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NSC

Second tower for Salford

June 2019
Vol 27 No 6

Industrial vision in Manchester

Offices span Crossrail

Euston scheme's sustainability boost

Iron and steel houses for Slough

Cover Image
Circle Square Multi-Storey Car Park
Main client: Bruntwood
Concept Architect: Fielden Clegg Bradley Studios
Main contractor: Russels Construction
Steelwork contractor: James Killelea & Co
Steel tonnage: 2,000t

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Steel supporting air quality drive

Nick Barrett - Editor

Imagine having the opportunity to make a simple design decision that would give a building carbon savings equivalent to a gas and electricity emission free operation for 26 years. And at the same time as adding three storeys to an existing five-storey office block.

That is being achieved at British Land's 1 Triton Square development on the north side of London's Euston Road, as you can read in this issue of NSC. The existing concrete-framed building was no longer attractive to modern commercial tenants and would usually have been heading for demolition. But by deciding to use steel for a vertical expansion the design team was able to redevelop the originally concrete-framed structure to allow the reuse of materials including some 1,900 tonnes of steel.

Some innovative strengthening of the existing structure along with the extra floors almost doubled the building's internal area, increasing its all-important lettable space. As you can read, this was only possible using steel.

For the client, sustainability was more of an attraction of this solution than cost savings, something we can expect to hear more of. The world is growing ever more environmentally conscious, and one of the key areas of concern is the impact of emissions on air quality, especially in cities. Much of these emissions arise from traffic fumes and political attention is being driven by public concerns towards finding solutions like emission control zones, promoting electric vehicles and phasing out diesel vehicles.

But improving air quality will involve more than attacking traffic emissions, and buildings are well known to be major producers of emissions through their embodied carbon as well as their lighting, heating and air conditioning. Public and political attention is turning ever more closely to the air quality impact of buildings and design-led solutions like Triton Square will have a big part to play in delivering improvements.

Embodied carbon savings from projects like Triton Square may have little direct impact on local air quality but globally all of these carbon savings will add up, and they will have to be achieved as a matter of routine.

When strong environmental credentials can be delivered alongside cost-effective developments with the sort of modern, aesthetically pleasing environments that steel construction routinely provides, the case for steel has been made.

Other benefits of steel that we see deployed to great effect in this month's NSC include the 18 Hanover Square development, which sits on top of Bond Street station on the new Elizabeth Line, or Crossrail. Here, a late request by a tenant to have an atrium included as part of the design was easily accommodated by the steelwork contractor redesigning the fabrication programme while avoiding delays to the overall scheme.

In Salford, 100 Embankment is providing BREEAM 'Excellent' offices on a former railway station site, reinvigorating the area where Salford meets Manchester, overlooking Manchester Cathedral. In line with the increasing trend of building owners and designers to show off the fact that their frames are steel, the client has asked for the entire steel frame to be exposed, creating an office environment in keeping with the area's industrial heritage. Steel may be selected for a variety of reasons, but wherever you see a steel frame you'll know that it was also the environmental choice.

London office construction up despite Brexit uncertainty

Office construction volumes in London are up 12% compared to six months ago, with 37 new schemes breaking ground, adding 325,000m² of floor space into the development pipeline.

According to the latest Deloitte London Office Crane Survey for summer 2019, the capital's commercial sector has remained steady despite Brexit uncertainties, and total office space under construction between October 2018 and March 2019 amounted to 1.2M/m².

Encouragingly, the volume of new starts is also the highest since 2016, during the lead-up to the EU referendum. With 320,000m² of new office construction activity across 37 new schemes, the volume is 38% higher than 2018.

Deloitte Real Estate Director Mike Cracknell said: "London's office market remains resilient in the face of uncertainty as we witness an encouraging increase in new construction starts. This is testament to developer's continued confidence in London's office leasing market long-term.

"The City of London continues to dominate construction activity with 600,000m² across 33 schemes. This is over half (51%) of the total volume across the capital. The City has also seen a shift in favour of large-scale refurbishments versus new builds as developers began work on eight refurbishments which will deliver 74,000m² of Grade A space.

"Office development in the West End is up 10% compared to last year and currently has 176,000m² under construction across 27 schemes."

Steelwork installation begins for Antarctic wharf

Photo: Adam Roper

Following two months of deconstructing the old Biscoe wharf, the first steel frame of the new 74m-long wharf structure at the British Antarctic Survey (BAS) base at Rothera has been lowered into place.

Divers completed the final part of the wharf deconstruction along the sea bed, making way for the first 55t frame to be installed. During a 12-hour operation, it was lowered carefully into position onto temporary guides from a 300t-capacity crane.

The project team had to fine tune the frame, setting it to within the 40mm tolerance. This precision engineering was critical to ensuring the alignment for the new wharf, which will provide safe berthing and efficient operations for the new RRS Sir David Attenborough.

In total, 20 frames will make up the wharf's skeleton, with seven due for installation during this season by construction partner BAM and technical advisor Ramboll.

BAM Project Engineer Ian Wenkenbach said: "Two years of planning has come to bear fruit with the successful installation of the critical first frame. The full-scale trial assembly and lift undertaken back in September in the UK ensured that the operation here in Antarctica went according to plan.

"To install the frames, which form the skeleton of the new structure, we are using a hydraulic jacking system, a concept developed in-house to allow accurate levelling of the frames after installation, as well as specially designed lifting frames, support structures and access platforms."

Hampshire-based Four-Tees Engineers is fabricating and helping to erect the project's steelwork.

The commissioning of the RRS Sir David Attenborough is part of a major government polar infrastructure investment programme designed to keep Britain at the forefront of world-leading research in Antarctica and the Arctic.

This £200m commitment represents the UK government's largest investment in polar science since the 1980s. It includes a range of modernisation across the BAS estate.

Irish steelwork contractor celebrates 30th anniversary

Kiernan Structural Steel (KSS) has celebrated 30 years of business by inviting its clients, suppliers and employees to a factory tour and an evening of entertainment at a nearby hotel.

Founded in 1989 in Longford, Ireland by husband and wife team Frank and Dolores Kiernan, the company began its journey using a small shed as its production base.

The company's first projects were agricultural jobs in the local area. Over the intervening years KSS moved into industrial work and gradually enlarged its workforce. Today it has one of the largest structural steel fabrication works in the Republic of Ireland.

KSS's current core of clients are in the pharmaceutical sector and data centre operators, although it also specialises in warehouses, multi-storey car parks, offices and sports arenas.

It has recently completed the new Curragh Racecourse grandstand, which features a 45m-deep cantilevering roof.

Recognition for steel projects at RICS awards

Major completed projects throughout the UK, which utilised a steel-framed solution, were winners at the regional RICS (Royal Institution of Chartered Surveyors) Awards 2019.

The RICS Awards showcase the most inspirational initiatives and developments in land, real estate, construction and infrastructure. They are also said to celebrate the achievements and successes of RICS professionals and their impact on local communities.

In the North East region, the Project of the Year award went to Sunderland's Beacon of Light, which the RICS judges said had successfully delivered on its goal to involve, encourage, inspire and motivate.

This educational community asset was designed by FaulknerBrowns, with Harry Marsh (Engineers) fabricating and erecting the steelwork.

The steel-framed Westgate shopping centre development (top right) in Oxford scooped the Project of the Year accolade for the South East region. A total of 7,000t of steel was erected by BHC for this city centre redevelopment.

Also in the South East, the Lexicon retail development (steelwork by Severfield) won the Regeneration Award.

Two steel-framed projects picked up awards in the Wales region. The BBC Cymru Wales Headquarters in Cardiff, (above right) won the Design Through Innovation award, while Conwy County Borough Council Offices in Colwyn Bay (above left) picked up the Regeneration award.

Working on behalf of ISG, Severfield erected approximately 2,000t of steel for the BBC scheme, while 1,050t of steel was erected by EvadX for the Conwy Council job.

The prestigious Commercial Award for the London region was presented to the London Wall scheme. These state-of-the-art office buildings provide over 46,000m² of Grade A office space and are now considered to be a City landmark. Working on behalf of Multiplex, William Hare erected 8,500t of steel for the project.

All of the regional winners are entered into the RICS grand final which is held in October.

Cinema to showcase Hounslow regeneration

Big changes are afoot in the London Borough of Hounslow as a major mixed-use scheme, known as the High Street Quarter development, is set to transform the borough's town centre.

High Street Quarter will deliver a Cineworld multiplex cinema, along with a range of shops, restaurants and eateries, which will all be set around a new town square.

The project, being delivered by Barratt London and Wilson Bowden, will also include 528 homes, of which 41 per cent will be affordable.

The ten-screen multiplex cinema will include an IMAX screen and has been designed as a steel-framed structure.

BHC is fabricating, supplying and erecting 1,321t of hot rolled steelwork for the project, which equates to 3,234 individual pieces. The steel tonnage also includes a further 10t of cold rolled steelwork.

The cinema is set to be completed in early 2020.

UK steel supply – business as usual

While British Steel is officially in compulsory liquidation, the company continues with business as usual while the Official Receiver looks for a buyer. BCSA is hopeful that this key part of the UK's proud industrial heritage can be saved.

"The UK structural steelwork sector is in good shape," said BCSA Director General Sarah McCann-Bartlett. "Demand for structural steelwork is steady, and UK steelwork contractors have the capacity and capability to deliver the future pipeline of work.

"The UK has an efficient and mature stockholder and distribution sector, and steel stocks in the UK remain healthy as stockholders had already been preparing for a no deal Brexit."

