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NSC

Steel steals show at the BBC

Vol 25 No 3 March 2017

Retail expansion for Oxford

Cumbria Council opts for steel

Largest single building for South West

Steel's speed overcomes Surrey floodplain

Cover Image
Westgate shopping centre, Oxford
Main client: Westgate Oxford Alliance
Architect: BDP/Chapman Taylor
Main contractor: Laing O'Rourke
Structural engineer: Waterman Structures
Steelwork contractor: BHC
Steel tonnage: 7,500t

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Steel delivering value

Nick Barrett - Editor

Our news section always carries examples of projects that highlight the benefits of using steel as a framing material. This week's news includes a story about the building that was the first tower to reach completion in the City this year, One Angel Court. The completion dates of steel-framed buildings are more predictable than others, thanks to the higher degree of certainty on construction programmes once a steel solution is selected.

The advantages of constructing in steel are felt throughout the construction programme, and maintained throughout the life of the building or other structure. Evidence comes from press reports that a major London building that we featured in NSC several years ago, the Leadenhall Building, or 'Cheesegrater', has become the first City office building to be sold for £1,000 million. The purchaser is an overseas investor, proof, if any were needed, that assets made using steel hold and appreciate well in value, and the distinctive designs that steel makes possible are attractive to the investment world outside the UK.

We needn't stay in London to see evidence of steel's success. The projects NSC has visited this month are being built as far north as Cumbria, to Surrey in the south, as well as in Cardiff, Bristol and Oxford in between. All are outstanding examples of the wide range of buildings made possible by steel. We look at a warehouse construction project near Bristol, for example, where 36.5 m spans will be used to provide what is believed to be the single biggest building in the south west. Equivalent in size to 15 Wembley Stadiums, it is one of the biggest buildings in the entire UK.

Not too far from there in Cardiff, a construction programme is under way for the BBC, providing a new regional base for the broadcaster with exposed steel as a design feature. Steel is showing its cost and construction programme advantages there, replacing concrete for one of the building's cores when increased speed was desired.

Oxford is enjoying something of a retail boom with steel being used to build the city's largest retail development for about 10 years. Speed and ease of use in confined spaces are often reported as advantages delivered by using steel on projects of all types, and that is the case in Oxford. Future flexibility and low self-weight of the steel frame were other reasons highlighted by the construction team for selecting steel.

With all of its benefits including many sustainability advantages, steel is the most modern of methods of construction, fittingly being used to provide a new technology research centre in Surrey. Steel was selected for this project for its cost and speed advantages in particular.

Our technical article outlines the long history of the use of steel for trusses, going as far back as the Forth Bridge. Today, truss sections of 22 m length can be transported to site by road without any special travel arrangements, a key benefit to many projects that allows offsite construction in factory type controlled conditions to ensure the quality that modern construction demands. Quality has always been a feature of steel construction though – the Forth Bridge has been standing there fully operational in all its iconic glory since 1890.

Severfield bridge lift completed on Ordsall Chord

Weighing more than 600t, what is said to be the UK's first asymmetric network arch bridge was successfully lifted into place last month by two of the largest cranes in the UK.

The 90m-long Irwell Bridge forms part of Network Rail's Ordsall Chord scheme, which will provide 300m of new railway track to create a link for the first time between Manchester's main train stations; Oxford Road, Manchester Piccadilly and Manchester Victoria.

The two arches were initially assembled on-site from 12 weathering steel sections (six each side). Laid out flat they were both rotated into a vertical position after welding and placed on to temporary supports to allow the cross members to be installed.

In order to speed up the construction programme and lessen the amount of work to be done over the river, the steel composite bridge deck was installed separately and supported on temporary trestles in the river.

The arches were picked up and installed with a tandem lift using a 750t-capacity crawler crane in conjunction with a 1,350t-capacity crawler. They were then landed on to four bridge positions, one of which projects out over the River Irwell.

The bridge has an overall steel tonnage of more than 1,600t and is one of nine bridge structures Severfield is fabricating, supplying and installing for the Ordsall Chord.

The project, due to be completed in December, is being delivered by the Northern Hub Alliance that includes Network Rail, Siemens, Amey Sersa JV, Skanska BAM JV, AECOM Mott MacDonald JV as well as Severfield.

Galvanized solution for Yorkshire waste project

Scottish Galvanizers [part of the Wedge Group] is currently hot-dip-galvanizing around 2,500t of steel, for steelwork contractor BHC, which will be used at the Allerton Waste Recovery Park in North Yorkshire.

The site will use state-of-the-art technology to reduce the amount of waste going to landfill by 90%. Diverting the landfill will generate enough energy to power the equivalent of 40,000 homes, and around 320,000t of residual household waste will be processed over 25 years.

The site is being constructed by BHC for waste management firm AmeyCespa, which has signed a £1.4bn PFI contract with the two councils in the area.

Scottish Galvanizers will be galvanizing the steel as part of the £320M project, with construction expected to be completed this year before commissioning and rigorous testing, with the site fully operational by early 2018.

Commercial Manager at Scottish Galvanizers Paul Tait explained: "This is an exciting project to be part of and will make a real difference to how waste is processed in North Yorkshire.

"Taking on a 2,500t project is a big task but we're confident it will all be ready in time and we can't wait to see the site in action in the next 12 months or so."

BHC General Manager Bryan Cathcart added: "We've dealt with Scottish Galvanizers for many years. They have the capacity in Scotland to deal with a project this size, and one of the largest hot-dip galvaizing baths in the UK, so we knew that they would deliver effectively and on time for this project. We look forward to working with them in the months and years ahead."

First City tower to complete in 2017

One Angel Court, a prestigious 24-storey prime office building in the heart of London's financial district, next to the Bank of England, is said to be the first City tower to complete this year.

The steel-framed structure has been built around a retained core from a previous 1970s-built structure. The new building provides 32,500m² of floor space, 60% more than the old office tower.

Replicating the original concrete structure's octagonal shape, One Angel Court incorporates two podiums, north and south, both in the same positions as the previous building's podiums, but at seven-stories high these podiums are taller.

According to Mace Project Manager for Structures, Marios Antoniades, there are a number of reasons why the new tower and connecting podiums are steel-framed instead of concrete.

"Steel has helped us achieve longer spans, a quicker construction programme, add one additional floor and a double-height plant enclosure to the top of the tower, while allowing us to re-use the existing core and foundations."

Waterman's Director, Mark Terndrup, said: "We are very proud to have been involved in this prestigious scheme right from its inception in 2010. The completion and opening is a tremendous milestone for our multidisciplinary engineering and environmental teams.

"We worked closely with Fletcher Priest Architects throughout to provide sustainable and innovative solutions which have made this an exemplary project, one of the first London City commercial offices to secure a BREEAM 2014 'Excellent' Design Stage Assessment."

Severfield fabricated, supplied and erected 3,900t of structural steelwork for the project [see *NSC* Sept 2016].

Steel on patrol near Sellafield

Work is progressing on schedule for a bespoke steel-framed training complex for the Civil Nuclear Constabulary (CNC) near Sellafield.

Charged with protecting the UK's civil nuclear sites and materials, the CNC employs more than 1,500 armed police officers and members of staff.

To help better train its officers, a new CNC training facility is under construction at Sellafield in Cumbria, which consists of a series of interconnected steel-framed structures.

Working on behalf of Morgan Sindall, Border Steelwork Structures is erecting 950t of structural steelwork for the project.

The steelwork forms a four-storey hub with classrooms, operational stores, gym and offices, alongside communal use areas. Further connected steel-framed structures house two live fire training ranges – 50m and 100m long respectively, and a live fire skills area where various training scenarios can be played out within a three-storey building.

Commenting on the project that began last May, CNC Assistant Chief Constable Chris Armitt, says: "The new training facilities represent an important and necessary step forward for the CNC, ensuring we continue to effectively deliver our mission of maintaining public safety and protecting civil nuclear sites.

"It will allow us to continue to meet the most stringent armed policing standards set by the College of Policing and UK Government regulatory standards for the protection of nuclear sites such as Sellafield."

Redhill retail scheme progressing on schedule

The Warwick Quadrant scheme in Redhill, Surrey is progressing on schedule and will be completed by the end of the year.

Working on behalf of main contractor RG Group, steelwork contractor Billington Structures will eventually erect 3,000t of steel for the job.

Reinvigorating a large centrally-located plot, the scheme consists of a new Sainsbury's store with a two-level car park above, a gym and a 68-bed Travelodge hotel, all housed in one large interconnected steel braced frame.

The project team said that steel was chosen because it is quick to erect and adds flexibility into the building. Within the Sainsbury's store there is a 9m floor-to-ceiling height, high enough to allow another floor to be added if the tenant so wished.

The project has provided a new steel canopy entrance to the adjacent Harlequin Theatre, as well as new seating, planting and paving for the nearby streets.

Council awards design contract for River Clyde bridge

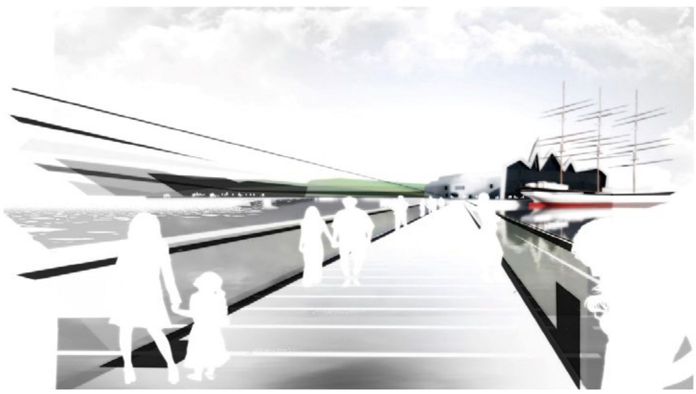
Glasgow City Council has appointed global engineering consultancy CH2M Hill to undertake the design of a new bridge across the River Clyde between Govan and Partick.

An exact location for the pedestrian/cycle bridge has yet to be finalised, and no decision has been made on whether the bridge will be a steel composite structure.

CH2M Hill (formerly Halcrow) has previously delivered a number of bridges across the River Clyde, including the Clyde Arc, the Dalmarnock Smart Bridge and the Tradeston Bridge.

The bridge will once again make the historical connection between the two areas, and will be able to open to ensure that vessels such as the Waverley will still be able to berth up-stream.

Councillor Frank McAveety, Leader of Glasgow City Council, said: "Govan and Partick shared a connection for centuries and, with so much regeneration happening in both communities, the time has come for this bridge to further and strengthen their development. I am delighted to see the beginning of work on this, the next phase of the regeneration of the Clyde."



NEWS IN BRIEF

Ealing Councillors have voted to grant planning permission for a new 15,700m^2 Grade A office development, the first major office scheme in **Ealing** for almost a decade. Developer Commercial Estate Group said the steel-framed scheme will rival office space in the rest of west London, as well as central London.

Developer Knight Dragon has unveiled a new mixed-use scheme designed by international architect and engineer Santiago Calatrava, at the heart of its transformation of the **Greenwich Peninsula** in south London. Sat on top of North Greenwich tube station, the development will include a 24m-high winter garden and glass galleria, theatre, cinema and performance venue, bars and shops.

Kier has been selected to deliver phase two of Eastbourne Arndale Centre's £85M extension for Legal & General and Eastbourne Borough Council. Phase two of the scheme will see the construction of 16,200m^2 of retail and leisure space, which will create an additional 22 shops at the centre. Over 300 extra parking spaces will be provided through the construction of two new decks above the existing multi-storey car park.

Construction of the new **International Convention Centre Wales** (ICC Wales) will begin this month after funding details were agreed between the Welsh Government, Celtic Manor Resort and NatWest (part of the RBS Group). With a total development cost of £83.7M including car parking and external landscaping, ICC Wales will be capable of accommodating up to 5,000 delegates with a total floor space exceeding 26,000m^2. It is expected that the new facility will open for business in June 2019.

Kensington and Chelsea Council has granted detailed planning consent for Exhibition Square, the next phase of the prestigious Earls Court development. The new **Exhibition Square** will be built on the site of the now demolished Earls Court Exhibition Centre.

AROUND THE PRESS

Manchester Evening News

21 February 2017

Giant 600 tonne arches of the Ordsall Chord lifted into place

Forming a major part of the railway link between Piccadilly and Victoria stations, the [steel] arches will be slowly suspended then inched into place by two giant cranes - one the biggest in Europe, the other the largest in the UK. The momentous feat of engineering has already begun this morning and will take more than four hours in total. The £85M Ordsall Chord - 300m of new track - aims at allowing more trains to cross the north and boost passenger capacity.

Oxford Mail

12 January 2017

Builders at Westgate 'cracking on' with the biggest construction job in Oxford

Builders at the Westgate Shopping Centre are 'cracking on' with the biggest construction job in Oxford as its October reopening draws closer, with bosses saying the project is still on schedule. The £440M redevelopment of the centre will transform remaining sections of its 1970s arcade and create three new [steel-framed] buildings.

