago.

Apart from the Cathedral, all of the aforementioned projects have used structural steelwork as their main framing material.

Steel has a number of advantages over alternative framing solutions when it comes to construction on outlying islands [see box].

"A composite steel solution with metal decking was the best choice for the hospital, as other framing materials simply wouldn't have worked," explains Mark Dalziel, Senior Project Manager for Robertson Major Projects, which is delivering the project.

"For instance, there is only one concrete batching plant on the Orkney Islands and they could not have supplied our needs. Installing our own plant would have been very time-consuming and wouldn't have been cost-effective, so steelwork, which can be brought over from the mainland by ferry ready for erection, was the best option."

Minimising vibration generated by footfall is an important issue for hospitals, particularly in areas accommodating wards and operating theatres. At this hospital, all of these facilities are located on the first floor and, to minimise vibration, the composite reinforced concrete floor slab has been designed as 300mm thick as opposed to a more conventional 150mm in less sensitive areas.

Supporting the thicker slabs, the design has also required the use of short-span heavy steel beams and two additional lines of columns, further negating the potential for vibration issues.

Importantly, the hospital has a very complicated design and shape, necessary to support the required clinical adjacencies and flows, and this also lent itself to a steel composite solution.

The two-storey structure incorporates two inner circular courtyards, one completely enclosed by the building, and the other a partially enclosed horseshoe-shaped yard with an opening.

In between the courtyards there is a connecting hub containing the main entrance, restaurant, a shop and main waiting area. Adjacent to the hub and courtyards, and joining them altogether, the main hospital building is a long-curved structure.

Steel works

Delivering a major healthcare project on the Orkney Islands presented main contractor Robertson Major Projects with a unique set of challenges. To solve these, it took into account the remoteness of the island, supply chain logistics, local landscape, and challenging climatic conditions.

For example, procuring and shipping construction materials, such as steel, to the island and storing on-site well in advance of programme requirements reduced the vulnerability of the project to extreme weather conditions.

Steelwork's speed of construction was also vital as the envelope of the building is designed to take into account the available trades on the islands and to achieve an early wind and watertight position, thereby allowing internal trades to progress despite inclement weather.

"The plan geometry of the design is very complicated and the curved longitudinal grids are based on a number of different radii. We've used straight steel beams for most areas, effectively faceting the frame between grids, although for the tightest curves we've used curved steel members," says AECOM Project Engineer Chris Denton.

Utilising steelwork supporting metal decking has also made it easier to form the required curves in the floorplate.

"Metal decking is fairly easy to cut on-site compared to the alternative precast flooring solution, which would have been far more challenging and time-consuming," says Mr Dalziel.

Predominantly the steelwork is based around a fairly regular 6m grid pattern, at least as far as the perimeter columns are concerned. However, internal columns arranged around the tighter curves of the courtyards have been adjusted accordingly, presenting the scheme with a grid pattern that can also vary from 4m up to 7m spacings.

"There may be three columns positioned along the outside perimeter of a curved area, but the inside of the curve only requires two columns," explains Mr Denton.

The hospital's configuration is fairly standard throughout with a central corridor running down the middle of most parts of the building, separating rooms on either side. The corridors are where the services are located just below the steel first floor and roof beams.

As hospitals are heavily serviced, and this one is no different, some services have had to be accommodated within the beam's depth, via a series of bespoke holes.

"In some areas, we would have had severe congestion without running some services through the beams," says Mr Dalziel. "Having a BIM model to share with the steelwork contractor BHC and all of the other team members meant that we could avoid clashes and provide sufficient room for services."

The entrance to the hospital is accommodated within a large central column-free space known as the hub. This double-height space will have a series of north lights positioned within the roof, allowing plenty of natural light into the hub.

The hub is formed with a series of 15m-long rafters creating the required spacious zone.

From the hub the southern courtyard can be accessed. This totally enclosed outdoor area will be landscaped and feature a sensory garden and seating to create a sheltered area for visitors and patients alike. The other partially enclosed courtyard will be an outdoor area for a range of users.