The Official Receiver has said that British Steel will continue to trade as normal; taking orders, producing steel and despatching while they look for a buyer.

The major European mills supplying steel to the UK, along with other high quality international mills, have the capacity to fully service the needs of the UK structural steelwork market, if required. There are also other UK steel mills producing a variety of other products for the UK construction sector.

"The structural steelwork sector and its supply chain will continue to offer the construction sector the high level of service they expect, under any circumstances," said Sarah McCann-Bartlett.

NEWS IN BRIEF

Siemens Mobility has formally submitted an outline planning application to develop a rail manufacturing plant in Goole, East Yorkshire. The submission is said to be a major milestone towards establishing a £200M facility to manufacture and commission state-of-the-art trains for the expanding UK market.

North East Lincolnshire Council has given the green light for the construction of a £300M energy from waste (EFW) power station near Stallingborough. Known as the **South Humber Bank Energy Centre**, it will generate nearly 50MW a year. Work is expected to start later this year and the facility will support 600 construction jobs.

Plans have been submitted for a new 11-storey speculative commercial building in the NOMA district of Manchester, a 20-acre mixed-use neighbourhood in the centre of the city. Developer **MEPC** said 4 Angel Square will provide more than 18,500m² of Grade A office space alongside a new public square.

Ambitious plans for a new cultural quarter on **Stratford Waterfront** in east London's Queen Elizabeth Olympic Park are set to gain planning approval. The project, which is being led by architects Allies and Morrison, will include new buildings for the Sadler's Wells dance theatre, the BBC, the Victoria and Albert Museum (known as V&A East) and the University of London's College of Fashion.

Logistics developer, **db symmetry** has gained outline planning consent for a major new logistics scheme at Symmetry Park, Kettering. Tritax Big Box REIT is funding the development, which will provide up to 215,000m² of high-quality logistics floor space. The scheme has the potential to create up to 2,800 jobs and will be a major contributor towards Kettering's planned economic growth.

PRESIDENT'S COLUMN

I often use this column as a soapbox for issues facing the structural steelwork sector – who wouldn't? But this month's column is all about celebration.

Celebration of the incredible industry that is structural steelwork. An industry that I've worked in for 15 years. When I'm walking around the City of London and look up to see one of the many great buildings I've worked on over the years, I feel a rush of pride as I tell myself – I helped create that. And happily for me, I'm able to travel the length and breadth of the UK and more often than not, I will come across one of 'my' projects.

Of course, these projects aren't really mine. They belong to the whole team; from the client to the designers to the specialists who took a concept and made something out of it. They also belong to the people who live, work or play in that building or structure.

Every time I cross the Forth, I look at those three beautiful bridges lined up one next to the other. The grandfather, the father and the son. I think of the people who designed them, who built them, and those who maintain them today. All of them servicing a need, and each of them a fantastic piece of engineering and construction in their own right. And they will all still be there, serving our community long after I'm gone.

Of course, it would have been far better for UK Plc if the main span of the Queensferry Crossing had been made by a UK steelwork contractor – see I really can't keep off my soapbox – because UK steelwork contractors, and in particular, BCSA members, really are the best in the world.

BCSA members are pre-assessed across many different aspects. This means that clients and contractors can be assured they have the specialist experience and qualifications for the job.

Over time, BCSA has pushed faster compliance with new regulation, helped improve quality and health and safety in the sector and driven best practice among members. In turn, a better performing structural steelwork sector benefits clients and main contractors. BCSA members can also raise and address issues and problems of mutual interest that can only be solved by working together. I see BCSA membership as a benchmark for professionalism and the can-do attitude BCSA members have.

I know that like me, future generations of BCSA members across the UK will also look up with pride to admire 'their' buildings.

Tim Outteridge
BCSA President and Jamestown Manufacturing

Steelwork progresses on UK's largest higher education project

Work is progressing on schedule on the University of Manchester's £287M Manchester Engineering Campus Development (MECD), which is said to be one of the single, largest construction projects undertaken by any UK higher education institution.

Once complete, the development will provide over 75,000m² of modern facilities in a bespoke environment, to support research, teaching and learning in the 21st Century for more than 8,000 students and staff.

MECD will see the relocation of the University's schools of Chemical Engineering and Analytical Science; Electrical and Electronic Engineering; Material Science, and Mechanical, Aerospace and Civil Engineering.

Working on behalf of main contractor Balfour Beatty, Severfield is fabricating, supplying and erecting 4,100t of structural steelwork for the project.

Severfield's work consists of the erection of three steel-framed buildings and one hybrid structure. The latter is the largest building on the site and known as the MEC Hall. Approximately 1,750t of steel has been used to form the large open spaces that accommodate

atriums and lecture theatres within this seven-storey building.

"There is an old Victorian sewer that runs through the MEC Hall site, therefore to minimise the number of supports and foundations required in that area, large truss steelwork was incorporated into the steel frame," said Severfield Project Manager Dominic Charlton.

"The weight of the truss components exceeded the capacity of the tower cranes, therefore we had to erect them using large mobile cranes up to 400t capacity. This was challenging due to the confined site and close proximity of the other buildings."

Frame up for first of two Warth Park distribution centres

Winvic Construction and Caunton Engineering have completed the steelwork for the first of two distribution centres on the Warth Park phase 3 development in Northamptonshire.

The initial distribution centre measures 314m-long × 190m-wide, with a maximum height to eaves of 16.3m. It has five 38m-wide internal spans and required a total of 2,200t of steelwork.

It will have a total of 56 cross docks and 19 level access doors, while internally, it is sub-divided into three separate zones by two partition fire walls and features a three-level office block.

Steel erection for the second unit will begin in June.

This smaller unit measures 208m-long × 131m-wide with a maximum height to eaves of 16.3m. This four-span structure will require 1,050t of steel and also includes a 1,600m² two-level office block.

Both structures will be occupied by Howdens Joinery, adding to the company's existing on-site warehouse that was completed as part of the development's phase two works in 2016.

Warth Park is a 160-acre logistics and business park in Raunds, adjacent to the A45.

Major residential scheme takes shape on Merseyside

Working on behalf of main contractor ISG, Walter Watson has completed the erection of 1,200t of steelwork for a residential scheme in Liverpool's Baltic Triangle.

Located on Blundell Street, the 200-unit, nine-storey steel-framed apartment block includes two levels of basement car parking, with the uppermost of these floors also accommodating an entrance lobby, residents' lounge and a gym.

Stability for the steel frame is provided by a combination of traditional flat bar cross bracing in the lower floors and moment frames for the two upper levels.

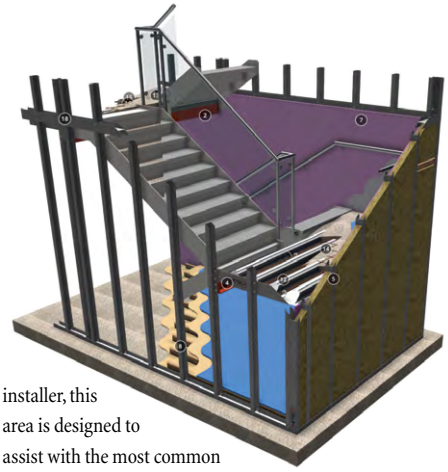
This hybrid design was chosen in order to assist

ISG in ensuring that materials needed by the follow-on trades could be easily transported within the upper floors, while maintaining full stability to the structure during the construction stage.

By avoiding moment frames on the lower levels, column sizes were slightly reduced which kept the steelwork tonnage as economical as possible.

The project is due to complete in summer 2020.

Interactive 3D models will aid Metframe installation and design



Light steel framing manufacturer voestalpine Metsec has created a new facility on its website which it said will allow the design, construction and installation teams to more easily understand and incorporate the company's pre-panelised building system, Metframe.

Sixty interactive 3D models have been created and organised into two distinct areas, each aimed at specific disciplines within the construction team.

Metframe Architectural Details feature 3D computer-generated, colour illustrations of a variety of common construction details, including window and brickwork, doors in internal panel, stairwells with concrete half and quarter landings, balcony and internal party wall with concrete floor.

Each of the twenty-four details in this section is designed to provide support for architects and other members of the design team by demonstrating the ease with which Metframe accommodates different areas of a building's design and giving a clearer understanding of how the various building elements interact with the system.

The screen also features a 'Revit download' button through which users can request Revit files which can be incorporated directly into their own design files, providing useful additional information and enhancing BIM compliance.

The second section of Metframe 3D Details shows thirty-six base level details. Aimed mainly at the contractor and installer, this area is designed to assist with the most common steel-to-steel connections encountered during the installation of Metframe. Illustrations include a typical panel, window detail, brick tie rules for movement joints and connections to different building elements such as steel beams and concrete foundations.

Lindapter to offer CPD seminar to specifiers of steelwork connections

Steelwork clamping systems producer Lindapter are to offer a new Continuing Professional Development (CPD) seminar to specifiers involved with the design of steelwork connections.

The company said it is committed to providing a faster, cost-effective alternative to drilling or welding and wants to give the highest level of service and technical expertise to its partners.

The seminar will cover the latest CE marked solutions for safely connecting structural steel sections including SHS, beams and channels. Delegates will receive an update about additional connection methods to complement their existing specification options.

The seminar content will include: an introduction to Lindapter; a comparison between traditional connection methods versus the Lindapter method; typical applications, installation and case studies; and a discussion on technical support, research and development.

"The seminar lasts around 50 minutes followed by a Q&A session and is a general awareness seminar. As you would expect, the CPD normally takes place at lunchtime with a complimentary lunch." said Lindapter's Marketing Specialist Damian Haigh.