Commercial New Media

27 February 2017

Angel Court becomes first City tower to complete in 2017

A hugely significant building for the City occupier market, Angel Court will provide approximately 20% of the Grade A space that will be delivered in the City over the course of 2017, with a much-needed range of new floorplates.

Aluminum foundry relies on steel

An important foundry that will produce components for the UK's car manufacturing industry is being erected by Caunton Engineering.

The aluminum casting facility in Telford is being built by McLaren Construction for global giant Magna International. Once complete, the foundry will supply products to Jaguar Land Rover.

The building is a twin-span portal frame with lean-to sides, measuring 204m by 84m. The overall plan area of the building including an attached shipping area is 20,900m² and this will require over 1,300t of structural steelwork.

The steelwork is being designed by Caunton's own technical team and they said that, due to the fatigue actions induced by large gantry cranes, elements of the steel structure had to be specified as Execution Class 3 (EXC3) for CE Marking purposes.

This places more stringent requirements on the fabrication and welding processes.

Once production begins in 2018, the facility will use Magna's innovative high-pressure vacuum die-casting process to produce a number of advanced lightweight aluminum castings, which are a key building block in the next generation of all-aluminum and multi-material vehicle architectures.

By using these types of castings, Magna says it helps carmakers deliver maximum strength and stiffness with minimum weight, that ultimately achieves better fuel economy, safety and handling.

Contractor appointed for Chichester hospice

Kier has been appointed as main contractor for the new £15.5M steel-framed St Wilfrid's Hospice in Bosham, Chichester.

The hospice will provide modern facilities to meet the growing and changing needs of 21st century care and will replace an existing facility in the city.

It will have 18 en-suite rooms, which will be over 9m² larger than the current rooms, with piped oxygen available in each. This will provide additional space for nurses to provide better care and for visiting family and friends.

Improved family facilities will include a coffee shop, five lounge areas, two quiet rooms and a dedicated shower room for visitors. There will be a larger day hospice, dedicated art therapy room and access to more private meeting and treatment rooms.

Kier Construction Southern Operations Director Trevor White, said: "We're delighted to be working with St. Wilfrid's Hospice to provide the local community with high quality care facilities. Kier has extensive experience in the delivery of acute, mental health and primary care facilities, and our extensive regional network enables us to provide nationwide, local coverage.

"We will work closely with the hospice to ensure the new design meets the needs of staff, patients, families and the local community."

Chief Executive for St. Wilfrid's Hospice, Alison Moorey, said: "The current hospice has served the local community for the last 30 years, however we have now outgrown our much-loved site in Donnington. The new hospice will give the local community high quality services and skills to deliver the very best end-of-life care for patients and their loved ones for the next 30 years and beyond. We look forward to working with Kier with their experience in delivering projects in the health sector."

The new steel-framed hospice is due for completion late 2018 with over half the money for the scheme being pledged by St. Wilfrid's Hospice Board of Trustees from hospice reserves.

David Bowie memorial planned for Brixton

The iconic lightning flash from David Bowie's Aladdin Sane LP cover could be recreated as a large memorial in Brixton.

The local community and a group of well-known artists are planning to get approval for a permanent Bowie memorial in the place of his birth.

The artists, This Ain't Rock'n'Roll – designers of the Brixton Pound paper currency that features Bowie on the £10 note – have reimagined the lightning flash as a gravity-defying red and blue-sprayed stainless steel piece of public art.

Standing approximately 9m-high, the steel monument will be located next to Brixton underground station, five streets away from Bowie's Stansfield Road birthplace, and situated next to Jimmy C's internationally famous Aladdin Sane mural.

This Ain't Rock'n'Roll's Charlie Waterhouse said: "This is a wonderful opportunity for the international David Bowie community to come together to deliver a heartfelt thank you.

"A thank you to a man who changed our lives – and changed the world. A thank you not from government, nor from industry, but from us. The people. The fans."

There is a campaign to raise £1M to make the memorial a reality via a crowd-funding scheme. This entails a large number of people each being asked to donate a small amount of money.

Bridge decks completed on London Bridge Station

Cleveland Bridge has completed its work to supply and install steelwork for rail decks and concourse bridge decks as part of the major redevelopment and improvement of London Bridge Station.

As the fourth busiest station in London, serving almost 54 million passengers each year, the rail-hub has remained open throughout the redevelopment.

This presented a logistical challenge because the construction team had to ensure installation works were completed efficiently and as part of a strict timetable.

Cleveland Bridge undertook trial erections of the steelwork at its facility in Darlington to ensure the on-site works would be completed efficiently and quickly.

In an attempt to reduce disruption for commuters, the project was split into nine phases allowing London Bridge Station to remain open throughout.

The decks were successfully delivered and installed on-site using a combination of cranes and, in the early stages of the project, commissioned scissor lifts alongside self-propelled modular transporters.

The first phase of the project started in May 2013 and the final three platforms and the new concourse will be open for passenger use in January 2018.

Chris Droogan, Managing Director at Cleveland Bridge said: "As London Bridge station is such an integral part of the capital's travel, it has remained open and this has been a huge challenge in itself. This has been an important project for our company and we're really pleased to have played a part in what will be a total transformation for people's everyday travel."

Andrew Hutton, Network Rail's Lead Development Manager for the London Bridge redevelopment project added: "The redevelopment of London Bridge station is a crucial part of Network Rail's Railway Upgrade Plan, which will improve rail travel for the millions of passengers that use the station network each year. Network Rail has worked effectively with our contractors, including Cleveland Bridge, who have played a huge part in making the redevelopment a success."

Towering export success for decking supplier

Structural Metal Decks (SMD) is supplying 114,000m² of its TR80+ floor decking to the Tiara United Towers project in Dubai.

Located on the main road into Dubai, the project features two steel-framed towers side by side, each 50 floors high. The East Tower boasts a five-star hotel spread over 35 floors with the West Tower comprising office, conference and retail areas.

The façades of the towers are inspired by the concept of stained glass. At night, the glazed panels will be illuminated from within, creating a dramatic pattern within the city skyline.

Last month SMD celebrated its 30 anniversary as the company initially opened its doors to business on Monday 9th February 1987. Originally founded by Severfield-Rowen, SMD soon moved to larger premises and by the end of the decade the company had hit the £1M benchmark in turnover.

New mixed-use scheme for Sheffield city centre

Outline planning consent has been granted for Sheffield's £175M mixed-use West Bar Square development, an ambitious regeneration scheme which will create up to 5,000 jobs.

Permission has been granted by the city council for delivery of a flexible master plan comprising up to 130,000m² of prominent city centre space with frontage to Sheffield's inner relief road.

Local developers, Urbo Regeneration, can now continue to progress negotiations with potential occupiers and investors for the proposed offices, high quality apartment blocks, a four-star hotel, restaurants, and retail units to be constructed on the site.

The granting of outline planning consent for West Bar Square represents another significant step forward for both the scheme and regeneration of Sheffield's Riverside Business District. The area is already home to some 3,500 jobs with employers such as the Home Office, Courts, Irwin Mitchell and other large occupiers.

Last year it was announced that Peveril Securities, the development arm of Bowmer & Kirkland Group, had been secured as the delivery partner for West Bar Square.

It is envisaged that more than half of the scheme will be steel-framed office space, providing jobs for up to 5,000 workers. It is anticipated that West Bar Square will deliver large floorplate modern office space, currently lacking within the Sheffield property market, with the aim of attracting further major private and public sector employers to Sheffield city centre.

Urbo Regeneration Managing Director Peter Swallow said: "The granting of outline planning consent represents another key milestone for the West Bar Square project and brings this ambitious scheme closer to delivery. Working in partnership with our delivery partner, Peveril Securities, I am confident we will be able to secure occupiers and investors and move forward with detailed planning applications for individual buildings in 2017."

Diary

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

Tuesday 21 March 2017
The National Structural Steelwork Specification (NSSS)
This 1 hour webinar will cover key content with helpful background to the specification clauses. Available to BCSA and SCI Members only.

Tuesday 28 March 2017
Portal Frame Design
This course provide in-depth coverage of the major issues surrounding the analysis, design and detailing of portal frames.
Bristol

Tuesday 4 April 2017
EC4 Composite Design
This course will cover the design of composite beams and slabs with reference to Eurocode 4 for composite construction (BS EN 1994-1-1).
Birmingham

Tuesday 25 April 2017
Web Openings in Composite Beams
This webinar will cover the design methods for steel and composite beams with circular, rectangular and elongated web openings for services. Available to BCSA and SCI Members only.

The galvanized M&S car park required 1,200t of steel

An introduction to corrosion protection

NSC looks at corrosion protection, outlining the issues which should be considered and the preventative processes adopted to ensure the durability and longevity of steel structures.

Why does steel corrode?

The corrosion of structural steel is an electrochemical process that requires the simultaneous presence of moisture and oxygen. Essentially, the iron in the steel is oxidised to produce rust, which occupies approximately six times the volume of the original material consumed in the process.

What dictates the level of corrosion protection required?

The environment. When steel is in a dry heated interior environment the risk of corrosion is insignificant and no protective coating is necessary. Conversely, a steel structure exposed to an aggressive environment needs to be protected with a high performance treatment and may need to be designed with maintenance in mind if extended life is required.

Surface preparation

Surface preparation is the essential first stage treatment of a steel substrate before the application of any coating, and is generally accepted as being the most important factor affecting the total success of a corrosion protection system. The surface preparation process not only cleans the steel, but also introduces a suitable profile to receive the protective coating.

Grit abrasives are used for high build paint coatings and thermally sprayed metal coatings, which need a coarse angular surface profile to provide a mechanical key. Shot abrasives produce more rounded profiles and are used for thin film paint coatings such as pre-fabrication primers.

Alternative methods of corrosion protection

Paint Coatings: A paint consists of a pigment, dispersed in a binder, and dissolved in a solvent. A modern paint system usually comprises a sequential coating application of paints or alternatively paints applied over metallic coatings to form a 'duplex' coating system.

Protective paint systems usually consist of primer, intermediate/build coats and finish coats. Each coating 'layer' in any protective system has a specific function, and the different types are applied in a particular sequence.

The method of application of paint systems and the conditions of application have a significant effect on the quality and durability of the coating. Standard methods used to apply paints to structural steelwork include application by brush, roller, conventional air spray and airless spray/electrostatic airless spray.

Hot-dip Galvanizing: Hot-dip galvanizing is a process that involves immersing the steel component to be coated in a bath of molten zinc (at about 450°C) after pickling and fluxing, and then withdrawing it. The immersed surfaces are uniformly coated with zinc alloy and zinc layers that form a metallurgical bond with the substrate. The resulting coating is durable, tough, abrasion resistant, and provides cathodic (sacrificial) protection to any small damaged areas where the steel substrate is exposed.

Commenting on the galvanizing process, Chris Woolridge, Managing Director of Wedge Group Galvanizing says: "Galvanizing is one of the most important elements to consider for construction works, given its ability to effectively protect against rust and corrosion.

"Our Worksop plant was recently called upon by steelwork contractor James Killelea to galvanize 1,900 pieces of steel, totalling 1,200t, for the construction of a multi-storey car park for Marks & Spencer. The nature of the coating means that the life to first maintenance can be in excess of 60 years depending on the environment it is used in."

Thermally Sprayed Metal Coatings:
Thermally sprayed coatings of zinc, aluminium, and zinc aluminium alloys provide corrosion protection to steel structures exposed to aggressive environments. They are also an important component of many 'duplex' coating systems. The metal, in powder or wire form, is fed through a special spray gun containing a heat source, which can be either an oxygas flame or an electric arc.

Appropriate specifications

The overall success of a protective coating scheme starts with a well-prepared specification. It is an essential document that is intended to provide clear and precise instructions to the contractor on what is to be done, and how it is to be done. In detail the specification needs to consider the following aspects:

- Environment and access for future maintenance
- Design of the structure
- Surface preparation
- Coating system and application
- Handling and transportation
- Inspection and quality control
- Health and safety

For further information on corrosion protection please visit *www.steelconstruction.info/Corrosion_protection*

Picture shows Block 3 which is two structures either side of the street and Blocks 1 and 2 at the bottom of the photo

Retail scheme buys into steel construction

Construction of a shopping centre in Oxford city centre combines a remodelled existing mall along with a steel-framed new build element. Martin Cooper reports.

FACT FILE
Westgate shopping centre, Oxford
Main client: Westgate Oxford Alliance
Architect: BDP/Chapman Taylor
Main contractor: Laing O'Rourke
Structural engineer: Waterman Structures
Steelwork contractor: BHC
Steel tonnage: 7,000t

Said to be the largest construction project in Oxford city centre in more than a decade, the multi-million pound Westgate scheme will transform an existing shopping centre and a large plot formerly occupied by a car park into a 74,300m^2 retail and leisure destination due to be completed by the end of the year.