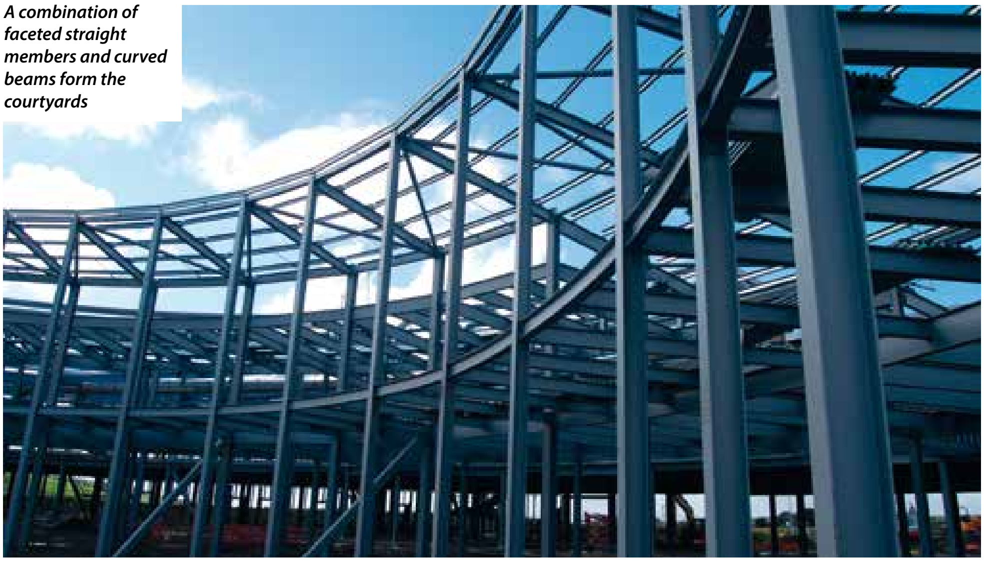
The building's steel frame derives most of its stability from vertical diagonal bracing, positioned in internal partition walls and perimeter areas where there are no windows. This has worked well for the ground floor where the GP practices, dentistry, outpatients, staff areas and kitchens are located.

The first floor, which predominantly has operating theatres and patient rooms – all en-suite single occupancy units – has been designed with more flexibility in mind. Stability to the steel frame on some parts of the upper floor is therefore provided by moment frames.

Using moment frames instead of bracing has allowed the scheme the flexibility to change partition walls and room layouts right up to the last minute, without causing any undue issues to the steelwork contractor's fabrication programme.

Summing up, NHS Orkney Chief Executive Cathie Cowan says: "This development will match our aspirations to deliver the highest quality care and services from fit-for-purpose facilities."

A combination of faceted straight members and curved beams form the courtyards



A durable steel structure – The Forth Rail Bridge (1890)

Steel and the circular economy

All steel construction products are inherently recyclable but structural steel elements are also inherently reusable. These and many other attributes of steelwork are becoming increasingly significant in the context of the evolving circular economy.

A circular economy is an alternative to a traditional linear economy (often described as a take, make, use, dispose economy) in which we keep resources in use for as long as possible, extracting the maximum value from them while in use, and then recover and regenerate products and materials at the end of each service life through recycling and reuse.

Current end-of-life scenarios for structural concrete, timber and steel

Within the context of the circular economy it is important to understand the difference between reuse and recycling.

- Recycling is the process of converting waste materials into completely new materials and products, which generally requires energy.
- Reuse is the subsequent use of an object in its original form after its first life with only minor alterations.

It is also important to differentiate between different types of recycling since the circular economy benefit can vary significantly:

- True or closed-loop recycling in which products are recycled into products with exactly the same material properties. An example of true recycling is re-melting steel.
- Downcycling which describes the process of converting materials into new materials of lesser quality and reduced functionality. Examples of downcyling in construction include crushing concrete to produce aggregates for fill and chipping timber to produce chipboard, etc.

Benefits of the circular economy

Steel has excellent circular economy credentials both as a material which is strong, durable, versatile and recyclable and as a structural framing system which is lightweight, flexible, adaptable and reusable. Steel's combination of strength, recyclability, availability, versatility and affordability makes it unique.

A circular economy promotes long product lives. Maintaining products at their highest utility and value for as long as possible, is a key component of the circular economy. Put simply, the longer a product lasts the less raw materials will need to be sourced and processed and less waste generated.

Properly designed and, where appropriate, properly protected steel structures provide long-term durability. Buildings like the National Liberal Club in London (1887) and structures like the Forth Rail Bridge (1890) demonstrate the longevity of steel buildings and structures.