For further information on the venue and dates, and how to book online visit: *http://www.lindapter.com/Contact/CPD_Request*

Barrett Steel has Scottish expansion plans

Using its Montrose base as a launch pad, steel stockholder Barrett Steel says it has ambitious Scotland-wide expansion plans.

Barrett Steel views its Montrose operation as the first part of a potential three-phase plan that could see it expand into Scotland's central belt to the south and the Inverness area in the north.

The firm's Montrose arm currently focusses on an area that runs from Aberdeen to the Forth Bridge.

Strategic Business Development Director Rob Ridge says the company had just one employee in 2016 in Montrose and now has a total of 32 members of staff.

Substantial investments of £2M in stock and a further £1M in plant and machinery at the Montrose base has seen the firm sell 17,500t of steel per year.

Barrett Steel has already expanded its Scottish operation. In addition to its three-acre outdoor storage yard and warehouse in Montrose, the company now has a second warehouse in the town as well as a presence in Dundee and Bathgate.

Diary

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

Wednesday 19 June 2019
The Use of Structural Justification to Underpin HSE/ONR Explosives Licences
The seminar will cover the legal and regulatory framework that underpins explosives licensing and will be illustrated by practical case studies with presentations from the regulator, licence holders and consultants.
London

Tuesday 9 July 2019
Fire Resistance of Composite Slabs and Beams
This webinar provides a solid introduction to the design of composite slabs and beams at elevated temperature. Relevant procedures included in BS EN1991-1-2, BS EN1993-1-2 and BS EN1994-1-2 will be covered.
Webinar

Wednesday 10 July 2019
Portal Frame design
The course aims to provide in-depth coverage of the major issues surrounding the analysis, design and (crucially) the detailing of portal frames. The course covers frame design to BS EN 1993-1-1. Nottingham.

Thursday 7 November 2019
UK Steel Construction Day 2019: Innovative Steel Solutions
At this event we will look at a range of different solutions that address the multiple needs to build with improved speed, quality, safety, predictability, and using less materials. Some of these solutions are already being applied, others are for the future. London

One hundred and out

Both buildings sit on a podium once occupied by Exchange Station

The second of two commercial buildings sat on a former railway station podium in Salford is quickly taking shape. Martin Cooper reports.

FACT FILE
100 Embankment, Salford
Main client: Ask Real Estate
Architect: Flanagan Lawrence
Main contractor: BAM Construction
Structural engineer: Ramboll
Steelwork contractor: Elland Steel Structures
Steel tonnage: 1,800t

The 100 Embankment building forms the second and final phase of an ambitious commercial development set to reinvigorate an area where the cities of Manchester and Salford meet.

Sat alongside its completed sister building, 101 Embankment (see NSC June 2016), the nine-storey 100 structure will offer 15,400m² of BREEAM 'Excellent' Grade A office space.

Sat on the banks of the River Irwell, overlooking Manchester Cathedral, both buildings are situated on a plot once occupied by Exchange Station that closed down in 1969.

Although the original buildings and platforms are long gone, the sandstone façade of the masonry podium that once supported the station has been retained. The podium forms the exterior for a three-storey car park on top of which the two office blocks now sit.

The steel-framed car park infills most of the retained façade, except the rounded corner areas, creating 442 spaces. It was erected as part of the initial phase, along with building 101.

The roof of the car park or podium deck initially presented the design team with the project's biggest challenge. Both of the office buildings have a similar design that includes main columns set at 7.5m centres, which does not match the car park grid below.

The client's requirement to maximise the number of car parking spaces did not permit either of the building cores to continue down through the podium structure. Therefore, steel-framed braced cores sat on transfer structures positioned at podium deck level have been adopted to minimise the loads.

Encompassing an area around each of the building's cores, which equates to approximately one third of their footprints, the two transfer slabs have employed an innovative design, with a 1,500mm thick RC slab built off a 130mm thick composite slab acting as permanent formwork.

The remainder of the podium slab is 170mm thick. In order to resolve complex punching shear issues, 914UB cruciform sections were cast within the depth of the transfer slabs.

"During phase one, transfer beams and a temporary slab were installed over the area where building 100's core would sit," explains BAM Construction Senior Design Manager Chris Edwards. "When we started on-site for phase two, we initially had a 16-week enabling works programme, which required us to take possession of the car park's top level, while we broke out the temporary slab, and installed temporary steelwork to enable the pouring of the new 1,500mm-thick slab."

During the enabling works, steelwork contractor Elland Steel Structures installed more than 40t of temporary steelwork to support the load of the wet concrete in the temporary case.

Once these early works had been completed and Elland Steel had removed the temporary steelwork, it was able to begin its main steelwork erection programme.

Building 100 is similar to its neighbour, although it is one floor lower with a slightly larger floorplate, which means it has approximately the same lettable space.

The steel frame consists of CHS columns supporting cellular beams offering clear internal spans of up to 12m. The beams are all 680mm-deep Westok members, with 475mm diameter holes for service integration.

Kloeckner Metals UK Westok first became involved with the project in 2014 when it provided Elland Steel with a first draft value engineered floor solution for the first tower.

By adopting a mix of Westok cellular beams at the office levels, and discrete Westok plate beams at both office and podium deck level, savings were realised.

Kloeckner Metals UK Westok Design ▶12

500t-capacity mobile crane used to erect the site's tower crane

Logistics challenge

Both 100 and 101 sit on an island site, as the podium is surrounded by roads, railway lines, the River Irwell and a culvert.

Logistically, this is challenging when it comes to bringing material to site, as there is little or no room for temporary storage and access routes are also limited.

Erecting the site's tower crane encompassed all of the project's logistical challenges, as the mobile crane needed to erect it could not be positioned anywhere near.

"When the first building was built, the site had the adjacent vacant plot," explains BAM Senior Design Manager Chris Edwards. "For this building we had no room on site and the project's surrounding roads could not be used as they are either bridges, and couldn't take the weight of the crane, or in the case of near the cathedral, too close to historic crypts."

The solution was to use a 500t-capacity mobile crane, positioned on the opposite side of the River Irwell. This large crane required a 150t-capacity slave crane to erect it and had a reach of nearly 80m to lift the tower crane's elements into place.

A similar challenge is anticipated at the end of the project when the tower crane is dismantled. As it will be surrounded by the completed steel frame, an even larger mobile crane will be required to lift the tower crane's elements out and over 100 Embankment.

▶10 Team Manager John Callanan comments, "It's particularly pleasing to see the second tower taking shape and it has been a fruitful exercise working closely with the Manchester team at Ramboll and Elland Steel on both blocks."

The project's floor beams support metal deck flooring, installed by SMD, and a concrete topping forming a composite steel design.

Internally, the building is not quite column-free as there are five CHS columns, installed to break up a span that would have been more than 20m-long.

"Without these five columns, it would not have been possible to follow and adopt the same structural depth as the adjacent Building 101," explains Ramboll Senior Structural Engineer Allan Wilson.

Offering some aesthetic appeal around the exterior, all of the perimeter CHS columns are set within a 900mm cantilever and will be left exposed in the building's completed form. These sections are 406.4mm diameter columns at the lower levels, decreasing to 323.9mm diameter columns for the upper two storeys.

"The perimeter columns are not the only elements to be left exposed," adds Mr Edwards "A client-driven decision means the entire steel frame will be on show in the completed building, along with the underside of the floors and all of the services, creating a modern industrial-like office environment."

Adding some more visual appeal to 100 Embankment, the structure's perimeter incorporates curves to follow the shape of the listed retained façade of the podium, and includes a 7m cantilevering prow on its south western corner.

100 Embankment is due for practical completion by June 2020.

A 7m-deep cantilever adorns the south western corner of the building

Temporary steelwork was installed to allow the new ground floor slab to be poured

Full circle

The commercial blocks overlook a new public square

Structural steelwork has been chosen as the framing solution for two commercial blocks on a multi-million-pound mixed-use scheme in central Manchester.

FACT FILE
Circle Square Buildings No. 2 & 4, Manchester
Main client: Bruntwood and Select Property Group
Architect: Feilden Clegg Bradley Studios
Main contractor: John Sisk & Son
Structural engineer: Curtins
Steelwork contractor: Billington Structures
Steel tonnage: 3,760t

Both buildings have compositely-formed floors

A large plot that was once the home of BBC North West and the facility which hosted the filming of many TV favourites, such as A Question of Sport and Mastermind, is now being transformed into a new neighbourhood known as Circle Square.

The £750M mixed-use development will offer office space, retail outlets, serviced apartments and private residential accommodation as well as communal spaces that will be open to the public.

Being built over three phases, to be completed by 2023, the first phase is now well underway. This initial phase, being constructed by John Sisk & Son, includes two residential blocks and two adjacent commercial buildings that are designated buildings two and four, which will top out at 17-storeys and 13-storeys respectively.

Both commercial buildings are steel-framed structures, compositely designed with steel beams supporting metal deck flooring and a concrete topping. The beams are all bespoke plate girders containing holes

to accommodate the services within their depth.

The structures are expected to achieve a BREEAM 'Excellent' rating and will offer 21,300m² of floor space in No.2 and 14,000m² in No.4.

"Using steelwork for these two buildings was all about getting clear open internal spans, which is always important for modern commercial schemes," explains Curtins Structural Project Coordinator Paul Milne.

Emphasising the need to create the maximum amount of floor space, building No.2 has a smaller footprint than its neighbour and consequently features an offset core, located along its northern elevation.