The new Westgate Oxford will include more than 100 new shops, 25 restaurants and cafes, a boutique cinema, rooftop terrace dining, a large John Lewis anchor store and a residential block containing 59 flats.

Main contractor Laing O'Rourke began work in January 2015, and its 30-month contract encompasses the construction of the new elements, which are predominantly sat atop a 1,000-space underground car park, as well as the extensive remodelling of the existing Westgate shopping centre.

This 1972-built reinforced concrete shopping mall has been partially demolished, leaving approximately three quarters of the three-storey structure to be integrated into the new scheme.

Fronting Bonn Square and Castle Street, this retained structure will provide one of the main entrances into the new Westgate and more than 1,000t of the project's overall 7,000t steel tonnage has been used for the remodelling.

The rear portion of the structure, formerly occupied by C&A, was demolished, with the cut between what stayed and what went being made along an existing movement joint.

"A new entrance has been created, but most of the new steelwork within this building has been used to form new and more prominent shop fronts along the central pedestrian mall, as well as infilling areas that previously accommodated lift and stair cores and creating structural support around new tenants opening requirements," explains Waterman Structures Project Director Karen Telling.

"Steelwork supporting metal decking is ideal for this kind of infilling work as it is quick and relatively easy to install in confined spaces."

The remodelled and revamped mall will connect directly into the new covered shopping street, which, similarly to the older mall, will be spanned by a glazed roof.

To help the existing building fully integrate into the new scheme, it was cut back approximately to the structural movement joint line and a new steel-framed extension, comprising two independent bespoke buildings, has been connected onto the reinforced concrete frame to create a transition zone.

The extensions are three-storeys high,

matching the retained structure's height, providing the scheme with modern flexible retail space.

The steel extensions include a basement which will be used as a service yard. As delivery trucks need a large column-free space, three large steel trusses weighing up to 33t and measuring up to 25m-long have been installed.

"The trusses are the depth of one storey, with the top boom being at second floor level and the bottom boom being at first floor level. The upper ground floor steel was suspended from the bottom of the trusses," explains BHC Project Manager Bobby McCormick.

BHC, the project's steelwork contractor, has predominantly used the site's tower cranes for its steel erection, but some of the larger and heavier elements, including the trusses, have necessitated the need for mobile cranes to be brought to site.

For the new build part of the scheme steelwork is playing a leading role in the construction programme.

Excluding the concrete-framed John Lewis store (known as block 1), the project includes three other steel-framed retail buildings: block 4 which is the remodelled building and its new extensions, Block 3 which is in fact two buildings sat either side of the shopping street and block 2 which is another three-storey retail building positioned at the 90 degrees to 3 and 4, and sat at the top of the street where it turns at right angles towards the John Lewis store.

A series of steel bridges links the blocks at second and third floor levels, with the longest of these structures spanning 22m across the main covered street.

The majority of the new build parts of the scheme are founded on a suspended concrete slab which sits atop of a two-level underground car park.

Prior to the steelwork starting on this area a large enabling works and excavation programme was undertaken by Laing O'Rourke.

"An archaeological dig was also undertaken and a number of interesting objects were discovered as there was once a priory on the site," says Laing O'Rourke Project Director Chris Rafferty.

The new steel-framed retail blocks are predominantly erected around a 7.5m x 7.8m grid pattern, while below in the car park there is a larger 7.5m x 15.6m grid. As not every steel column has a subterranean member to sit on, a series of transfer beams is incorporated into the suspended slab.

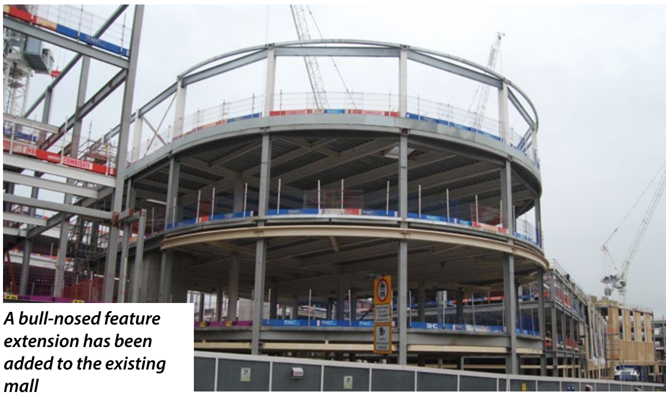
Explaining why steel was chosen for the retail blocks, Ms Telling says: "The steel buildings offer flexibility as tenant requirements may change over time and columns can be removed to create larger stores. Steel was also chosen to minimise the overall structural weight."

Each of the three-storey steel-framed retail blocks is an independent structure, gaining its stability from a combination of discreetly positioned concrete cores, bracing and moment frames.

All of the steel frames support a precast twin wall cladding system that has a brick exterior face. The concrete-framed John Lewis store also has the same cladding, which was chosen for its likeness to the existing Oxford city centre buildings.

As with many city centre projects, logistics is playing a key role on this job.

"There are numerous sub-contractors working on site simultaneously and so sequencing the programme and making sure the project's eight tower cranes are used by everyone as efficiently as possible is vitally important," sums up Mr Rafferty.


A bull-nosed feature extension has been added to the existing mall


Three trusses form a service yard


Steel bridges span the new mall

The revamped existing mall has new steel-framed shop fronts

Council in the frame

A steel-framed solution has been chosen for Cumbria County Council's new offices in Carlisle.

FACT FILE
Cumbria County Council offices, Carlisle
Main client: Cumbria County Council
Architect: AHR Architects
Main contractor: Eric Wright Construction
Structural engineer: Curtins
Steelwork contractor: Border Steelwork Structures
Steel tonnage: 400t

As part of an ongoing cost-saving exercise, Cumbria County Council has moved into a new custom-built £10.4M office block in central Carlisle.

By moving the majority of its staff into the new premises, the Council is able to sell more than 20 older offices throughout the city, a move which will save it around £1M each year.

Located on the historic Botchergate, the headquarters building features 450 workstations and accommodates around 700 staff, with hot desking, mobile working and modern technologies helping to further slash overheads and cut the council's carbon output in half - from 1,546t to 826t.

Eric Wright Construction Managing Director John Wilson says: "As a business, and working in partnership with our design team, we've extensive experience in creating high-profile, bespoke office accommodation for clients across the UK, and we believe we have delivered such a project that will help Cumbria County Council achieve its commitments to ongoing overhead reductions and cost savings."

Working to a 62-week programme Eric Wright Construction initially had to prepare the site by demolishing some shops and houses and then installing pad foundations in readiness for the steel frame.

An archeological dig was also undertaken during the early part of the programme. Medieval and Roman artifacts were unearthed and some of these will be exhibited within the main entrance of the new Council offices.

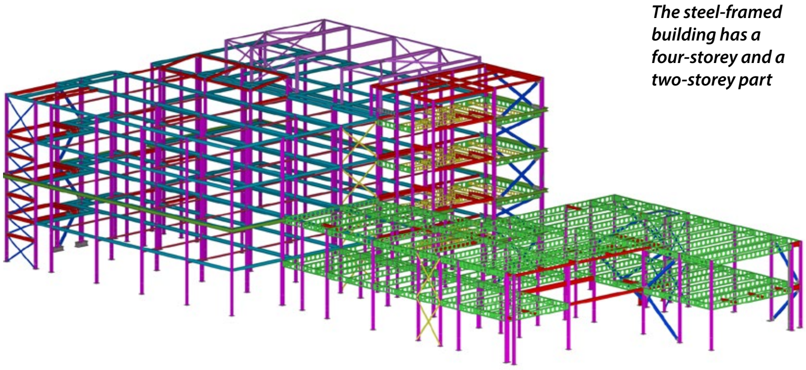
The steel-framed building is configured into two connected parts, consisting of a four-storey office block arranged around a large central atrium and a two-storey element at the front, which contains the public areas and the main entrance.

"It's all one large braced structure," explains Curtins Project Engineer Joe Guest. "All of the structural stability is derived from bracing located in stairwells and in each corner of the building."

Deciding on where to put the bracing was quite time-consuming as the building's elevations all have numerous windows, which makes them unsuitable for large cross bracing, while internally there are very few partition walls that could have provided a location.

"We have used conventional cross bracing comprising flat sections in the two-storey part of the building, while the rear block was mainly RHS bracing due to the restricted number of bracing locations leading to forces too high for conventional cross bracing," adds Mr Guest.

The two-storey part of the structure has been designed with Westok cellular beams (to assist with services integration), while the four-storey structure was designed with SlimFlor beams supporting 200mm reinforced concrete planks sat on the beam's bottom flange, providing the offices with the desired exposed soffit.



The steel-framed building has a four-storey and a two-storey part

Offices are arranged around a large central atrium

The area where the two types of steel-frame link provided the designers with a challenge as the floor heights did not correspond. Some complicated detailing was required to ensure the levels worked seamlessly.

As well as fabricating, supplying and erecting the steel, Border Steelwork Structures also installed metal decking in the two-storey part of the building and placed the precast planks in the office block, all of which was done with a single 50t-capacity mobile crane.

Commenting on the erection programme, Border's Senior Contracts Manager Stuart Airey says: "With over 50 loads of concrete and 20 loads of steel, the steel and concrete works had to be planned and coordinated meticulously to ensure continuity of the build.

"We had a 12-week programme for all of our works but achieved it in eight weeks, which was greatly appreciated by the Eric Wright Construction site team."

Prior to the construction starting, the design of the project went through a number of changes before its final form was decided on.

The client wanted a modern building that also fitted into and complemented its surroundings. A steel-framed solution was chosen for its cost-effectiveness and speed of construction.

"It's a tried and tested method for this type of office building," explains architects AHR. "As well as achieving the required long spans in the offices, steel is also very flexible and suitable for a range of cladding solutions, in this case glazing, brickwork and stone."

Summing up the project, Council Leader Stewart Young says: "The Council has to make the best out of the financial situation it is in. Our downsizing deal is a crucial part of making the organisation ready to face the future. We need modern, flexible accommodation with lower overheads.

"The only way to do this is to sell off our older properties and we are already working in innovative ways with developers to manage this. It's like making that move from a big old family home into a smaller, modern house that you know will be cheaper to run and look after.

"On the plus side, this scheme will help to secure the economic future of Botchergate. Our new office will act as a magnet to attract other businesses and regenerate the southern gateway into Carlisle, which has been run-down for quite some significant time."

The steel frame erection begins

Staff parking is provided to the rear of the new building

Floodplain development

A new commercial block close to the River Thames has been redesigned as a steel structure that will sit above any potential flood waters.

The angled facade supports a canopy over the main entrance

FACT FILE
Tamesis One Redevelopment, Egham, Surrey
Main Client: Royal London Asset Management
Architect: Scott Brownrigg
Main contractor: BAM Construction
Structural engineer: Heyne Tillett Steel
Steelwork contractor: H Young Structures
Steel tonnage: 1,100t

Located at Egham in Surrey, close to the River Thames, the redevelopment of Tamesis One involves the construction of a new five-storey office block to replace a previously demolished building.

Client Royal London Asset Management has pre-let the offices to technology research company Gartner, who also occupy the adjacent Tamesis Two building. The scheme also includes the construction of a dedicated four-storey steel-framed car park to the rear and new landscaping throughout.

Initial designs considered both concrete and steel-framed options. Main contractor BAM opted to go with the steel solution as it offered a quicker programme. A cost saving was also gained as shallower foundations were required, while more slender columns were attainable with steel giving the project a more aesthetic look.

"The top floor was always going to be built with steel because it has 15m-long spans, however we redesigned the entire scheme as a steel structure during Stage 3," explains Heyne Tillett Steel Project Engineer Szymon Lukas.

The site has historic flooding issues as it is close to the River Thames. This was a key consideration in the design of the new development. A comprehensive sustainable urban drainage system has been incorporated in the works.

Supported on up to 25m-deep CFA piles, the steel-framed office building has been raised above the flood plain to create a 800mm void under the building that could be used, in the event of a deluge, as a flood water reservoir.

The flood zone void has been created with a suspended ground floor structure comprising a beam and block floor system spanning between RC beams. Steel columns are sat directly on the pile caps and are encased in concrete below ground floor level. The encasement was introduced to protect columns from corrosion and to provide structural bearing for the RC beams.

"We've designed the scheme for a one in 100-year flood plus 20%," explains BAM Project Manager John Rabey. "The car park has also been included in the flood design as its lowest level has been constructed so that it can accept flood water."

Space is at a premium on this confined site and so logistics have played an important role in the construction process. As the two structures take up most of the site, leaving little room for material storage or plant equipment, a phased sequence was adopted with the office block erected first. Once this was up and the envelope nearly complete, the adjacent steel-framed car park was erected.