Steel-framed buildings are among the most adaptable and flexible assets a business can invest in. The steel frame itself can be easily adapted, with parts added or taken away, and its light weight means that extra floors can often be added without overloading existing foundations.

Steel structures are commonly used to renovate buildings for example behind retained façades. In this way the historic value, character and resources of the façade are retained and the building structure can be reconfigured to create open, flexible internal space that meets modern client requirements and maximises net lettable floor area.

Steel is strong and has a good strength-to-weight ratio. Compared to other commonly used structural materials, steel buildings are lightweight meaning that significantly fewer materials are required to construct them.

Steel's two key components are iron ore, one of Earth's most abundant elements, and recycled (scrap) steel. Once steel is produced (from iron ore) it becomes a permanent resource for society; as long as it is recovered at the end of each product life cycle, because it is 100% recyclable without loss of quality.

In theory, all new steel could be made from recycled steel. However, this is not currently possible because global demand for steel exceeds the supply of scrap. This imbalance is due to steel's global popularity and its durability; meaning that an estimated 75% of steel products ever made are still in use today.

Steel products in use today all contain a proportion of recycled steel from previous incarnations; this can be one or many previous uses. Originally this 'recycled' steel was produced from iron ore and therefore how the initial impacts of primary production are shared over subsequent uses of the same material is an important question in quantifying its whole life environmental impacts.

Reuse and remanufacture

Reusing simple, low-rise structures such as portal frames, is relatively common particularly in the agricultural sector. Larger, whole building reuse is less common but there are some examples where this has worked well.

One such example is the International Aviation Academy, Norwich, where an historic steel-framed hangar is being refurbished into a new academy specialising in education and skills in aviation.

Component, i.e. beam or column, reuse is currently relatively rare but there are very real prospects of this changing soon. BIM technologies overcome several of the barriers to steel reuse by providing certainty about material properties, traceability and provenance and eliminating the need for testing.

Looking ahead therefore, structural steel (BIM) models offer a cost-effective means of enabling future reuse.

The ability to reuse building components is, to a large extent, dependent on how buildings have been constructed in the first place. Although designers routinely consider the constructability of buildings, historically little thought is given to their deconstruction and how elements and components could be reclaimed and reused.

At its simplest level, there are two main considerations:

1. The types of materials and components used; some products, like structural steel, are inherently more reusable than other structural materials and systems.
2. The way the materials and components are put together (thus able to be taken apart) and deconstructed.

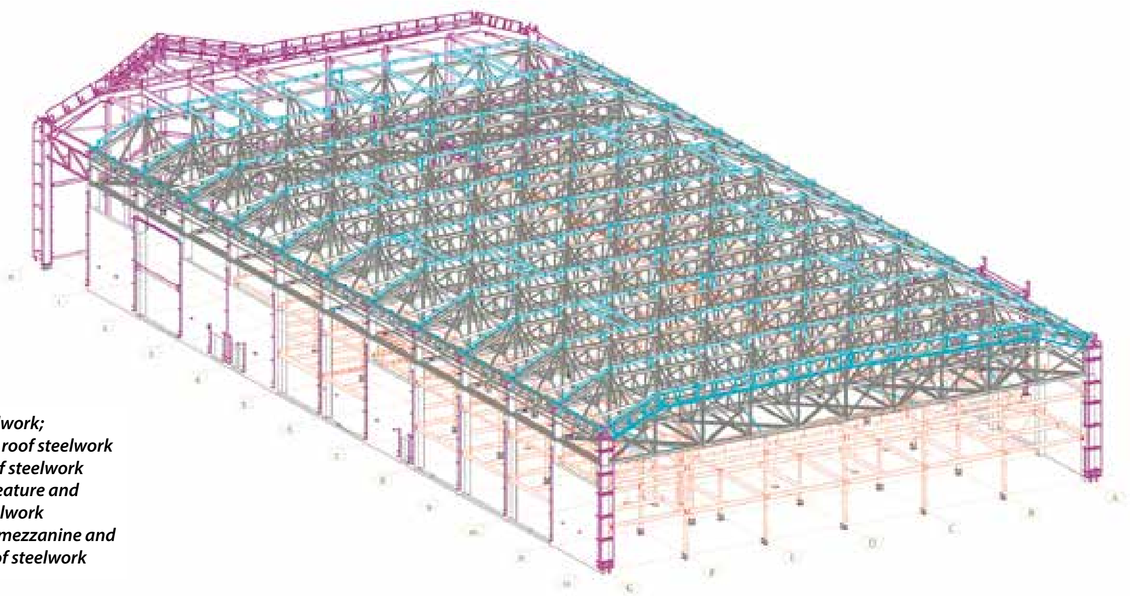
What next for steel and the circular economy?