"This allows all of the office floorplates to have clear uninterrupted spans up to 12m-long," adds Mr Milne.

Meanwhile, No.4 has a much larger footprint and so its design has a more traditional centrally-positioned stability-giving core. With beams radiating out from the core, the building features internal spans of up to 14m on all four sides.

The buildings are founded on 705 bored piles and share a large basement. All internal columns go down to the basement slab, while the perimeter members are supported on the concrete retaining walls of the subterranean level and begin at ground floor.

Steelwork erection progresses behind the core installation programme

Steelwork wraps around a centrally-positioned core in Building No. 4

Aside from the cores, they have similar designs, with each commercial floorplate – from level one upwards – having the same grid pattern. The ground floors are slightly different, as they will accommodate entrance foyers and retail outlets within a mostly double-height space.

The most visual difference between the structures, apart from their heights, is the fact that No.2 has a 3m cantilever from the second floor upwards along its main Oxford Road and Brancaster Road elevations.

No.4's design features raking columns that splay outwards from level two to the underside of level five along the Oxford Road elevation. This increases the footprint on the upper levels, although the raking columns will not be visible from the outside in the completed scheme as they will be behind the cladding line.

According to Billington, this raking architectural feature means the second and fifth floors are heavily braced in plan in order to transfer the extra loadings to the concrete core.

Both commercial buildings, along with the two residential blocks being constructed by John Sisk & Son, will be complete by early 2021.

FACT FILE
Circle Square Multi-Storey Car Park
Main client: Bruntwood
Concept architect: Feilden Clegg Bradley Studios
Main contractor: Russells Construction
Steelwork contractor: James Killelea & Co
Steel tonnage: 2,000t

The cladding has holes allowing the steel frame to be visible

Car parking

A key element of the overall Circle Square master plan and part of the phase one works is the 1,031-space multi-storey car park, which James Killelea is erecting on behalf of main contractor Russells Construction.

As well as fabricating the project's steelwork, James Killelea has also been employed on a design and build basis for this unusual car park.

The structure has 10 parking levels, more than the average facility, but what marks it out as unusual is the fact that it will support a six-storey 158-bed hotel on top of its upper level.

Supporting a hotel would be challenging enough, however the design has also had to incorporate large bridging elements as there are two subterranean 600mm-diameter water pipes crossing the site.

"It's a very unusual design and one that was originally designed as a concrete-framed structure," says James Killelea Senior Structural Engineer Charlie Twist.

"However, the bridging parts would have proven to be too difficult to build and consequently a steel-framed solution was chosen for the car park, which in turn supports a precast concrete hotel."

A series of four × two-storey-deep lattice girders and a single one-storey girder, all measuring up to 27m-long, span over the zone where the underground pipes are located. In these parts, the car park has no first floor level as the local water board needed a 5m ground-to-ceiling clearance in case they had to undertake any maintenance works.

Consequently, the first floor is only a partial level and is set within the depth of the larger lattice girders, as is the second floor, while the third level is supported on top of these members.

Elsewhere in the car park, which has an overall footprint of 64m × 60m, the majority of the structure features a regular column grid pattern of 3m × 15m.

Taking into account the loadings the hotel will impose on the car park's steelwork; some large members have been used in the design. Most of the beams are 1.7m-deep plate girders, while some of the columns, especially those supporting the lattice girders are 356 × 406 × 634 sections with 200mm-thick base plates.

The design also incorporates four concrete cores, one in each corner, that provide the structural stability along with strategically-positioned cross bracings.

Precast planks form the floors and these are being installed by James Killelea as the steel erection progresses.

The car park has been designed as a Vertical Circulation Module (VCM), which is said to offer a more efficient solution for confined city plots. This design contains no external ramps as all of the circulation is via slopes within the floors, which creates more parking spaces.

Concept architect for the car park and hotel, Feilden Clegg Bradley Studios, have produced a design that reflects the city's industrial past. Inspired by the nearby 19th century warehouses, the building's façade is being constructed from a pre-cast concrete panel system, utilising inset bricks which draw on Manchester's rich links to the grand infrastructure of the Victorian era.

A series of round openings in the façade allow the steel frame to be visible from outside, making it part of the overall architectural industrial vision.

Bruntwood Chief Development Officer Chris Roberts says: "When complete, Circle Square will be home to a wide selection of innovative workspaces, shops, homes and bars and it will attract visitors from far and wide. The car park and hotel will play a key role in supporting the high level of interest that we anticipate."

The steelwork's stability is derived from four cores

A retained façade along New Bond Street fronts one of the scheme's four buildings

Steel is just the ticket for over-station development

Structural steelwork has provided the required lightweight solution for a mixed-use scheme that sits directly above an Elizabeth line ticket hall. Martin Cooper reports.

The construction of the (Crossrail) Elizabeth line is providing London with a number of prime opportunities for over-station developments that will sit above the soon-to-open stations and ticket halls.

Possibly the most prestigious of these is currently being built above the Bond Street station eastern ticket hall, where a large 1.3-acre development has been commissioned by Great Portland Estates and will provide 20,400m² of premium office spaces, retail, a restaurant and residential accommodation all centred around a new public courtyard.

The project consists of four separate buildings including 18 Hanover Square. This is an eight-storey structure that sits directly above the new Elizabeth line Bond Street station eastern ticket hall and uses the Crossrail facility's concrete roof as its first-floor slab.

From the ticket hall slab/roof, the steel frame for the building rises up, while also spanning a new ground floor retail colonnade.

Approximately 1,850t of steel has been erected to complete 18 Hanover Square, to provide 11,700m² of offices and 213m² of retail space.

The development's other buildings

18 Hanover Square represents the scheme's main element

consist of an adjacent six-story steel-framed building at 1 Medici Courtyard that features a retained façade along its main New Bond Street elevation. This building will also accommodate six lower ground and first floor flagship retail units, with more than 3,100m² of offices on the upper levels.

At the junction of New Bond Street and Brook Street, a concrete-framed structure will house further retail space with six residential apartments above, while abutting 18 Hanover Square, number 20 is a listed Grade II Georgian house, which is being restored to accommodate offices and a restaurant.

"The success of this project has relied on us continually liaising with the Crossrail team, who are working directly below our site," explains Mace Project Manager Stephen Wells.

"This has been crucial right through our programme, from the demolition of the site's previous buildings to the erection of the new structures."

Discussing the use of steelwork, Mr Wells adds that the material was chosen for the project's two biggest buildings (18 Hanover Square and 1 Medici Courtyard) because of its speed of construction and efficiency.

"Steel has also helped us logistically, as this is a very tight site surrounded by occupied buildings and with limited room for storage. Steelwork is fabricated offsite and delivered just-in-time, which means less traffic on the already busy central London roads."

There is also another significant advantage associated with using a steel-framed solution as WSP Director Steve Miller explains: "A steel frame solution is relatively lightweight compared to a solid concrete solution.

"We had restrictions on loading of the Crossrail structure, while the ability to incorporate large clear spans and minimal internal columns was also an advantage in providing Grade A office space."

1 Medici Courtyard was similar in concept, with large clear spans and minimal slab construction with downstand beams for services to pass through. This frame is founded on a raft which is located directly over the Crossrail running tunnels and escalator shaft. Keeping the new frame light to match the previously demolished building loads is said to have helped keep the ground movements within acceptable limits.

Steelwork contractor Severfield began its erection programme with the 18 Hanover Square building during October 2018. This structure is based around a 12m x 10.5m column grid pattern, but with the perimeter structure columns set at approximately 3m centres to align with the cladding design; all of the columns are founded on the ticket hall's concrete roof.

The layout changes slightly for the three uppermost levels, as the columns along the main Hanover Square elevation are set back to form a sixth-floor terrace and atrium space.

The desire to minimise floor-to-floor height in both steel-framed buildings led to the use of shallow beams, which were designed as plate girders in many cases, due to the long spans involved.

"Modern fabrication techniques make these more economic than they might have been previously. Careful attention to detailing was required to achieve the complex ceiling services distribution system which was usually in the same plane as the beams; a mixture of circular and rectangular holes was used to route the services, with the latter requiring the addition of stiffeners," explains Mr Miller.

A design change now means 18 Hanover Square has a sixth-floor atrium

The use of steel also allows better flexibility for tenants to provide openings through the slab and other alterations with reduced effect on the main framing compared to a concrete solution. An example of this is the sixth floor of 18 Hanover Square which incorporates an atrium that extends up to roof level and creates extra circulation space between the three upper levels.

"The inclusion of the atrium at the upper levels of 18 Hanover Square was a design change requested by the client to suit the tenant's requirements," explains Mr Wells. "An advantage of using steelwork was the fact that Severfield were able to re-design this part of the frame during their fabrication programme without any delays to the overall scheme."

The development will be completed with a phased handover of the individual elements, beginning with the residential apartments on Brook Street late this year. The entire scheme will be finished by late 2020.

FACT FILE
18 Hanover Square, London
Client: GHS Limited Partnership (a joint venture between Great Portland Estates and Hong Kong Monetary Authority)
Architect: Lifschutz Davidson Sandilands
Main contractor: Mace
Structural engineer: WSP
Steelwork contractor: Severfield
Steel tonnage: 2,450t

The project will create a new public courtyard

Commercial scheme reinvented

Steel construction has come to the fore as a concrete-framed central London commercial block gets redeveloped with additional floor space.

Visualisation of the completed scheme

FACT FILE
1 Triton Square, London
Main client: British Land
Architect: Arup Associates
Main contractor: Lendlease
Structural engineer: Arup
Steelwork contractor: William Hare
Steel tonnage: 2,142t

A growing trend in the UK city centre construction sector has been the increasing number of projects that involve refurbishing and enlarging existing office blocks as an alternative to demolishing the building and starting again with a blank canvas.