The five-storey structure will provide 11,600m² of office space and measures approximately 60m × 50m. It is a composite steel frame with in situ concrete slabs cast on profiled metal decking.

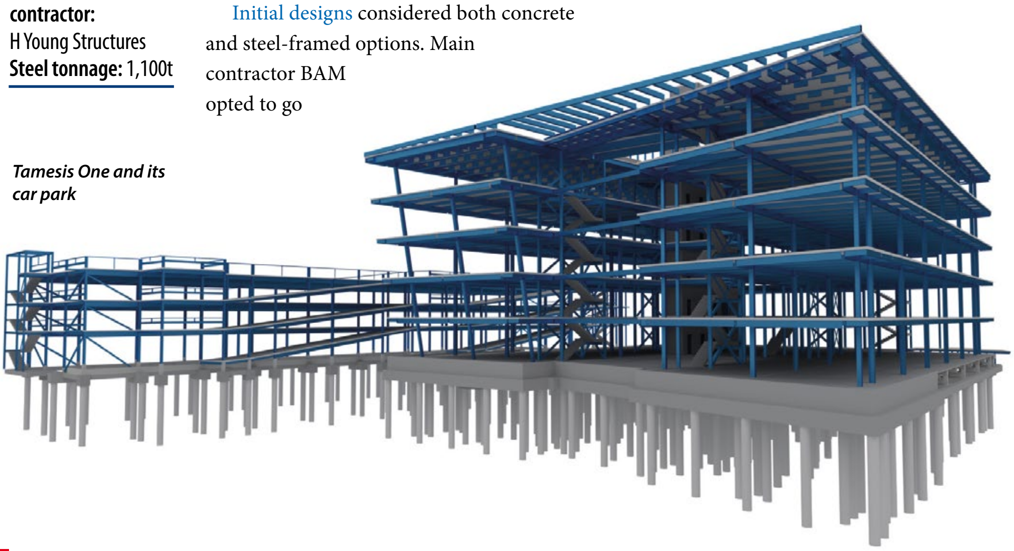
Steelwork contractor H Young Structures erected the 800t of structural steelwork for the office building as well as installing metal decking, stairs and lift shafts in an 11-week programme.

"We erected the structure in a multi-phased sequence as it had to be handed over at various stages to allow follow-on trades to get started to keep the overall programme on schedule," says H Young Structures Managing Director Ian Peachment.

The structure is generally on a 7.5m × 9m grid except for the uppermost floor where internal columns have been omitted to create a large open-plan area with 15m clear spans.

"The idea was to create a statement for the top floor as it also benefits from having good views over the surrounding countryside," explains Mr Lukas.

Internally a full-height atrium splits the building in half. Topped with glazed rooflights the atrium allows natural light to penetrate the inner parts of the building and also accommodates the main reception areas and entrance.



Tamesis One and its car park

The 3m cantilevered façade was erected first

The car park was erected after the office building

Steel link bridges on each floor span across the 12m-wide central atrium providing access between the two sides of the building.

Structurally, the entire building is one large braced frame deriving all of its stability from strategically positioned bracing.

Westok fabricated beams with large web openings have been used at roof level to provide flexible services distribution within the depth of the structural roof zone.

Externally, the offices feature a series of perimeter cantilevers of 1.5m, with a larger 3m cantilever to the front façade. As well as helping to increase the available floorspace, the cantilevers provide a stand-out architectural feature to the building.

The larger 3m-deep cantilever is located on a raking façade which occupies half of the building's main eastern elevation. Adjacent to the main entrance, the raking columns slope outwards by 10 degrees to the rest of the frame and had to be temporarily propped until the floors were cast, which then gave them the necessary stability.

Adjacent to the raking elevation the building also features an angled façade which cuts in on plan to form the entrance. The exterior of this angled zone is topped by a brise-soleil at roof level formed with 400mm × 200mm × 10mm RHS sections, which cantilever out from the main frame by up to 7m.

Steelwork for the stand-alone car park was completed by H Young in a separate six-week programme and required the erection of 300t of fully galvanized steel.

The four level car park measures 80m long × 21m wide, including exterior ramps, and provides 240 parking spaces. There are no internal columns, which creates 16m clear spans for maximum flexibility.

The project's construction programme has recently completed and it is expected to achieve a BREEAM "Very Good' rating.

"We've recently been awarded the fit-out programme for the offices which means our hand-over date has been extended to August," sums up Mr Rabey.

Warehouse opts for a range of steel options

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

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.”

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 last year 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 Range distribution hub is expected to be fully operational by the end of the year.

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 36.5 m and centres of 8 m are quite orthodox, and 15 m 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.

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

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

BBC design show

Exposed architectural steelwork will play a leading role at the new BBC Wales headquarters in Cardiff. Martin Cooper reports.

FACT FILE
BBC Wales Broadcasting House, Cardiff
Main client: Rightacres
Architect: Foster + Partners
Main contractor: ISG
Structural engineer: Arup
Steelwork contractor: Severfield
Steel tonnage: 2,100t

The multi-million pound Central Square development is radically altering a large swathe of land directly opposite Cardiff Central Railway Station turning it into a new city gateway.

On the plot of the city's former bus terminal, the scheme will eventually yield commercial office space, a new frontage to the railway station and most prominently a new headquarters building for BBC Wales.

Plot 1 of the scheme, consisting of an office block, was handed over last year and plots two and three are now under way. This second part of the development will see main contractor ISG construct the new BBC Cymru Wales Broadcasting House and Two Central Square (a 10-storey speculative commercial building) - totalling an £80M package.

Designed by architect Foster + Partners, the new home for the BBC is a 13,900m² building set over five floors and includes office, studio and production areas, providing working space for over 1,200 BBC Wales staff.

ISG's UK Construction West Regional Director Jon James says: "Constructing the new headquarters for BBC Wales is a major win for the business, and brings all of our office expertise to bear on one of the largest ever private developer-led projects to be built in Wales."

Prior to the steel frame for the BBC HQ going up, ISG had to form a 7,000m² basement structure by installing secant piles and excavating approximately 50,000m³ of material, which was removed and re-used offsite.

The BBC building is a hybrid structure, with a reinforced concrete frame to ground floor level, encompassing two basement levels, three concrete cores and a steel framed superstructure for the upper floors.

"Steel has been used for a number of reasons such as speed of construction and the ability to create the 18m-long clear spans in the offices which provides the BBC with maximum flexibility," says ISG Project Director Kevin McElroy.

"To help speed up the programme we also changed the design of one core from reinforced concrete to steel."

The design for the BBC building is based around creating visibility and connectivity by allowing as much daylight into the inner parts of the HQ as possible.

To this end it consists of three main elements: two five-storey office blocks arranged in an L-shape around a centrally positioned media hub structure. Separating the offices from the hub is a large 9m-wide and 30m-high covered atrium.

"All three parts are connected to form one large steel frame with the cores, which are all positioned in the offices, providing the structural stability," explains Arup Director Ben Tricklebank. "The media hub has no cores, but bridges across the atrium connect it to the offices thereby providing stability."

Steelwork contractor Severfield began

The media hub consists of five acoustically isolated TV studios

Curved members form the internal façade of the hub

its erection sequence with the media hub as this is the most complex part of the HQ and the area that will require the longest fit-out.

The majority of the project's steelwork will be left exposed within the completed building and consequently aesthetically-pleasing CHS columns are predominantly being used.

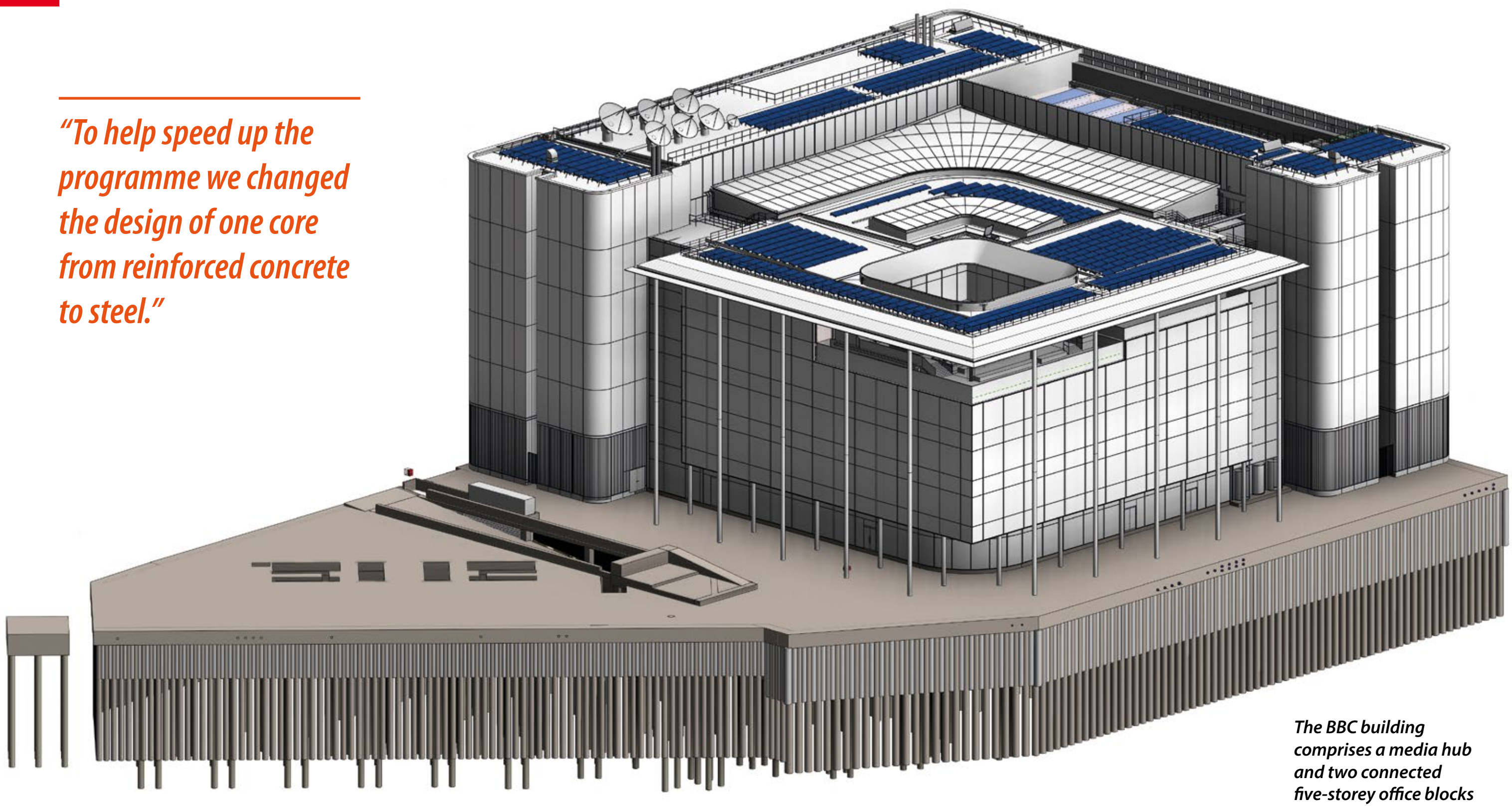
Visible connection details have been designed to be as aesthetic as possible, with many beams tapering to provide the slimmest connection.

Five acoustically isolated TV studios are located throughout the five floors of the hub, with the main and largest facility positioned at second floor level. To construct the necessary isolated box-in-box configuration, the studio steelwork is positioned on acoustic pads set into the concrete slab.