The circular economy is an important, evolving agenda. However, the need to move towards a more circular economy is not in doubt nor are the potential economic opportunities.

Steel, both as a material and a structural framing system, already has excellent circular economy credentials, inherent attributes that cannot be matched by competing structural materials. Structural steel also has the advantage that it can go further and deliver truly circular demountable and reusable buildings.

New legislation, technical developments and different business models are required to realise these opportunities, but the steel sector is ready and working in partnership with its supply chain to deliver the circular economy.

Further details on steel and the circular economy are available at: *www.steelconstruction.info/Steel_and_the_circular_economy*



Model of steelwork;
Grey: Existing roof steelwork
Blue: New roof steelwork
Purple: New feature and elevation steelwork
Orange: New mezzanine and classroom roof steelwork

New guidance on steel costs

A new series of guides from the steel construction sector helps estimators arrive at accurate costs for steel-framed buildings. Architects and engineers will also benefit from the detailed insights provided into key cost drivers.

Steel construction has many proven benefits over alternatives, able to demonstrate a uniquely high score on circular economy calculations thanks to features like its recyclability, versatility and ability to be designed with future changes of use in mind.

A chief attribute for any market leading construction material will always be cost, which is where the benefits of steel can probably be most easily shown, although shorter construction programmes and lower embodied carbon calculations are sometimes seen as the key benefits.

The steel sector has a long history of providing design and other guidance that engineers, architects and other construction professionals value in making the design and construction process as straightforward as possible, and that service is being extended with a new series of studies called Costing Steelwork that will be published quarterly on *www.steelconstruction.info*

There are potential pitfalls that can trap the unwary when estimating costs of structures which the new series and other guidance already available aims to guide estimators through.

Costing Steelwork is produced by AECOM, the British Construction Steelwork Association and Steel for Life. Each quarter it will examine the key cost drivers for a range of building types, providing a type-specific cost comparison. A cost table will indicate the ranges of costs for the main alternative types of frame.

"The cost ranges will act as a benchmark that can be used at all the stages of the design," explains Steel for Life's Chris Dolling. "We will ensure that the data is always current through regular updates that will be made freely available."

A previous series of Steel Insight studies focused on office buildings only, but Costing Steelwork will deliver guidance on a wider range of building types. The series started with a focus on the offices sector, with a detailed cost model based on an office building that has actually been built (see box on One Kingdom Street), and the most recent one looks at an industrial building (see box on Prologis Park below).

The study looks at the process of cost planning throughout the design stages, and examines the key steel framing cost drivers for office buildings.

Updates will provide the same insight for education, mixed-use and retail buildings, all based on actual projects that have been completed.

Steel delivers at Prologis Park

The building AECOM used for the cost model of an industrial building is a distribution warehouse on ProLogis Park in Stoke-on-Trent.

The building's key features are:

- Warehouse: four-span, steel portal frame, with a net internal floor area of 34,000m^2
- Office: 1,400m^2, two-storey office wing with a braced steel frame with columns.

Three structural options for the building were assessed; a steel portal frame with a simple roof solution, a hybrid option consisting of precast concrete columns and glulam beams with timber rafters, and a steel portal frame with a northlight roof solution.

The full building cost plans for each structural option have been reviewed and updated to provide current costs at Q4 2017. The costs, which include preliminaries, overheads and profit and a contingency, are summarised in the table alongside.

The steel portal frame option provides the optimum build value at £664/m^2, with the glulam option being the least cost-efficient. This is primarily due to the cost premium for the structural members required to provide the required spans, which are otherwise efficiently catered for in the steelwork solution. The consequence of having a hybrid option is that the component elements are from different suppliers, which contributes to the increases in cost.

The northlights option is directly comparable with the portal frame in relation to the warehouse and office frame; the variance is in the roof framing. There is significantly more roof framing to form the northlights.