An example of this trend is 1 Triton Square, which was originally built for the First National Bank of Chicago and opened in 1997. This concrete-framed office building was the first structure to be completed at Regent's Place, a 13-acre fully managed mixed-use campus on the north side of London's Euston Road.

Now more than 20 years later, British Land has decided the time has come to update and refurbish the office building to meet the evolving needs of their customers and provide a modern, flexible office space, some affordable workspaces, new retail units and a new gym.

A number of criteria come into play when deciding to refurbish a building or not. These include whether the building is of any historic interest; if the surrounding neighbourhood is logistically suitable for a large-scale construction programme; the environmental impact of a demolition package as opposed to a refurbishment and, possibly the most important issue for many developers – the cost.

All of the above criteria were mulled over by the client and design team, but for the 1 Triton Square scheme, Lendlease Project Director Chris Carragher says the decision to refurbish the building instead of demolishing it was all about creating the most sustainable construction solution possible and is testament to British Land's sustainable values.

"Refurbishing a project is a more environmentally-friendly option, as well as being cost-effective."

According to Arup Structural Lead Andrew Robertson there have been significant carbon savings for this refurbishment compared with a new build equivalent.

"About 35,000t of concrete and 1,900t of steel have been re-used and saved from demolition. The re-use of the structure and façade elements have resulted in carbon savings equivalent to a gas and electricity

A steel solution for the project's new floorplates was the most environmentally-friendly option

A core in the south east corner, which is split in two, has been infilled with new steelwork

Cellular beams have been used for all new floors

emission free operation for 26 years."

Employing the same design consultant from the original scheme, the project will see the five-storey building extended upwards with the addition of three new steel-framed office floors and a roof plant level.

Meanwhile, an unusually large 36m-wide atrium will be partially infilled with one new bay of steelwork all the way around, creating more office space for each of the existing floors and a smaller but impressive 18m-wide atrium space.

Steelwork for the new upper floors is based around a 9m column grid pattern, in line with the existing structure's layout. For the new infill floor areas inside the atrium, a series of long beams create an open-plan floor area.

These new floor beams are all approximately 18m long, but vary in length due to the atrium stepping in and out at every floor with balconies and breakout spaces.

The atrium starts at level one, as this was originally designed as a large trading floor and extends across the building's entire footprint and also has a slightly higher floor-to-ceiling height.

The new nine-storey building is now centred around this reconfigured atrium, which will provide links between floors via internal feature staircases.

Explaining the decision to use a steel-framed solution for the project's new additions, Mr Robertson says: "A key part of our design strategy was to employ lightweight steel-framed construction for the new floors and atrium infill framing, alongside limiting the proposed imposed loading requirements for the office floors and roof plant. This, alongside a range of innovative strengthening techniques for the existing structure, resulted in almost doubling the internal area of the building."

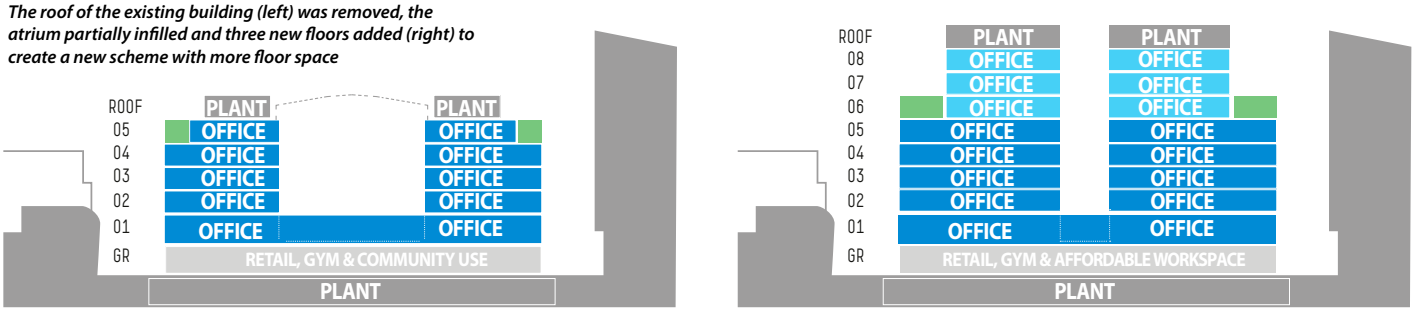
Unusually for a concrete-framed structure, 1 Triton Square's original design contained four braced steel cores, one in each corner.

Steel cores were primarily chosen because they were suited to the awkward geometry in these areas, with various riser, lift and stair openings to be accommodated. They were also simpler to coordinate with the pre-fabricated risers originally employed on the scheme.

▶20

New steelwork partially infills some of the atrium, creating a smaller void

The roof of the existing building (left) was removed, the atrium partially infilled and three new floors added (right) to create a new scheme with more floor space



▶19 Each of the cores is being heightened up to the top floor level with new steelwork. The core in the southeast corner is actually split into two parts (1a and 1b, but still referred to as one core) either side of a large opening that originally led straight to the central atrium. This large void is also being infilled with new steelwork to create even more office space.

All of the new steelwork is either founded on existing steel (in the cores) or concrete columns, but in the area between 1a and 1b, another solution was employed.

"Here we cut and carved the existing structure all the way back down to the basement, formed a new basement slab and cast the lift shafts out of the basement, forming a new ground floor slab and erected the steel from this," explains Mr Carragher.

Prior to steelwork contractor William Hare beginning its package, Lendlease had to undertake preliminary works that included strengthening existing concrete columns as well as installing 180 new piles in preparation for the new steelwork.

This early work also included the removal of a steel-framed glazed roof that covered the atrium. Once the roof was gone, the construction team then had easier access to the central void and internal floorplates.

Before William Hare could add the new steelwork to the cores, cross bracing was replaced to accept the additional loads, while the new levels had to have some complex connections for the columns, as the original steelwork did not match the desired grid pattern and so column positions had to be realigned.

Where possible the strengthening of existing steel core columns has typically been undertaken by welding steel plates to the existing UC sections. These plates have typically been positioned between the flanges of the UC section, allowing the size of the columns to remain largely unchanged while achieving a significant increase in capacity.

According to Arup, this option was significantly lighter than the concrete encasement option, limiting impact on the structure below.

Summing up, William Hare Construction Manager Bill Fletcher says: "This has been a very complex project as steelwork had to be installed around existing retained cladding panels.

"Meanwhile, we had to work on the structure when part of the building was being demolished and so controlled safe systems of work were successfully applied at all times."

1 Triton Square is scheduled to be completed in December 2020.

Column Strengthening

Richard Henderson of the SCI discusses some of the issues

Columns in buildings are provided to carry axial loads in compression and, unless very squat, are designed so that their flexural buckling resistance exceeds the design load. The axial resistance of columns designed for buckling can be increased by either adding material so as to increase the section properties or providing restraints to reduce the effective length of the column, thereby reducing the slenderness and increasing the flexural buckling resistance (see reference i). For example, if a column can be restrained at mid-storey height such that its system length is halved, the critical (Euler) buckling load of the column N_{cr} is increased by a factor of 4. The flexural buckling resistance is increased by a factor which varies with slenderness from only about 13% for a very short, heavy column to 340% for a very slender column as examination of the "Blue Book" table for UC sections shows. Where the slenderness of a column is toward the lower end of this range, adding material is probably a more effective strategy.

The non-dimensional slenderness of a column is inversely proportional to the radius of gyration *i* about the relevant axis as indicated in para. 6.3.1.3 of BS EN 1993-1-1:2005:

$$\bar{\lambda}=\sqrt{\frac{Af_y}{N_{cr}}}=\frac{L}{\pi}\sqrt{\frac{f_y}{E}}\frac{1}{i}$$

Material added is the most effective when it is as far as possible from the centroidal axis of the column.

When load carrying columns are strengthened by adding material, the load shared by the original and additional material is the additional load applied after the strengthening work has been completed. Axial stresses in the original column material are increased by a stress equal to the new load divided by the total area. Axial stress in the new material is equal to the increase in stress.

At stage 1 (strengthening) the stress in original column: $\sigma_1=\frac{N_1}{A_1}$; the stress in the additional material (Area A_2) is zero.

At stage 2 (in service), the load in the strengthened column is $N_1 + N_2$. The axial stress due to the new load is $\sigma_2=\frac{N_2}{A_1+A_2}$. The stress in the new material is σ_2. The stress in the original column is $\sigma_1 + \sigma_2$; the load in the new material is $N_{new} = A_2\,\sigma_2$.

The connection between the additional material and the original column has to be designed to transfer the axial load N_{new}. If the strengthening material is discontinuous at beam joints and a cross section check shows the original column resistance is adequate, the additional load has to transfer back into the original column section. The weld between the original and new material can be sized to transfer the load N_{new} over a short length and a smaller weld can be used over the remaining length to restrain the additional material from buckling under the load N_{new}.

One of the columns that was strengthened at 1 Triton Square

i: Strengthening existing steelwork, January 2019, New Steel Construction

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The majority of the steel erection was completed with MEWPs positioned on the basement slab

Added metal

A steel-framed solution has ticked all of the boxes for the Metalworks residential scheme in Slough.