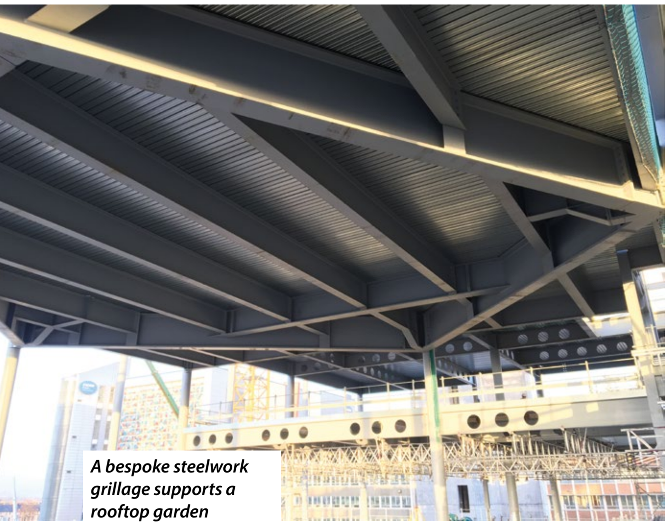
"The studio steelwork has to be erected later than the surrounding main frame as we have to wait until the floors have been cast to ensure acoustic separation is ▶22

Visualisation of the completed BBC Wales building

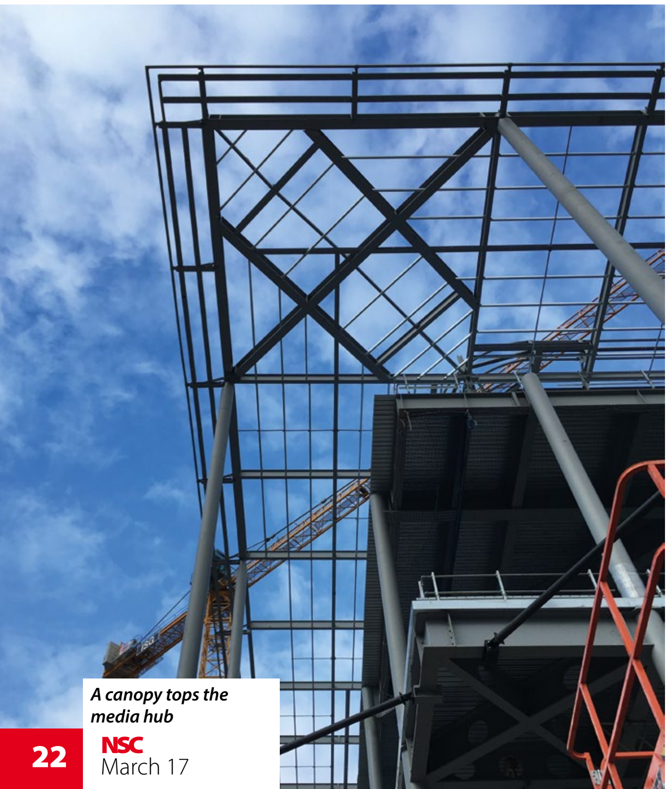
"To help speed up the programme we changed the design of one core from reinforced concrete to steel."



The BBC building comprises a media hub and two connected five-storey office blocks



A bespoke steelwork grillage supports a rooftop garden



A canopy tops the media hub

▶20 achieved," explains Severfield Project Manager Glen McCleary.

To create the required column-free space for a ground floor studio, two transfer beams have been positioned at first floor level. These plate girder beams measure 20m and 17m-long and weigh 23t and 14t respectively.

Most of the steelwork is being erected with the on-site tower cranes, but for these transfer beams a 500t-capacity mobile crane was needed.

The hub's uppermost floor steps back to form an outdoor terrace that overlooks the public realm in front of the railway station, while a third of this level is taken up by a roof garden containing a number of planters for shrubs and small trees.

Supporting the roof garden and creating the large column-free space below for the main studio called for some bespoke steel design. Four 800mm-deep plate girders, weighing up to 12t and arranged in a diamond formation, support the roof garden.

This formation was chosen for its efficiency by lessening the distance the steelwork has to span. The girders are connected to the surrounding steel frame via a series of nodes, all of which cater for multiple beam connections and weight up to 3.5t each.

Topping the hub is a large canopy roof, supported by ten 28.2m-high CHS columns positioned along two perimeter elevations. Elsewhere the canopy is supported off the main internal steel frame.

"The canopy supporting columns were brought to site in single pieces as a splice would have ruined their appearance," says Mr McCleary. "They are the longest elements to have ever left our Northern Ireland facility and transporting them to site was very challenging."

Severfield completed the media hub steel erection at the end of last year and it is now concentrating on the atrium and the two office areas.

Housed within the atrium are three steel feature staircases, providing connectivity between the hub, atrium and the adjacent offices.

The entire structural frame design is based on 9m bays, creating clear spans of 18m in the offices. Fabsec cellular beams have been used throughout for service integration and to create these long spans efficiently.

The long spans and the desire for an exposed soffit detail throughout the scheme has added an extra element to the construction programme. With these long grids the metal decking has to be temporarily propped because it is not stable until the slabs are cast.

"The propping follows-on behind the steel and metal decking installation," says Mr McElroy. "Once a couple of floors have been completed, they are de-propped and the equipment is then re-used on the next levels."

Summing up Alan Bainbridge, BBC Property, said: "Getting the BBC project from the design board to site has been a huge team effort and we are delighted that this project is now becoming a reality. Together with Rightacres and ISG and the respective design teams we are developing a facility which delivers real value for money."

The BBC building is scheduled for a Spring 2018 completion, after which a fit-out programme will commence.

Steel construction with trusses

Richard Henderson of the SCI discusses the use of trusses in buildings.

1 Introduction

Trusses have been used in construction for centuries, originally manufactured from timber and used to form pitched roofs. Early truss railway bridges in the United States were constructed of timber and iron rods. With the development of wrought iron, truss bridges in this material were built in large numbers from the 1870s. The Forth Bridge was the first major steel bridge adopting truss construction and opened in 1890.

Steel trusses in buildings are used extensively to cover large clear spans and this article will mainly focus on this sort of construction.

2 Roof trusses

Roof trusses are an efficient means of supporting a roof covering for spans upwards of 20 m. Upper bound spans of 100 m are suggested on the steelconstruction.info web site. The upper limit is in fact dictated by the value and utility to the building user of the clear span and enclosed volume because examples of truss bridge construction illustrate that much longer spans are possible.

Space trusses and diagrids have been used to form two-way spanning roofs but the most common arrangement of truss roof construction uses one-way spanning elements. A common form of truss is the Pratt truss (or N frame) with vertical shear elements in compression and diagonal shear elements in tension.

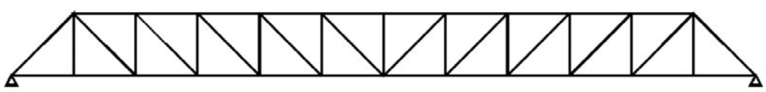


Figure 2.1: Pratt truss

Another is the Warren truss with all shear elements inclined at the same angle to the horizontal in alternating tension and compression from the support to mid-span of a simply supported span.

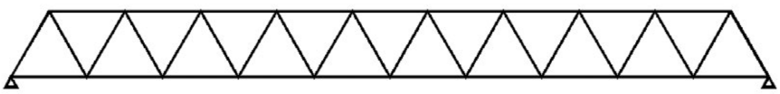


Figure 2.2: Warren truss

Primary trusses are commonly spaced at about one quarter or one fifth of their span but consideration should be given to the form of the secondary elements and roof decking when choosing the truss spacing as it is usual to have no more than two "layers" of structure supporting profiled roof sheeting. Deep-profile decking is capable of spanning five metres or more depending on the loading and can therefore be used with secondary elements spanning 20 metres or more between long-spanning primary trusses.

The span to depth ratio of trusses ranges from 10 to 25, depending on the intensity of the applied load. The lower the ratio, the longer are the shear members in the truss and the larger is the volume occupied by the roof structure. However, the load in the truss booms is lower in a deep truss so there is a trade-off between the truss booms and the members carrying shear forces. The slope of the top boom must also be considered because for a long span truss the increase in depth from eaves to mid span can be significant. The slope must also allow rainwater run-off to occur without ponding.

3 Truss modelling and analysis

The first step in modelling trusses for analysis, when designing to EN 1993-1-1 is to classify the joints in accordance with clause 5.1.2. If the joints are classified as fully pinned or fully fixed, the stiffness of the joints does not need to be taken into account in the global analysis. If the joints have an intermediate stiffness, the moment-rotation curve of the joint does affect the results. It is usual to choose fully pinned or fully fixed joints as the moment-rotation characteristics of the joints are not normally known. A common arrangement is for the tension and compression booms to be modelled as continuous with the bracing members pin ended because this matches the usual built arrangement.

Hand analysis of statically determinate trusses can easily be made if all the joints are assumed to be pinned and computer modelling can follow the same approach. The axial forces found in the members will be slightly higher following this approach than if all the joints are assumed fixed. Appropriate releases must be included in the analysis model, e.g. a roller support at one end. Where a truss boom is connected to a column which is included in the model but not intended to provide lateral stability, the connection should be released to ensure the column does not develop unintended bending moments.

Initial selection of members can be made from a hand estimate of the maximum bending moment divided by the mid-span depth and shear force at the support. The starting point can be improved by more detailed hand analysis or the choice of truss members can be refined by iterative computer analysis. If a vertical deflection criterion is to be met, it is worth noting that, unlike in solid-webbed beams, the deformation of the bracing (shear) members contributes significantly to the total deflection. If the truss is to have bolted joints, the adoption of non-slip joints will eliminate the significant additional deflections due to bolt slip. Such joints are particularly recommended for splices.

4 Choice of truss members and connections

4.1 Tubular members

Tubular members with fully-welded joints are often used for visible roof trusses because they give the cleanest appearance. In conventional steel building design and manufacture, it is usual for the structural engineer responsible for the overall design to select the members and for the steel fabricator to design and detail the connections. In the case of trusses made from steel ▶24

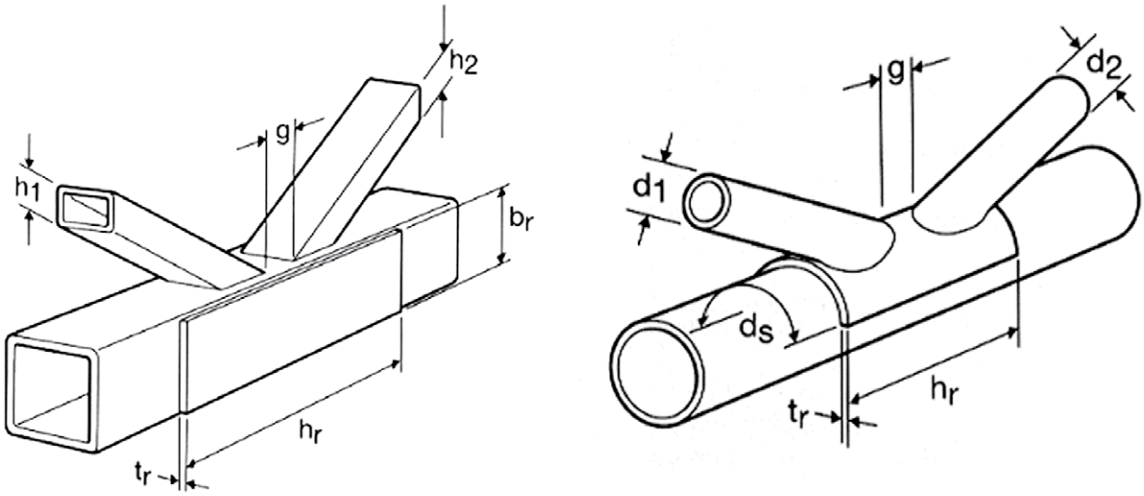


Figure 4.1: Tubes with external strengthening

▶23 tubes, it is important for the structural engineer to consider the design of the connections when selecting the members. It may be tempting to select a large size thin-walled element for a compression boom because of its efficient buckling performance. However it is likely that joints between such a member and shear members in the truss will require external strengthening to prevent failure of the thin wall.

A cheaper, easier to fabricate choice of member would be a smaller size, thicker walled section with joints that required no strengthening. Connection design rules and details are given in BS EN 1993-1-8.

Splices are necessary in long-span trusses for transportation: a 22 m length does not require any special arrangements for movement by road. Pipe-flange type joints are often used in truss booms and are efficient in compression. In tension, thick end plates may be required.

Spade-type joints with cover plates can be connected to tubes by slotting them. Although introducing boom splices at mid span of a truss may not initially appear sensible, for a uniform load, the reduction in forces at third points for a parallel boom truss is only 11% so the difference in the splice arrangement is not likely to be large.

Figure 4.2: Thick end plate splices

4.2 Open sections

Open section members are utilitarian and give more scope for bolted forms of connection. Booms can be oriented with webs vertical or horizontal with different benefits for each arrangement. Vertical webs with gusset plates welded on centreline result in a planar element through which forces can flow from member to member which may not require any strengthening.

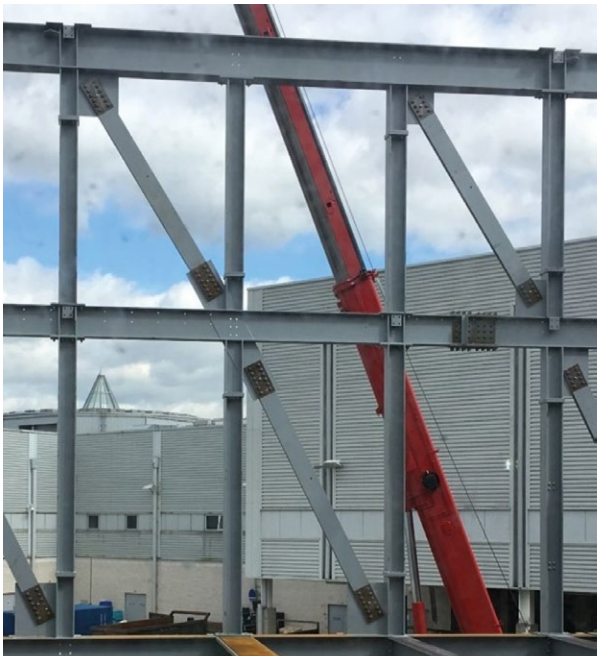


Figure 4.3: ***Thick end plate splices.*** *Photo courtsey of H Young Structures Ltd*

Vertical flanges provide a surface to which tension diagonals (flats or angles) can be welded in pairs with single compression members between. Top and bottom booms must be the same size however.