Table of key costs (£/m^2 GIFA), for Stoke-on-Trent distribution warehouse (Q4, 2017)

Elements	Steel portal frame	Glulam beams and purlins supported on concrete columns	Steel portal frame with northlights
Warehouse	£70	£137	£81
Office	£124	£165	£124
Total frame	£72	£138	£83
Total building	**£664**	**£743**	**£712**

Steel comes to One Kingdom Street

AECOM's cost comparison of an actual office building looks at the steel-framed, 10-storey, grade A central London office at One Kingdom Street near Paddington railway station which was completed in 2008.

The building comprises 10 storeys with two basement levels and plant housed at roof level. It incorporates clear spans of 12m X 10.5m and was built with three cores, with an open atrium on the main core.

This cost comparison updates cost models developed in 2010 when the building was part of the Target Zero study to provide guidance on design and construction of sustainable, low and zero carbon buildings. Costs current in the fourth quarter of 2017 are the latest used for the new Costing Steelwork study (see table alongside).

The 40m high building is rectilinear, with a footprint of 81m x 45m. The western half of the building is partly constructed on a podium transfer structure that encloses works access for the Crossrail project.

It is founded on 750mm diameter bored piles with in situ pile caps laterally restrained by ground beams. The piles are the same size as those used to support the Crossrail podium to reduce the potential for differential settlement.

Two structural options were assessed with a concrete-framed post-tensioned concrete flat slab for comparison. The analysis shows the steel composite solution as 8% lower than the concrete alternative for the frame and upper floors, and 5% lower for the total building.

Table of key costs (£/m² GIFA), for City of London Office Building (Q4, 2017)

Elements	Steel cellular composite	Post-tensioned concrete flat slab
Substructure	£87	£92
Frame and upper floors	£423	£458
Total building	**£2,549**	**£2,687**

Costs benchmark framed

AECOM has provided costs based on the structural framing of a commercial office development in central London, expressed as a cost/m² on Gross Internal Floor Area, to be used as a benchmark. A range of costs is indicated for the key costs drivers as these can very between projects for a variety of reasons, as detailed in the full report.

To use the table first identify which frame type most closely relates to the project being costed, select and add the proposed floor type and add fire protection if required.

Indicative cost ranges based on gross internal floor area (Q4,2017)

Type	Base index 100	Notes
Frame		
Steel frame to low rise building	£97-117/m²	Steelwork design based on 55kg/m²
Steel frame to high rise building	£163-185/m²	Steelwork design based on 90kg/m²
Complex steel frame	£185-218/m²	Steelwork design based on 110kg/m²
Floor		
Composite floors, metal decking and lightweight concrete topping	£60-91/m²	Two-way spanning deck, typical 3m span, with concrete topping up to 150mm
Precast concrete composite floor with concrete topping	£97-137/m²	Hollowcore precast concrete planks with structural concrete topping spanning betwen primary steel beams
Fire protection		
Fire protection to steel columns and beams (60 minutes' resistance)	£14-20/m²	Factory-applied intumescent coating
Fire protection to steel columns and beams (90 minutes' resistance)	£16-29/m²	Factory-applied intumescent coating
Portal frames		
Large-span single-storey building with low eaves (6-8cm)	£73-95/m²	Steelwork design based on 35kg/m²
Large-span single-storey building with low eaves (10-13cm)	£83-113/m²	Steelwork design based on 45kg/m²

Any estimate that falls outside these ranges should be taken as a signal that the design should be looked at closely to determine why.

Location of a project will be a key factor in establishing price and indices are used to allow for adjustment of cost data between regions.

The variations in these indices, such as the BCIS location factors, provide a clear indication that market conditions differ between regions to a significant extent, which is a key consideration for cost analyses to take into account.

BCIS rates for different locations as of Q4 2017 (UK Mean = 100)

Location	BCIS Index
Central London	126
Manchester	104
Nottingham	104
Birmingham	102
Liverpool	99
Leeds	97
Newcastle	92
Dublin	92*
Glasgow	92
Cardiff	85

** AECOM index*

Steel knowledge online

The steel sector's website – *www.steelconstruction.info* – is the number one destination for engineers and other construction professionals to access steel related information.

Launched five years ago, *www.steelconstruction.info* brings together all of the sector's technical and cost information, which was only previously available from a variety of different sources.