FACT FILE
The Metalworks, Slough
Main client: SevenCapital
Architect: BDG
Main contractor: Colmore Tang Construction
Structural engineer: CWA
Steelwork contractor: Mifflin Construction
Steel tonnage: 950t

Second only to London as a UK location for global corporate headquarters, the Berkshire town of Slough is a business and innovation hub, based around its proximity to Heathrow Airport and having a large workforce within its catchment area.

The town is also increasingly becoming a destination for people looking to move outside of the capital and it is listed in Knight Frank's top 20 UK destinations for London leavers. The population is predicted to increase by an impressive 18,000 by 2021.

Commuters find Slough a convenient location as the town has good transport links, with half-hourly train services running to London Paddington station. These services will soon be complemented by the Crossrail Elizabeth line that will create direct, door-to-door connections between Slough and the West End of London, the City and Essex.

Slough's attractiveness to residents is highlighted by the number of new residential schemes that are currently being built in the town. Many of these are close to the railway station and town centre, making them ideal for both people working in Slough and those wishing to commute.

An example is The Metalworks scheme, which is a stone's throw from Slough station and is being constructed by Colmore Tang for SevenCapital.

The development comprises two steel-framed blocks, known as Iron House and Steel House, containing 155 apartments, and both sat on top of a shared basement car park accommodating 127 spaces.

Including ground floor, both blocks have seven-storeys above basement level and will contain a mixture of one, two and three bedroom apartments.

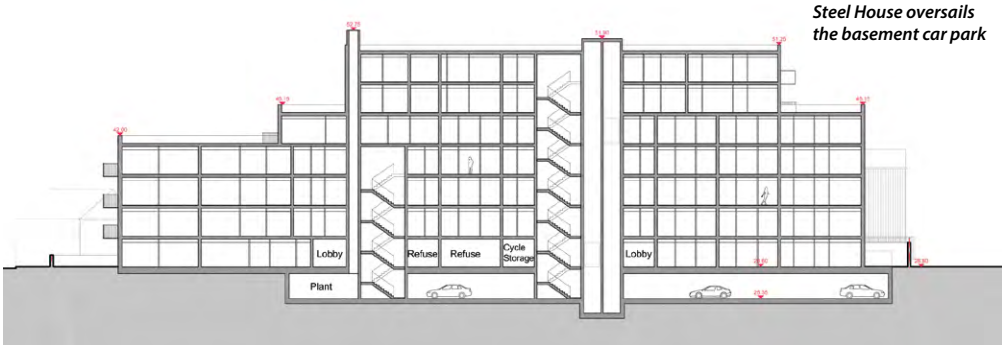
Steelwork starts at basement level as the subterranean level covers the majority of the site's footprint. A podium deck covers the basement car park and supports the two residential blocks and a landscaped realm that separates the structures.

The podium is also a transfer deck, as the steelwork is based around a larger column spacing in the car park (spans of up to 10m) than the above residential areas, where spans are predominantly 6m and 8m long.

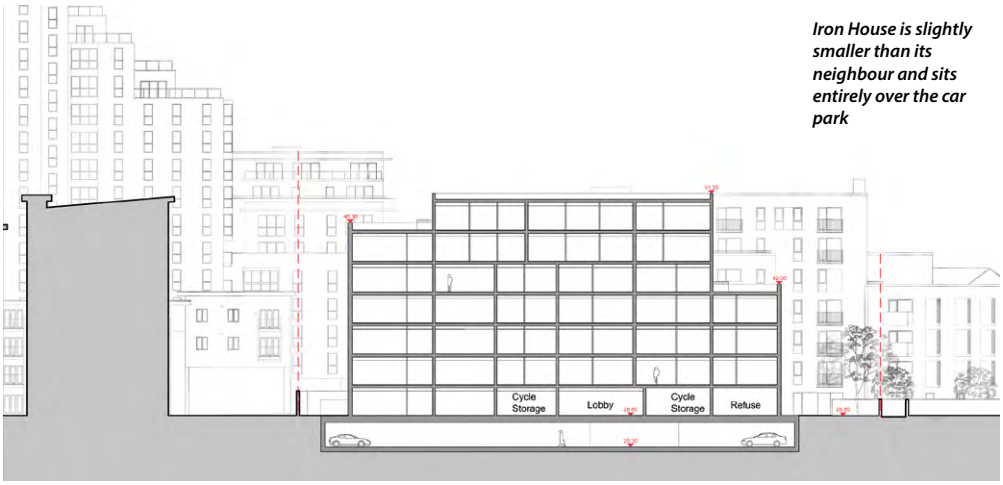
The project's steelwork supports metal deck flooring throughout, as this was deemed to be the most efficient design as Colmore Tang Construction Contracts Manager David Scott explains: "Initially we were going to use precast planks for the floors, but this design would have needed many more crane lifts for the individual precast units.

"We may have slightly more steelwork in the frames to support the metal decking, but this solution has given us a quicker programme."

Colmore Tang started work on this



Steel House oversails the basement car park



Iron House is slightly smaller than its neighbour and sits entirely over the car park

previously brownfield site during May 2018, initially demolishing existing buildings and then installing steel piles and excavating the basement. The slab was also cast in the basement prior to Mifflin Construction beginning the steel erection programme.

Using the site's tower crane in combination with MEWPs, Mifflin estimates that it erected some 3,275 individual steel pieces for the scheme. The steelwork programme, which also included the procurement and installation of reinforced concrete staircases was completed this month (June).

"By choosing a steel-framed solution for the project we have the advantage of not just a quicker programme, but also a safer and easier solution," adds Mr Scott.

The Metalworks plot is a logistically challenging site, as it is hemmed in by existing residential buildings on three sides, with the fourth side offering the only access via Petersfield Avenue.

This thoroughfare is already quite busy, and the site team say a concrete-framed solution for this project would have meant far more delivery trucks on the neighbouring roads, which would have been an inconvenience to local residents. On a positive note, Mifflin has only needed to make one or two steel deliveries every couple of days to supply its steel erection programme.

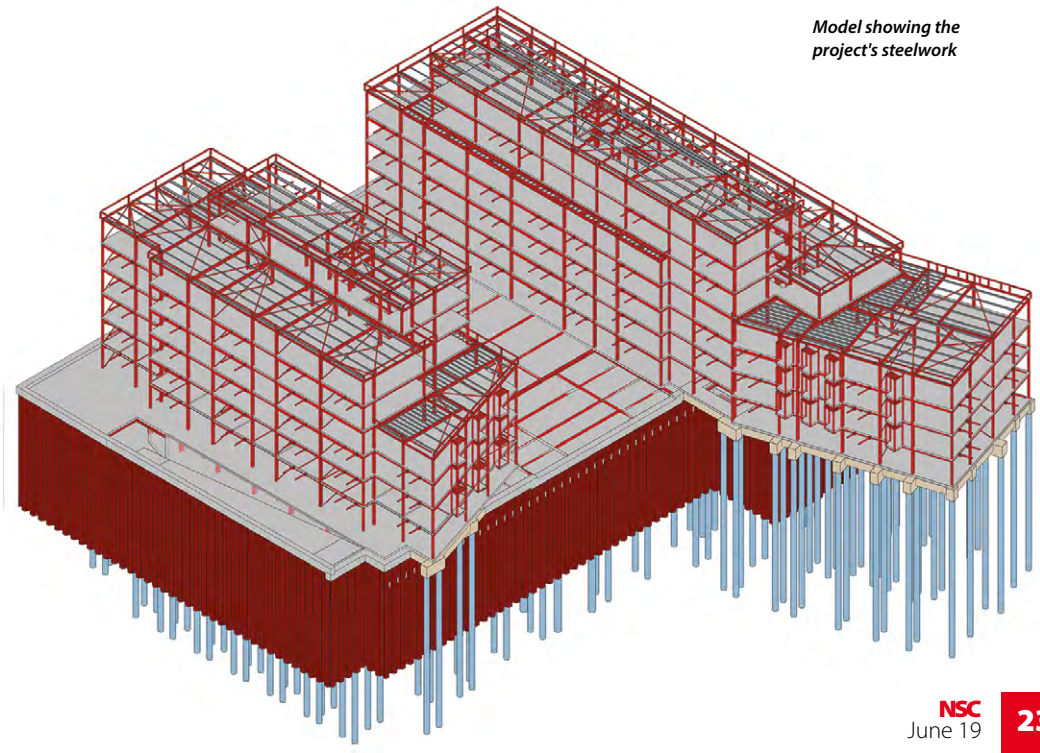
Both Iron House and Steel House have similar designs, with the main difference being the latter structure is slightly longer than its neighbour as it over-sails the basement along the site's northern perimeter.

Stability for the blocks is provided by cross bracing, predominantly located in the steel cores. While Iron House has one central core, Steel House has two cores, one containing a lift and stairs and serving all of the building's floors, and another stair core that serves levels one, two and three.

Each of the blocks feature a number of set-backs, giving the otherwise rectangular buildings some architectural interest. These steps occur at level four and six on both blocks, with Steel House having an extra set-back at floor five.

The buildings will be clad with brickwork, with 90% of the apartments having retrofitted balconies installed as part of the latter works.

The Metalworks development is due to be completed by July 2020.



Model showing the project's steelwork

Fatigue of bracing in buildings

BS5950 states that buildings subject to fluctuating wind loads do not need to be checked for fatigue but EC3 contains no such statement. Richard Henderson of the SCI considers the issues and illustrates a fatigue check of wind bracing in a conventional building.