Figure 4.4: Vertical flanges

Open sections in compression can be orientated so that minor-axis buckling in the plane of the truss is restrained by secondary members provided for that purpose. The efficient use of material in the strut is traded off against the extra members and joints. Gusset plate details are included in the SCI 'Green Book'.

5 Compression boom restraints

A system of restraints to the compression boom of trusses is essential to their structural performance in a roof. Such restraints are usually provided by a system of in-plane bracing connected to purlins or specially provided restraint members. As discussed in the article on restraint to chords in (NSC, January 2017), careful consideration to the effectiveness of the connections between the truss booms and restraining members must be made. Clause 5.3.3 of BS EN 1993-1-1 gives guidance on the design of bracing systems used for restraint of truss compression flanges and indicates that such restraint forces are internal forces and are not transmitted to the building foundations.

Long-span light-weight roofs may be subject to wind uplift such that the bottom boom of the truss goes into compression. If this occurs, the bottom boom must also be adequately restrained to prevent buckling.

Figure 5.1: Top and bottom boom restraints

6 Conclusion

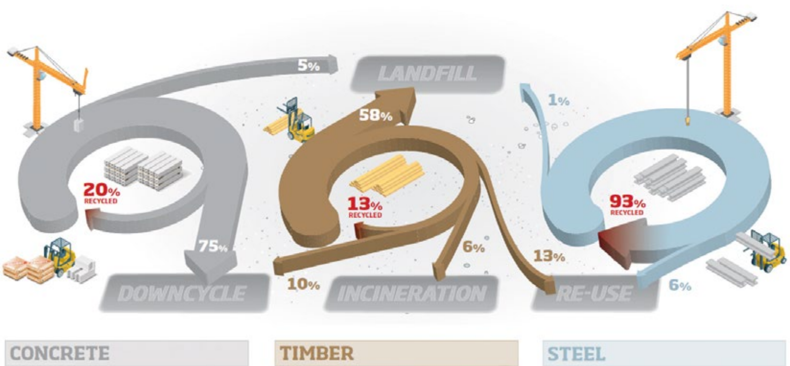
Trusses are a common and effective way of supporting long-span roofs in buildings. The variations in possible arrangement are very wide and the results range in appearance from delightful to utilitarian.

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 downcycling 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.

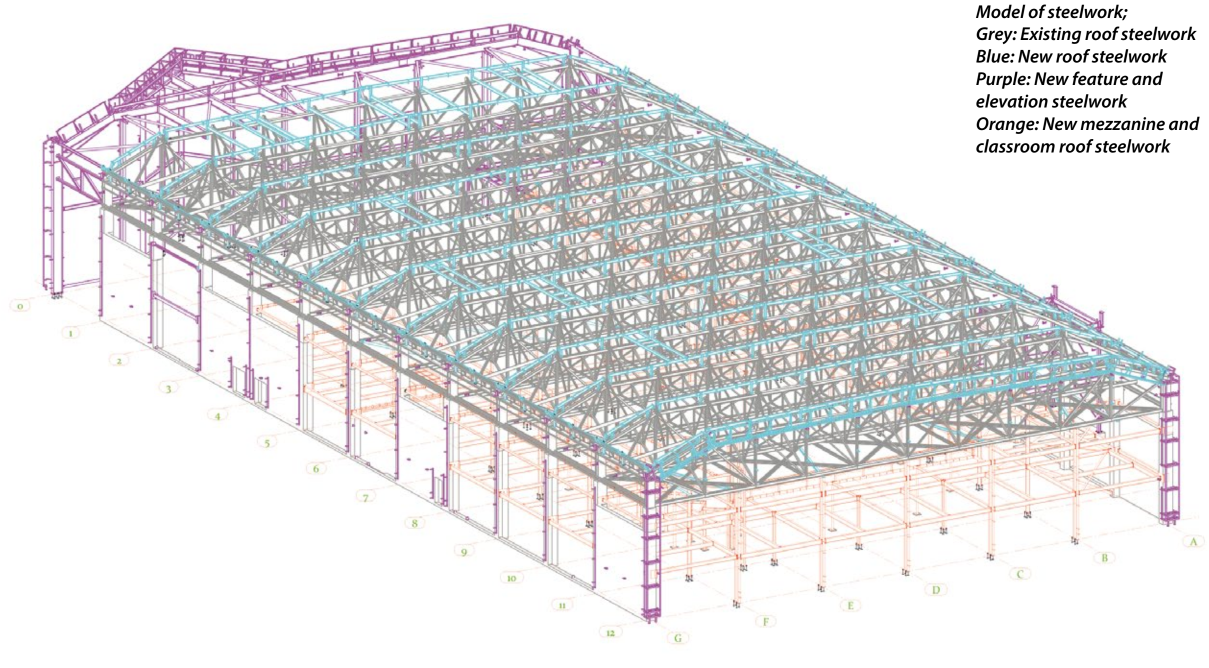
What next for steel and the circular economy?

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: *http://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

AD 405:
Vibration assessment of transient response factors

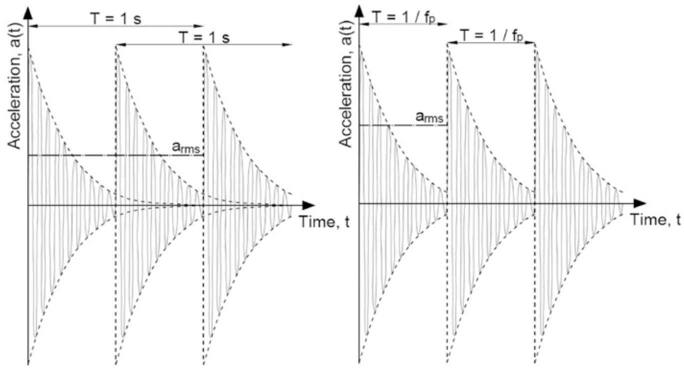
This advisory desk note clarifies advice given in SCI P354: Design of floors for vibration: a new approach, regarding the calculation of the transient response factor of a floor system. The transient response factor R is given by equation (38) in the publication as the weighted root mean square (rms) acceleration, $a_{w,rms}$, divided by 0.005 ms^{-2}. A generic formula to calculate the weighted rms acceleration is given as equation (12) in section 2.4.1.

$$a_{w,rms} = \sqrt{\frac{1}{T}\int_0^T a_w(t)^2 dt}$$

For the calculation of $a_{w,rms}$, values are needed for the time period under consideration, T, and the acceleration function, $a_w(t)$. For transient vibration analysis, the weighted acceleration function, $a_w(t)$, can be found in section 6.3.3, as equation (34). A superposition formula is provided to calculate the acceleration of each impulse by summing the acceleration responses of each mode of vibration of the floor.

In section 2.4.1 and 6.3.3 different values for the time period T to be considered are given. In section 2.4.1, it is suggested that a time period of $T = 1$ s should be used, while in section 6.3.3 it is recommended to take $T = 1/f_p$ when calculating the rms acceleration using equation (12). For an average walking pace of $f_p = 2$ Hz that would lead to a time period of $T = 0.5$ s.

Both of these recommendations refer to a single step. The time period $T = 1$ s does not represent two steps, but instead allows for the time that it takes for the acceleration caused by a single step to fade out, which may overlap with other steps. The time period $T = 1/f_p$ represents the time between two steps.



The difference between the two assumptions can be better understood with the figure above.

SCI recommends $T = 1/f_p$ to be used for the calculation of the transient response factors. This ignores the response at the tail end of the step, but this is generally small compared to the initial acceleration caused by the step. As seen in the figure above, using $T = 1/f_p$ leads to a marginally higher rms acceleration, and is therefore on the safe side.

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New and revised codes & standards

From BSI Updates February 2017

BS EN PUBLICATIONS

BS EN ISO 148-1:2016
Metallic materials. Charpy pendulum impact test. Test method
Supersedes BS EN ISO 148-1:2010

BS EN ISO 148-3:2016
Metallic materials. Charpy pendulum impact test. Preparation and characterization of Charpy V-notch test pieces for indirect verification of pendulum impact machines
Supersedes BS EN ISO 148-3:2008

BS EN ISO 9934-1:2016
Non-destructive testing. Magnetic particle testing. General principles
Supersedes BS EN ISO 9934-1:2015

BS EN ISO 10675-1:2016
Non-destructive testing of welds. Acceptance levels for radiographic testing. Steel, nickel, titanium and their alloys
Supersedes BS EN ISO 10675-1:2013

BS EN ISO 17635:2016
Non-destructive testing of welds. General rules for metallic materials.
Supersedes BS EN ISO 17635:2010

BS EN ISO 17637:2016
Non-destructive testing of welds. Visual testing of fusion-welded joints
Supersedes BS EN ISO 17637:2011

BS EN ISO 19598:2016
Metallic coatings. Electroplated coatings of zinc and zinc alloys on iron or steel with supplementary Cr(VI)-free treatment
No current standard is superseded

NEW WORK STARTED

BS 5427:2016/A1
Code of practice for the use of profiled sheet for roof and wall cladding on buildings

ISO 4986
Steel castings. Magnetic particle inspection
Will supersede BS ISO 4986:2010

ISO 4987
Steel castings. Liquid penetrant inspection
Will supersede BS ISO 4987:2010

ISO 4992-1
Steel castings. Ultrasonic examination. Steel castings for general purposes
Will supersede BS ISO 4992-1:2006

ISO 4992-2
Steel castings. Ultrasonic examination. Steel castings for highly stressed components
Will supersede BS ISO 4992-2:2006

ISO 16573
Steel. Measurement method for the evaluation of hydrogen embrittlement resistance of high strength steels
Will supersede BS ISO 16573:2015

ISO PUBLICATIONS

ISO 8502-2:2017
(Edition 3)
Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness. Laboratory determination of chloride on cleaned surfaces
Will be implemented as an identical British Standard

ISO 8502-3:2017
(Edition 2)
Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness. Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)
Will be implemented as an identical British Standard

AD 401a: Appropriate anchorage of parallel decking Revised

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

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

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

UK NA.4 refers to Non-Contradictory Complementary Information (NCCI), which is available in a recently updated NCCI document (PN003c-GB), now available on *www.steel-ncci.co.uk* and defines three alternatives for ensuring decking is appropriately anchored when through deck welded studs are not present. In order of increasing 'complexity' these are presented as Options 1 to 3 here.

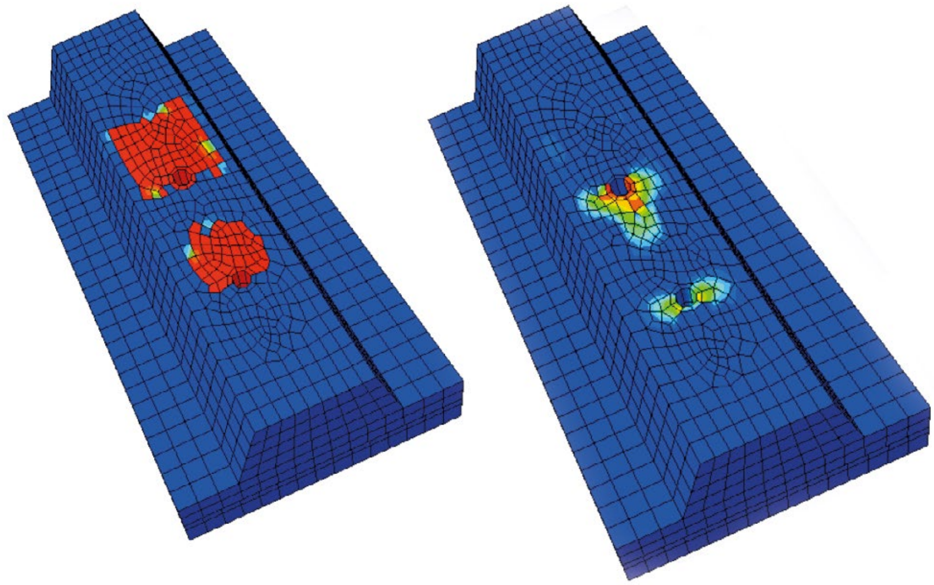

Figure 1: : Concrete damage in a) compression and b) tension at a slip of 6 mm

Option 1

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

- The decking geometry, flange width and stud placement is such that the angle between the base of the stud and shoulder of the decking is no more than 50°.
- There are single studs fixed along the beam centreline, providing edge cover of not less than 50 mm. Multiple studs at a given cross section must be avoided because of their potential to transfer a higher force into the concrete.
- The longitudinal stud spacing is not less than 150 mm. When studs are more closely spaced there is an increased likelihood of interaction between adjacent studs resulting in slab splitting, but the FEM demonstrated that even at slips in excess of 10 mm - which is almost twice the slip anticipated by BS EN 1994-1-1; there is no interaction for studs at 150 mm centres (Figure 1).
- The beam is simply supported.