Described as the free encyclopaedia for the UK steel construction sector, it was designed to be easy to use, as comprehensive as possible, and the one-stop-shop for technical guidance on steel construction.

Chris Dolling, Manager, Technical Development at BCSA explains: "We set out to provide the best possible internet-based source for steel construction information and we feel this is exactly what we've achieved.

"Feedback has been very positive and the Google Analytics for the website continues to show year-on-year growth in the number of users."

Key to the success of the website is the continuous stream of new content and the regular updates to ensure the information provided remains current. Highlights so far this year include:

- A new article discussing Steel and the circular economy.
- A major new release of the design software that calculates the Elastic critical moment for lateral-torsional buckling (M_{cr}).
- A new interactive version of the "Blue Book" that provides design data for both open and hollow sections to the Eurocodes and BS 5950 (see box).
- A new article that brings together and indexes all of the Advisory Desk Notes published since January 2010.
- Quarterly updates to the cost table, cost comparison figures, and BCIS location factors to suit the latest data from AECOM.
- A new series of written CPD Modules.
- A new SCI guide (P419) on 'Brittle fracture' that presents modified steel thickness limits for use on buildings where fatigue is not a design consideration (see box).

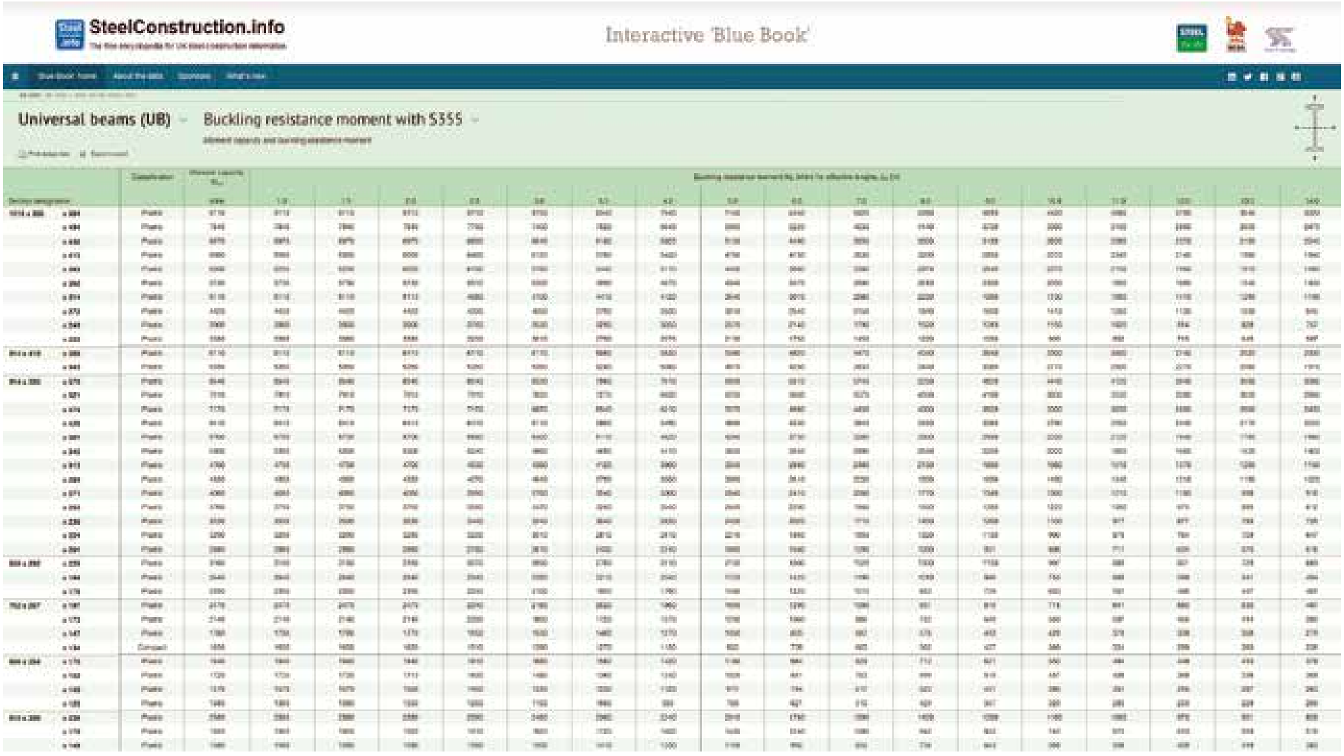
The Structural Steel Design Awards article was recently updated to feature the 2017 projects winning Awards, Commendations and Merits, and fully hyperlinked 'case studies' for each winning project have been added to the ever-growing bank of project data.