Introduction

Clause 2.4.3 Fatigue in BS5950-1:2000, a code specifically for the design of steelwork in buildings, states "Fatigue need not be considered unless a structure or element is subjected to numerous significant fluctuations of stress. Stress changes due to normal fluctuations in wind load need not be considered". The ANSI/AISC 360-16 Specification for structural steel buildings Chapter B clause 11 states "… Fatigue need not be considered … for the effects of wind loading on typical lateral force-resisting systems …". BS EN 1993-1-1 and BS EN 1993-1-9 (Part 1-9) include no such clause but BS EN 1993-1-1 forms the foundation for a series of codes for the design of bridges, towers and other structures. Bridges are routinely checked for fatigue. Other structures such as chimneys and masts may be subject to wind-induced oscillations and need to be checked for fatigue.

The connections at the ends of wind bracing are often made using gusset plates, fillet welded to end plates and beam flanges. Tubular tension/compression bracing members may have bolted spade-end connections fillet welded to end plates.

Fatigue Strength Curves

An introduction to fatigue design was published in NSC magazine last year. Part 1-9 clause 7.1 gives the fatigue strength for nominal stress ranges for a range of details, identified in Tables 8.1 to 8.10. The fatigue strength is defined by a ($\log\Delta\sigma_R$) – ($\log N$) curve for each detail category as shown in Figure 1. For a constant amplitude nominal stress range, the curve gives the number of cycles to failure or endurance. The curve number is the detail category and is the constant amplitude nominal stress range that will result in failure after 2 million cycles. The curves change in slope at $N = 5$ million cycles. For nominal stress ranges lower than a certain value known as the cut-off limit $\Delta\sigma_L$, fatigue damage is considered not to occur. The curves are based on the results of tests on large-scale specimens collected over several decades.

Fatigue damage can be calculated for a given detail using the relevant fatigue curve from Part 1-9 to determine the number of cycles to failure N_i for a given stress range i and using Miner's summation for fatigue damage $\Sigma n_i/N_i$ where n_i is the number of occurrences of this stress range over the life of the structure. The fatigue damage should be less than or equal to 1.0 for the detail to be acceptable (see Part 1-9, Annex A clause A5). Some fillet welded details are in the lowest classes of detail identified in Part 1-9 Table 8.5: either detail category 36* or 40.

Wind loads

BS EN 1991-1-4 Annex B includes a graph of the number of times in 50 years that a wind gust load equals or exceeds a given proportion of the once in 50 year gust load, expressed as a percentage (see Figure 2). This curve is introduced in Annex B for use in the procedure for determining the structural factor $c_s c_d$ in wind load calculations. BS EN 1991-1-4 gives no guidance on the use of the curve for fatigue calculations due to gust loads.

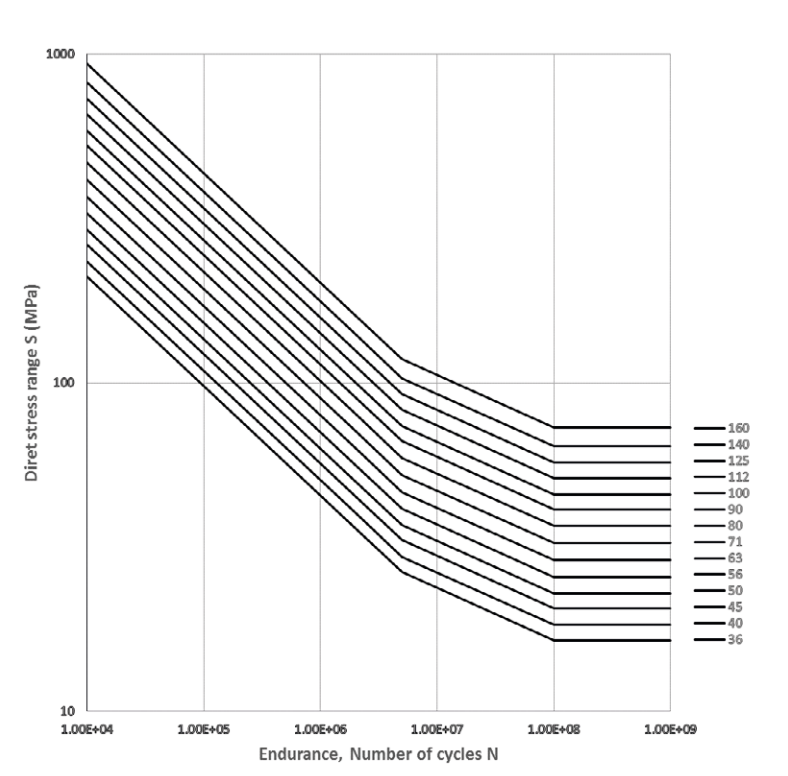


Figure 1: Fatigue strength curves

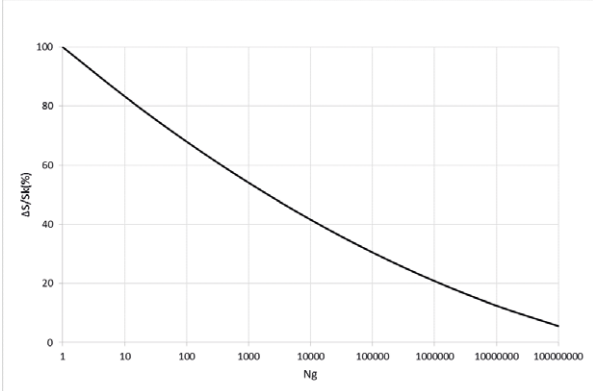


Figure 2: Number of gust loads N_g during a 50 year period

The relationship between the quantities is given as:

$$\frac{\Delta S}{S_k} = 0.7\left(\log_{10}(N_g)\right)^2 + 17.4\log_{10}(N_g) + 100$$

This graph provides the spectrum of stress ranges to which a detail is subjected. An unconsidered examination of the graph suggests that a load equal to 15% of the once in 50 year load ($\Delta S/S_k$ = 15%) occurs about 5 million times during the 50-year design life of the building. If the design load results in a stress equal to yield, a serviceability stress range of 36 MPa (about 355 × (0.15/1.5)) occurs enough times to cause a fatigue failure in a class 36 joint, for which a constant amplitude stress range of 36 MPa causes failure after 2 million cycles. ▶26

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As you would expect, **www.steelconstruction.info** contains a wealth of guidance on the design and construction of steel frames for buildings, but it encompasses much more. Information is also freely available on a range of related topics including:

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BCSA

STEEL *for life*

▶24 A crude examination such as this neglects a proper assessment of the stress ranges to which the bracing connection details are subjected. The bracing members are usually designed for wind loads and equivalent horizontal forces (EHF). These forces may also be amplified by a factor based on the elastic critical load factor of the building. Fatigue is a serviceability load case and the load factor on the wind load is therefore equal to unity instead of 1.5. Also, the EHF and amplification factor are intended to allow for global imperfections and second order effects respectively and are therefore not included in fatigue calculations. The stress ranges for the fatigue check are therefore significantly smaller than might initially be imagined.

Design Example

An example fatigue check on a connection detail for a bracing member taken from the design example in SCI's publication P365 Steel building design: medium rise braced frames is illustrative.

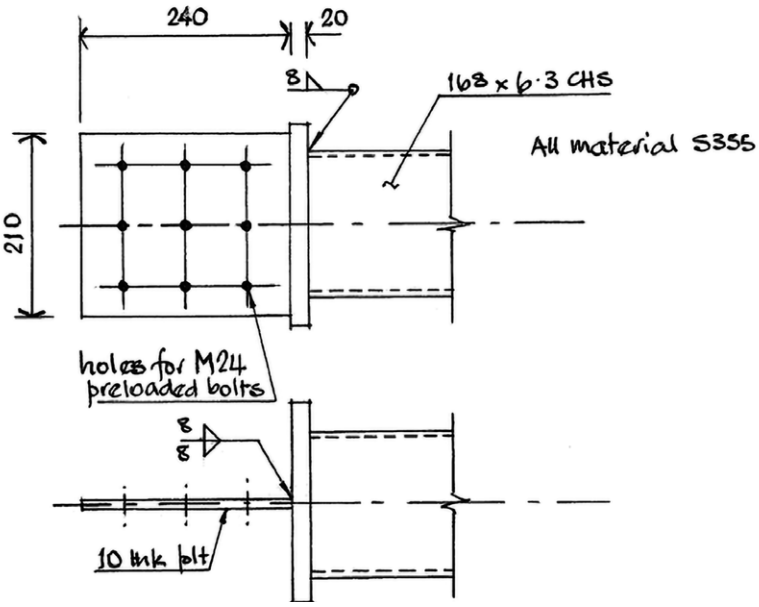

Figure 3: Bracing connection

The ultimate design load in the bracing member from ground to first floor is 539 kN. 60.9% of this force is due to wind load and it includes an amplification factor of 1.17. The serviceability load due to wind alone is therefore:

$$\frac{537.4}{1.17} \times 0.609 \times \frac{1}{1.5} = 187.2 \text{ kN}$$

The bracing member chosen is a 168 x 6.3 CHS in S355 material. A Tee or spade end connection is adopted and the double-sided fillet weld between the end plate on the tube and the projecting plate is designed in accordance with clause 7.6 of BS EN 1993-1-8 which determines the effective lengths of the weld. If the welds are sized according to the design load, as allowed in clause 7.3.1(6) of BS EN 1993-1-8, 8 mm leg fillet welds are adequate (weld throat = 5.7 mm). The connection detail is illustrated in Figure 3.

Fatigue Check

Checks on two welds are necessary for the end connection: the tube to end plate and the end plate to spade end welds. The relevant detail categories are 40 and 36*; the latter category has a modified curve in accordance with clause 7.1(3) Note 3 in Part 1-9. The curves are shown in Figure 4.