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

Option 2

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

Option 3

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

REVISION a: The minimum stud spacing has been reduced to 150 mm based on additional FEM undertaken in early 2017. Figure 1 has been updated to reflect the new findings, with indicative concrete damage now shown at a slip of 6 mm.

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Wholesale and retail markets use steelwork

The City of Leeds has long recognised the need for modern facilities to handle the collection and wholesale distribution of fish, fruit and vegetables and in 1964 the Markets Committee recommended the building of a new wholesale market for these commodities. Work on the site began in July 1965 and the £947,000 project was completed and opened for trading in October 1966.

The market is built on a 23-acre site situated south-east of the city in an area more readily accessible than the existing market to roads from the ports and southern growing districts. It is of considerable size, having a covered area of approximately 100,000 sq. ft. There are 80 stands in the Fruit and Vegetable sections, each 20 ft wide by 40 ft deep by 23 ft high accommodated in four separate blocks of 20 stands. In the Fish Market Hall are a further 22 stands of the same dimensions as those above: each has an office at first floor level. There is also a line of 33 open stands in the Market Gardeners' section, 30 ft deep by 12 ft wide, and a single warehouse block with 20 storage units. Dining and refreshment facilities are provided in two of the blocks.

All buildings are of similar basic design, ie exposed structural steel frames incorporating castellated beams and supporting thermally insulated sheet steel roof decking: by spacing the main roof beams at 10 ft centres it was possible to support the sheets directly on these without the need for purlins. Vitreous enamelled panels provide the wall cladding, and each of the blocks terminates with flank walls of engineering brickwork.

Headroom requirements in the stands, together with the need for a continuous canopy over the delivery doors at the rear of the stands, led to the adoption of cantilever construction for the offices above. The castellated roof beams are constructed from three different universal beam cuttings: the slope of the top flanges gives the necessary fall to the gutters, the bottom flanges are horizontal within the main building and the section tapers in the cantilever portion. The calculated maximum deflection for the extremity of the cantilevers was 2.65 in. and to counteract this an upward camber of 2½ in. was fabricated into them.

The wind girders for the buildings span 220 ft and are placed in the roofs of the offices. By this means the facia channels at the head of the office elevation acts as one boom of the girder. The other members are rectangular hollow sections cut to exact length and provided with 1-in thick end plates. Connections are made with high-strength friction grip bolts in tension, a system that has proved economical and gives the bracing a neat appearance.

Space frames slung from the main building structure provide covered ways between the buildings. Over the central 40-ft wide buyer's walk between each two rows of stands are 'butterfly' roofs alternating in opposite directions to give even distribution of light and ventilation.

Prior to delivery all steelwork was blast-cleaned and coated with zinc-rich primer. On-site treatment consisted of two coats of micaceous iron oxide followed by a final coat of gloss paint.

Architects – John Brunton & Partners, who were also responsible for the structural design, in association with E W Stanley, BA(HonsArch) ARIBA, City Architect of Leeds.

(Above) Space frames from the main structures provide covered walks between buildings.

(below) general view of the Fruit and Vegetable Hall and the offices above it. The butterfly roofs alternate in opposite directions to give even lighting and ventilation.

Reprinted from Volume 4 No. 5
February 1967

Glenrothes retail shopping centre

To meet the needs of the rapidly increasing population of Glenrothes, Fifeshire, which has more than doubled during recent years, the central area of the town is being developed to provide improved amenities, this work including 34 shops, two multiple stores, post office, bowling centre and an hotel.

The first stage to be completed is the shopping centre illustrated on this page, a covered area measuring 180 ft by 100 ft giving access to shops around three sides of it. The W-profile roof canopy is carried on two rows of five 14-in diameter, 36-ft long steel tube columns linked by castellated valley beams which support the main roof beams, also of castellated design. Steel purlins carry the patent roof glazing. Steelwork is also used for bracing purposes and for supporting the glazed end screens.

A store for F W Woolworth & Co Ltd forms part of the Centre and this, in accordance with the policy of the company, is steel-framed. The roof and support structure was designed by T. Harley Haddow and Partners, and with the exception of certain shops the remaining work was designed by the Chief Architect's Department of Glenrothes Development Corporation which is also responsible for the project in general.

Steelwork contractors for buildings

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

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

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

- **C** Heavy industrial platework for plant structures, bunkers, hoppers, silos etc
- **D** High rise buildings (offices etc over 15 storeys)
- **E** Large span portals (over 30m)
- **F** Medium/small span portals (up to 30m) and low rise buildings (up to 4 storeys)
- **G** Medium rise buildings (from 5 to 15 storeys)
- **H** Large span trusswork (over 20m)
- **J** Tubular steelwork where tubular construction forms a major part of the structure
- **K** Towers and masts
- **L** Architectural steelwork for staircases, balconies, canopies etc
- **M** Frames for machinery, supports for plant and conveyors
- **N** Large grandstands and stadia (over 5000 persons)
- **Q** Specialist fabrication services (eg bending, cellular/castellated beams, plate girders)
- **R** Refurbishment
- **S** Lighter fabrications including fire escapes, ladders and catwalks
- **FPC** Factory Production Control certification to BS EN 1090-1
  1 – Execution Class 1; 2 – Execution Class 2; 3 – Execution Class 3; 4 – Execution Class 4
- **BIM** BIM Level 2 assessed
- **QM** Quality management certification to ISO 9001
- **SCM** Steel Construction Sustainability Charter
  (● = Gold, ● = Silver, ● = Member)

Notes

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

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

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
A & J Stead Ltd	01653 693742			●	●					●	●			●	●		2			Up to £200,000
A C Bacon Engineering Ltd	01953 850611			●	●	●	●				●			●			2			Up to £3,000,000
A&J Fabtech Ltd	01924 439614	●					●		●	●	●		●	●		✔	3			Up to £400,000
Access Design & Engineering	01642 245151					●				●	●			●	●	✔	2			Up to £4,000,000
Adey Steel Ltd	01509 556677	●		●	●	●	●	●	●	●	●			●	●	✔	3		Silver	Up to £2,000,000
Adstone Construction Ltd	01905 794561			●	●	●	●									✔	2	✔	Gold	Up to £3,000,000
Advanced Fabrications Poyle Ltd	01753 653617				●	●	●	●		●	●			●	●	✔	2			Up to £800,000
AJ Engineering & Construction Services Ltd	01309 671919			●	●					●	●			●	●	✔	4			Up to £2,000,000
Angle Ring Company Ltd	0121 557 7241												●			✔	4			Up to £1,400,000
Apex Steel Structures Ltd	01268 660828			●	●	●	●			●	●			●			2			Up to £2,000,000
Arminhall Engineering Ltd	01799 524510	●			●	●		●		●	●			●	●	✔	2			Up to £400,000
Arromax Structures Ltd	01623 747466	●		●	●	●	●	●	●	●	●	●		●	●		2			Up to £800,000
ASA Steel Structures Ltd	01782 566366			●	●	●	●			●	●			●	●	✔	4			Up to £800,000
ASME Engineering Ltd	020 8966 7150				●	●				●	●			●	●	✔	4		Gold	Up to £2,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●	●	●				●			●	●	✔	2			Up to £1,400,000
Austin-Divall Fabrications Ltd	01903 721950			●	●		●	●		●	●			●	●	✔	2			Up to £800,000
B D Structures Ltd	01942 817770			●	●	●	●				●	●		●		✔	2			Up to £1,400,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✔	4			Up to £1,400,000
Barnshaw Section Benders Ltd	0121 557 8261												●			✔	4			Up to £2,000,000
BHC Ltd	01555 840006	●	●	●	●	●	●	●			●	●		●	●	✔	4		Silver	Above £6,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●	●	●	●	●		●	●	✔	4		Gold	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●		4			Up to £3,000,000
Bourne Construction Engineering Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●			●	●	✔	4			Up to £6,000,000
Builders Beams Ltd	01227 863770			●	●	●	●			●	●			●	●	✔	2	✔		Up to £3,000,000
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●				●	●	✔	4		Silver	Up to £3,000,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●		●	●	●		●	●	✔	4	✔	Gold	Above £6,000,000
Cementation Fabrications	0300 105 0135	●			●			●			●		●		●	✔	3		Gold	Up to £6,000,000*
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	●		●		✔	4		Gold	Above £6,000,000*
CMF Ltd	020 8844 0940				●		●	●		●	●				●	✔	4			Up to £6,000,000
Cook Fabrications Ltd	01303 893011				●					●	●			●	●		2			Up to £1,400,000
Coventry Construction Ltd	024 7646 4484			●	●	●	●		●	●	●			●	●	✔	4			Up to £800,000
D H Structures Ltd	01785 246269			●	●		●				●						2			Up to £100,000
D Hughes Welding & Fabrication Ltd	01248 421104				●	●	●	●		●	●		●	●	●	✔	4			Up to £800,000
Duggan Steel	00 353 29 70072		●	●	●	●	●	●	●		●	●			●	✔	4			Up to £6,000,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●	●	●	●	●			●	●	✔	3			Up to £3,000,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●	●	●	●	●	●		●		✔	4	✔	Gold	Up to £6,000,000
EvadX Ltd	01745 336413			●	●	●	●	●	●	●	●	●				✔	3		Gold	Up to £3,000,000
Four Bay Structures Ltd	01603 758141			●	●	●	●	●		●	●			●	●		2			Up to £1,400,000
Four-Tees Engineers Ltd	01489 885899												●		●	✔	3		Member	Up to £2,000,000
Fox Bros Engineering Ltd	00 353 53 942 1677			●	●	●	●	●			●				●		2			Up to £2,000,000
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●				●	●	✔	2			Up to £1,400,000
Gregg & Patterson (Engineers) Ltd	028 9061 8131			●	●	●	●	●				●		●		✔	3			Up to £3,000,000
H Young Structures Ltd	01953 601881			●	●	●	●	●		●	●			●	●	✔	2		Member	Up to £2,000,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
Had Fab Ltd	01875 611711				●				●	●	●				●	✔	4			Up to £3,000,000
Hambleton Steel Ltd	01748 810598		●	●	●	●	●	●				●		●		✔	4		● (grey)	Up to £6,000,000
Harry Marsh (Engineers) Ltd	0191 510 9797			●	●	●	●			●	●				●	✔	2			Up to £1,400,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●	✔	2			Up to £3,000,000
Intersteels Ltd	01322 337766				●	●	●	●					●			✔	3			Up to £2,000,000
J & A Plant Ltd	01942 713511				●	●									●		4			Up to £40,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●				●	●		●			4			Up to £6,000,000*
John Reid & Sons (Strucsteel) Ltd	01202 483333		●	●	●	●	●	●	●	●	●	●		●	●	✔	4		● (grey)	Up to £6,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445			●	●	●	●	●	●	●	●	●		●	●	✔	4		● (orange)	Up to £6,000,000
Kloeckner Metals UK Westok	0113 205 5270												●			✔	4			Up to £6,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●					✔	2		● (grey)	Up to £6,000,000
Legge Steel (Fabrications) Ltd	01592 205320			●	●		●		●	●	●			●	●		3			Up to £800,000
Luxtrade Ltd	01902 353182									●	●				●	✔	2			Up to £800,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●				●	✔	4			Up to £2,000,000
M J Patch Structures Ltd	01275 333431				●					●	●			●	●	✔	2			Up to £1,400,000
M&S Engineering Ltd	01461 40111				●				●	●	●			●	●		3			Up to £1,400,000
Mackay Steelwork & Cladding Ltd	01862 843910			●	●		●			●	●			●	●	✔	4			Up to £1,400,000
Maldon Marine Ltd	01621 859000				●	●		●	●	●	●			●	●	✔	3			Up to £1,400,000
Mifflin Construction Ltd	01568 613311			●	●	●	●				●						2			Up to £3,000,000
Murphy International Ltd	00 353 45 431384	●			●		●	●	●		●				●	✔	4			Up to £1,400,000
Newbridge Engineering Ltd	01429 866722	●	●	●	●	●	●	●	●		●			●	●	✔	4		● (green)	Up to £1,400,000
Nusteel Structures Ltd	01303 268112						●	●	●	●						✔	4			Up to £4,000,000
Overdale Construction Services Ltd	01656 729229			●	●		●	●			●				●		2			Up to £400,000
Painter Brothers Ltd	01432 374400								●		●			●	●	✔	3			Up to £6,000,000*
Pencro Structural Engineering Ltd	028 9335 2886			●	●	●	●	●	●		●			●	●	✔	2			Up to £2,000,000
Peter Marshall (Steel Stairs) Ltd	0113 307 6730									●					●	✔	2			Up to £800,000*
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●		2			Up to £1,400,000
Rippin Ltd	01383 518610			●	●	●	●	●						●	●		2			Up to £1,400,000
S H Structures Ltd	01977 681931	●			●		●	●	●	●	●	●				✔	4	✔	● (grey)	Up to £2,000,000
SAH Engineering Ltd	01582 584220			●	●	●				●	●			●	●		2			Up to £800,000
SDM Fabrication Ltd	01354 660895	●	●	●	●	●	●				●			●	●	✔	4			Up to £2,000,000
Sean Brady Construction Engineering Ltd	00 353 49 436 4144			●	●	●	●			●	●			●	●		2			Up to £800,000
Severfield plc	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4		● (orange)	Above £6,000,000
SGC Steel Fabrication	01704 531286				●					●				●	●	✔	2			Up to £800,000
Shaun Hodgson Engineering Ltd	01553 766499	●		●	●		●			●	●			●	●	✔	3			Up to £800,000
Shipley Structures Ltd	01400 251480			●	●	●	●		●	●	●			●	●		2			Up to £3,000,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●	●	●	●			●				●		2	✔		Up to £1,400,000
South Durham Structures Ltd	01388 777350			●	●	●				●	●	●			●		2			Up to £800,000
Southern Fabrications (Sussex) Ltd	01243 649000				●	●				●	●			●	●	✔	2			Up to £800,000
Taziker Industrial Ltd	01204 468080									●				●	●	✔	3			Above £6,000,000
Temple Mill Fabrications Ltd	01623 741720			●	●	●	●				●			●	●	✔	2			Up to £400,000
Traditional Structures Ltd	01922 414172			●	●	●	●	●	●		●			●	●	✔	3	✔	● (grey)	Up to £2,000,000
TSI Structures Ltd	01603 720031			●	●	●	●	●			●			●		✔	2	✔		Up to £1,400,000
Tubecon	01226 345261						●	●	●	●				●	●	✔	4		● (orange)	Above £6,000,000*
Underhill Engineering Ltd	01752 752483				●		●	●	●	●	●			●	●	✔	4			Up to £3,000,000
W & H Steel & Roofing Systems Ltd	00 353 56 444 1855			●	●	●	●	●						●	●		4			Up to £2,000,000
W I G Engineering Ltd	01869 320515				●					●					●	✔	2			Up to £200,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✔	4			Up to £6,000,000
Westbury Park Engineering Ltd	01373 825500	●		●	●		●	●	●	●	●				●	✔	4			Up to £800,000
William Haley Engineering Ltd	01278 760591			●	●	●			●	●	●			●		✔	4		● (orange)	Up to £4,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	● (orange)	Above £6,000,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)