Over 30 other case studies of projects under construction in 2017 have also been added so far this year covering a broad range of building types and sectors.

For those who are new to www.steelconstruction.info the site has well over 100 wikipedia style articles, written by the steel sector's own experts as well as external consultants, and covering best practice in the use of steel across the construction sector, as well as topics such as fire engineering, costs, sustainability and health & safety.

These core articles act as a roadmap to each topic using links to more detailed information available from the sector and other external sources. A number of online CPD presentations are also included,

New Interactive Blue Book



Produced by the Steel Construction Institute (SCI) on behalf of Steel for Life, a new interactive version of the Blue Book is now available and can be found in the Key Resources menu of the website.

The comprehensive web-hosted resource includes design information in accordance with both the Eurocodes and BS 5950.

It provides design data for the full range of both open sections and hollow sections (both hot-finished and cold-formed), and does not require any software to be installed on a host computer.

Michael Sansom of the SCI said: "The new user-friendly and refreshed interactive Blue Book has a format that allows users to either print information directly or export information to a spreadsheet on their own computer."

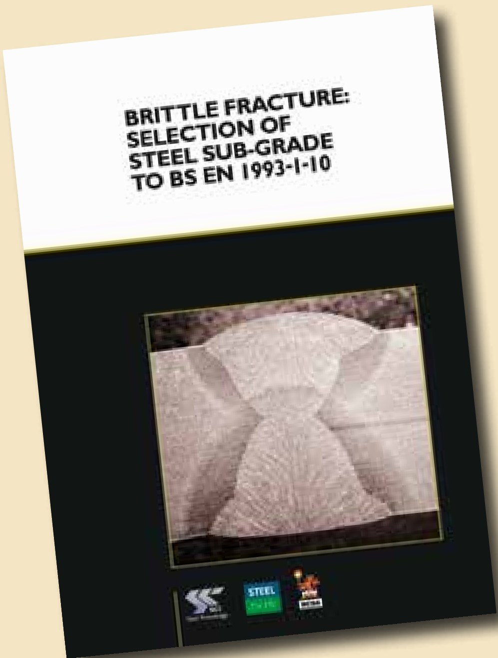
which enable the user to take a test and download a certificate for their records.

There is also a host of links where users can go directly to web-based steel design software and tools, while the news section allows access to a number of BCSA and Steel for Life supplements that have appeared in the construction and architectural press, such as NCE, Construction News and Building magazine.

The steel sector has an ongoing pipeline of research and development work, and continuously updates its guidance in line with changes in legislation, standards and industry practice. Articles are also regularly reviewed and updated where needed as part of a formal maintenance regime that ensures every article is kept up-to-date.

Registered users (one can register on the site) get quarterly email alerts highlighting all of the site's new features, updates and additional information. Visit www.steelconstruction.info today, register online and make the most of this comprehensive free resource for construction professionals.

Guide to brittle fracture now available



Commissioned and funded by the BCSA 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, has been added to the website.

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.

SIGN UP FOR YOUR **FREE SUBSCRIPTION** TO **NSC MAGAZINE**

NSC magazine is available free of charge in a paper format for the UK and Ireland as well as in a digital format for use on tablets, smartphones and desktop computers.

A regularly updated website also carries news of steel construction issues and projects, as well as the NSC digital library containing the current issue and archives.

Here's how to register for your copy

Visit ***www.steelconstruction.info***

If you already have an account:

- Login using the normal **'Login / create account'** button in the top left corner *(If you cannot remember your password, use the 'Email new password' button)*
- Go to the **'Toolbox'** sidebar menu on the lower left hand side
- Select **'My Profile'**
- Tick the box to receive either digital or printed NSC magazine, or both
- Click **'Save'**

If you don't have an account:

- Click the **'Login / create account'** button in the top left corner
- Click the **'Create an account'** blue link in the Login box
- Enter the required details to create an account
- Tick the box to receive either digital or printed NSC magazine, or both
- Click **'Save'**

or

Email your details to ***info@steelconstruction.org***