Corporate Members

Corporate Members are clients, professional offices, educational establishments etc which support the development of national specifications, quality, fabrication and erection techniques, overall industry efficiency and good practice.

Company name	Tel
A Lamb Associates Ltd	01772 316278
Balfour Beatty Utility Solutions Ltd	01332 661491
Griffiths & Armour	0151 236 5656
Highways England Company Ltd	08457 504030
Kier Construction Ltd	01767 640111

Company name	Tel
PTS (TQM) Ltd	01785 250706
Sandberg LLP	020 7565 7000
Structural & Weld Testing Services Ltd	01795 420264
SUM Ltd	0113 242 7390

RQSC
The Register of Qualified Steelwork Contractors Scheme

Steelwork contractors for bridgeworks

BCSA

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

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

- **FG** Footbridge and sign gantries
- **PG** Bridges made principally from plate girders
- **TW** Bridges made principally from trusswork
- **BA** Bridges with stiffened complex platework (eg in decks, box girders or arch boxes)
- **CM** Cable-supported bridges (eg cable-stayed or suspension) and other major structures (eg 100 metre span)
- **MB** Moving bridges
- **RF** Bridge refurbishment
- **AS** Ancilliary structures in steel associated with bridges, footbridges or sign gantries (eg grillages, purpose-made temporary works)
- **QM** Quality management certification to ISO 9001
- **FPC** Factory Production Control certification to BS EN 1090-1
  1 – Execution Class 1 2 – Execution Class 2
  3 – Execution Class 3 4 – Execution Class 4
- **BIM** BIM Level 2 compliant
- **SCM** Steel Construction Sustainability Charter (● = Gold, ● = Silver, ● = Member)

Notes

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

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

BCSA steelwork contractor member	Tel	FG	PG	TW	BA	CM	MB	RF	AS	QM	FPC	BIM	NHSS 19A	NHSS 20	SCM	Guide Contract Value [1]
A&J Fabtech Ltd	01924 439614	●	●	●	●				●	✓	3					Up to £400,000
Bourne Construction Engineering Ltd	01202 746666	●	●	●				●	●	✓	4	✓		✓	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	✓	4			✓		Up to £6,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●			●	●	✓	4			✓	Silver	Up to £3,000,000
Cementation Fabrications	0300 105 0135	●	●						●	✓	3			✓	Gold	Up to £6,000,000*
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Above £6,000,000*
D Hughes Welding & Fabrication Ltd	01248 421104	●		●			●	●	●	✓	4			✓		Up to £800,000
Donyal Engineering Ltd	01207 270909	●						●	●	✓	3			✓	Member	Up to £1,400,000
ECS Engineering Ltd	01773 860001	●	●	●	●		●		●	✓	3					Up to £3,000,000
Four-Tees Engineers Ltd	01489 885899	●	●	●	●		●	●	●	✓	3			✓	Member	Up to £2,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●		●				●	●	✓	4			✓	Gold	Up to £6,000,000
Millar Callaghan Engineering Services Ltd	01294 217711	●				●		●	●	✓	4			✓		Up to £1,400,000
Murphy International Ltd	00 353 45 431384	●	●	●	●				●	✓	4					Up to £1,400,000
Nusteel Structures Ltd	01303 268112	●	●	●	●	●		●	●	✓	4		✓	✓		Up to £4,000,000
S H Structures Ltd	01977 681931	●		●	●	●	●		●	✓	4	✓		✓	Silver	Up to £2,000,000
Severfield (UK) Ltd	01204 699999	●	●	●	●	●	●	●	●	✓	4			✓	Gold	Above £6,000,000
Shaun Hodgson Engineering Ltd	01553 766499							●	●	✓	3					Up to £800,000
Taziker Industrial Ltd	01204 468080	●	●	●	●			●	●	✓	3		✓	✓		Above £6,000,000
Underhill Engineering Ltd	01752 752483	●	●	●	●			●	●	✓	4			✓		Up to £3,000,000
Non-BCSA member																
Allerton Steel Ltd	01609 774471	●	●	●	●	●		●	●	✓	4			✓		Up to £4,000,000
Centregreat Engineering Ltd	029 2046 5683	●	●	●	●	●	●	●	●	✓	4					Up to £1,400,000
Cimolai SpA	01223 836299	●	●	●	●	●	●	●	●	✓	4					Above £6,000,000
CTS Bridges Ltd	01484 606416	●	●	●	●	●	●		●	✓	4			✓	Member	Up to £800,000
Francis & Lewis International Ltd	01452 722200							●	●	✓	4			✓	Gold	Up to £2,000,000
Harland & Wolff Heavy Industries Ltd	028 9045 8456	●	●	●	●	●		●	●	✓	3					Up to £2,000,000
Hollandia Infra BV	00 31 180 540 540	●	●	●	●	●	●	●	●	✓	4					Above £6,000,000*
HS Carlsteel Engineering Ltd	020 8312 1879	●	●					●	●	✓	3			✓		Up to £40,000
IHC Engineering (UK) Ltd	01773 861734	●							●	✓	3			✓		Up to £400,000
Interserve Construction Ltd	020 8311 5500							●	●	✓	N/A					Above £6,000,000*
Lanarkshire Welding Company Ltd	01698 264271	●	●	●	●	●	●	●	●	✓	4		✓	✓	Silver	Up to £2,000,000
P C Richardson & Co (Middlesbrough) Ltd	01642 714791	●						●	●	✓	N/A					Up to £3,000,000
Total Steelwork & Fabrication Ltd	01925 234320	●						●	●	✓	3			✓		Up to £3,000,000
Victor Buyck Steel Construction	00 32 9 376 2211	●	●	●	●	●	●	●	●	✓	4		✓	✓	Silver	Above £6,000,000

Industry Members

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

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

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

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

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM	BIM
AJN Steelstock Ltd	01638 555500								●		M		
Albion Sections Ltd	0121 553 1877	●									M		
Arcelor Mittal Distribution - Scunthorpe	01724 810810								●		D/I		
Autodesk Ltd	01252 456893		●										
AVEVA Solutions Ltd	01223 556655		●								N/A		
Ayrshire Metals Ltd	01327 300990	●									M		✓
BAPP Group Ltd	01226 383824									●	M		
Barrett Steel Services Limited	01274 682281								●		M		
Behringer Ltd	01296 668259					●					N/A		
British Steel	01724 404040				●						M		
BW Industries Ltd	01262 400088	●									M		
Cellbeam Ltd	01937 840600	●									M		
Cleveland Steel & Tubes Ltd	01845 577789								●		M		
Composite Profiles UK Ltd	01202 659237	●									D/I		
Cooper & Turner Ltd	0114 256 0057									●	M		
Cutmaster Machines (UK) Ltd	01226 707865					●					N/A		
Daver Steels Ltd	0114 261 1999	●									M		
Daver Steels (Bar & Cable Systems) Ltd	01709 880550	●									M		
Dent Steel Services (Yorkshire) Ltd	01274 607070								●		M		
Duggan Profiles & Steel Service Centre Ltd	00 353 56 7722485	●							●		M		
easi-edge Ltd	01777 870901							●			N/A	Gold	
Fabsec Ltd	01937 840641	●									N/A		
Ficep (UK) Ltd	01924 223530					●					N/A		
FLI Structures	01452 722200	●									M	Gold	
Forward Protective Coatings Ltd	01623 748323						●				N/A		
Graitec UK Ltd	0844 543 8888		●								N/A		
Hadley Group Ltd	0121 555 1342	●									M	Silver	
Hempel UK Ltd	01633 874024						●				N/A		
Highland Metals Ltd	01343 548855						●				N/A		
Hilti (GB) Ltd	0800 886100									●	M		
Hi-Span Ltd	01953 603081	●									M	Member	
International Paint Ltd	0191 469 6111						●				N/A	Gold	
Jack Tighe Ltd	01302 880360						●				N/A		
Jamestown Cladding & Profiling Ltd	00 353 45 434288	●									M		
John Parker & Sons Ltd	01227 783200								●	●	D/I		
Joseph Ash Galvanizing	01246 854650						●				N/A		
Jotun Paints (Europe) Ltd	01724 400000						●				N/A		
Kaltenbach Ltd	01234 213201					●					N/A		
Kingspan Structural Products	01944 712000	●									M	Gold	
Kloeckner Metals UK	0113 254 0711								●		D/I		
Lindapter International	01274 521444									●	M		
MSW UK Ltd	0115 946 2316	●									D/I		
Murray Plate Group Ltd	0161 866 0266								●		D/I		
National Tube Stockholders Ltd	01845 577440								●		D/I		
Peddinghaus Corporation UK Ltd	01952 200377					●					N/A		
Pipe and Piling Supplies Ltd	01592 770312	●									M		
PPG Performance Coatings UK Ltd	01773 814520						●				N/A		
Prodeck-Fixing Ltd	01278 780586	●									D/I		
Rainham Steel Co Ltd	01708 522311								●		D/I		
Sherwin-Williams Protective & Marine Coatings	01204 521771						●				M	Silver	
Structural Metal Decks Ltd	01202 718898	●									M	Gold	
StruMIS Ltd	01332 545800		●								N/A		
Tata Steel Distribution UK & Ireland	01902 484000								●		D/I		
Tata Steel Ireland Service Centre	028 9266 0747								●		D/I		
Tata Steel Service Centre Dublin	00 353 1 405 0300								●		D/I		
Tata Steel Tubes	01536 402121				●						M		
Tata Steel UK Panels & Profiles	0845 3088330	●									M		
Tension Control Bolts Ltd	01948 667700						●			●	M		
Trimble Solutions (UK) Ltd	0113 887 9790		●								N/A		
voestalpine Metsec plc	0121 601 6000	●									M	Gold	
Wedge Group Galvanizing Ltd	01909 486384						●				N/A		
Yamazaki Mazak UK Ltd	01905 755755					●					N/A