Fatigue damage is defined in Annex A para. A.5 of Part 1-9 as:

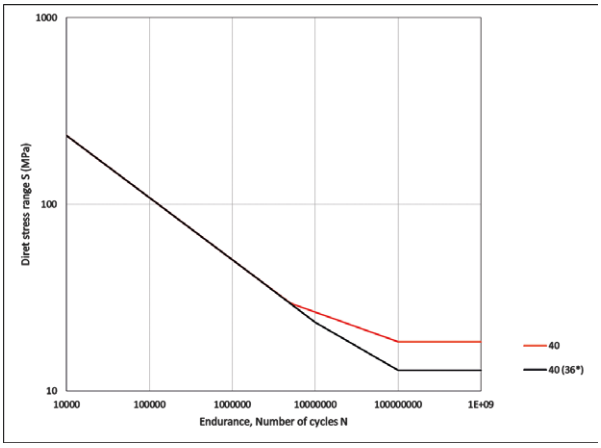

Figure 4: Fatigue strength curves

$$D_d = \sum_i^n \frac{n_{Ei}}{N_{Ri}}$$

where n_{Ei} is the number of cycles associated with the stress range $\gamma_{Ff}\Delta\sigma_i$ for band i in the factored spectrum and N_{Ri} is the endurance in cycles from the fatigue strength curve for a stress range of $\gamma_{Mf}\gamma_{Ff}\Delta\sigma_i$. According to the UK National Annex, $\gamma_{Mf} = 1.1$ and $\gamma_{Ff} = 1.0$.

The factored stress range spectrum is found from Figure 2. Stress ranges $\Delta\sigma_i$ corresponding to equal intervals of $\log_{10}N_g$ along the horizontal axis are considered in calculating the fatigue damage. The values of N_g range between 1.0 at 100% of S_k multiplied by the partial factors and the value of N_g at the factored cut-off limit $\Delta\sigma_L$. 100 intervals are chosen to achieve good convergence. The number of cycles n_{Ei} of the occurrence each stress range is calculated from the spectrum and the number of cycles to failure N_{Ri} for the stress range is calculated from the fatigue strength curve (Figure 3). The ratio of n_{Ei}/N_{Ri} is summed to calculate the fatigue damage.

Taking the details in turn, the effective length of the 8 mm fillet weld between the tube and end plate is 334 mm. The force /mm is:

$$\frac{187}{334} = 0.56 \text{ kN/mm}$$

The throat thickness is 5.7 mm. The fatigue direct stress is:

$\sigma_r = \dfrac{0.56 \times 10^3}{5.7} = 105$ MPa. This stress factored as described corresponds to S_k in the curve in Figure 2. The weld detail class is 40, described as "circular structural hollow section fillet welded end to end with an intermediate plate" in Table 8.6 of Part 1-9.

An example of the steps in the summation are given in the Table 1 for 10 intervals.

Using 100 intervals gives cumulative damage of 0.320.

For the tube to end plate weld, the damage summation equals 0.32 < 1.0 so the detail is satisfactory.

The second detail is the double-sided fillet weld between the end plate and the spade-end. The effective length of the weld between the tube and end plate is 388 mm. The force /mm is:

$$\frac{187}{388} = 0.48 \text{ kN/mm}$$

Index	$\log_{10}N_g$ int	n_i	$n_{Ei}=n_i+1-n_i$	$\gamma_{Mf}\gamma_{Ff}\Delta S$	$\Delta\sigma_i$	N_{Ri}	n_{Ei}/N_{Ri}	cum n_{Ei}/N_{Ri}
0	0	1	1	116	116	83000	0.0	0.0
1	0.68	4	3	104	110	97200	0.0	0.0
2	1.36	22	18	90.0	96.8	141000	0.0	0.0
3	2.04	109	87	77.9	83.9	216000	0.0	0.0
4	2.72	526	417	66.8	72.4	338000	0.001	0.002
5	3.40	2520	1997	56.5	61.6	546000	0.004	0.005
6	4.08	12100	9567	46.9	51.7	926000	0.010	0.016
7	4.76	57900	45831	38.1	42.5	1660000	0.028	0.043
8	5.44	277000	219568	30.1	34.1	3230000	0.068	0.111
9	6.12	1330000	1051898	22.8	26.4	8660000	0.121	0.233
10	6.80	6370000	5039407	16.2	19.5	39700000	0.127	0.356

Table 1: Calculation steps for 10 intervals

The fatigue direct stress is: $\sigma_r = \dfrac{0.48 \times 10^3}{5.7} = 85.2$ MPa. This stress when factored corresponds to S_k in the curve in Figure 2. The weld detail class is 36*, described as "root failure in partial penetration Tee-butt joints or fillet welded joint …" in, Table 8.5 of Part 1-9.

For the spade end to end plate weld, the damage summation equals 0.296 < 1.0 so the detail is satisfactory.

Conclusion

The foregoing examples indicate that for a bracing end connection, the predicted fatigue damage according to EC3 Part 1-9 indicates a fatigue life in excess of the normal 50 year design life of a building. This supports the inclusion of clause 2.4.3 in BS 5950:2000 and suggests that following the historical practice in the UK of not carrying out fatigue checks on bracing in conventional buildings is justified when designing to BS EN 1993-1-1 and Part 1-9.

References

1 Introduction to fatigue design to BS EN 1993-1-1, New Steel Construction, September 2018

NSC online

more that just a magazine

It's a digimag.

You can read this issue and all previous issues of NSC going back to 2005 online as digital magazines. You can read it on your computer, your tablet or your phone. And it comes with enhancements like links to further information on steelconstruction.info, and the ability to share, bookmark, print and download pages.

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All the content of NSC is also available on our website at newsteelconstruction.com. Like the magazine, the front page is divided into sections like News, Features and Technical. Once again, it's all cross referenced with links to steelconstruction.info, and contains extra video content. And it's all fully searchable with information going back to January 2005.

New and revised codes & standards

From BSI Updates May 2019

BRITISH STANDARDS

BS 7974 and PD 7974 Series Kit
Fire Safety engineering. Application of fire safety engineering principles to the design of buildings
No current standard is superseded

NA to BS EN 1992-4:2018
UK National Annex to Eurocode 2: Design of concrete structures. Design of fastenings for use in concrete.
No current standard is superseded

BS EN PUBLICATIONS

BS EN ISO 2063-1:2019
Thermal spraying. Zinc, aluminium and their alloys. Design considerations and quality requirements for corrosion protection systems
Supersedes BS EN ISO 2063-1:2017

BS IMPLEMENTATIONS

BS ISO 11484:2019
Steel products. Employer's qualification system for non-destructive testing (NDT) personnel
Supersedes BS ISO 11484:2009

PUBLISHED DOCUMENTS

PD 7974-3:2019
Application of fire safety engineering principles to the design of buildings. Structural response to fire and fire spread beyond the enclosure of origin (Sub-system 3)
Supersedes PD 7974-3:2011

BRITISH STANDARDS REVIEWED AND CONFIRMED

BS EN ISO 17641-1:2004
Destructive tests on welds in metallic materials. Hot cracking tests for weldments.
Arc welding process. General

BS EN ISO 17642-1:2004
Destructive tests on welds in metallic materials. Cold cracking tests for weldments.
Arc welding processes. General

BS EN ISO 17642-2:2005
Destructive tests on welds in metallic materials. Cold cracking tests for weldments.
Arc welding processes. Self-restraint tests

BS EN ISO 17642-3:2005
Destructive tests on welds in metallic materials. Cold cracking tests for weldments.
Arc welding processes. Externally loaded tests

BRITISH STANDARDS WITHDRAWN

BS 7974:2001
Application of fire safety engineering principles to the design of buildings. Code of practice
Superseded by BS 7974:2019

BS EN ISO 2063-1:2017
Thermal spraying. Zinc, aluminium and their alloys. Design considerations and quality requirements for corrosion protection systems
Superseded by BS EN ISO 2063-1:2019

BS ISO 11484:2009
Steel products. Employer's qualification system for non-destructive testing (NDT) personnel
Superseded by BS ISO 11484:2019

PD 7974-0:2002
Application of fire safety engineering principles to the design of buildings. Guide to design framework and fire safety engineering procedures
Superseded by BS 7974:2019

PD 7974-1:2003
Application of fire safety engineering principles to the design of buildings. Initiation and development of fire within the enclosure of origin (Sub-system 1).
Superseded by PD 7974-1:2019

PD 7974-2:2002
Application of fire safety engineering principles to the design of buildings. Spread of smoke and toxic gases within and beyond the enclosure of origin (Sub-system 2)
Superseded by PD 7974-2:2019

PD 7974-3:2011
Application of fire safety engineering principles to the design of buildings. Structural response and fire spread beyond the enclosure of origin
Superseded by PD 7974-3:2019

PD 7974-6:2004
The application of fire safety engineering principles to fire safety design of buildings. Human factors. Life safety strategies. Occupant evacuation, behaviour and condition (Sub-system 6)
Superseded by PD 7974-6:2019

PD 7974-7:2003
Application of fire safety engineering principles to the design of buildings. Probabilistic risk assessment
Superseded by PD 7974-7:2019

PD 7974-8:2012
Application of fire safety engineering principles to the design of buildings. Property protection, business and mission continuity, and resilience
Superseded by BS 7974:2019

NEW WORK STARTED

UK NA+A1:2019 to BS EN 1991-2
National Annex (informative) to BS EN 1991-2:2003, Eurocode 1. Actions on structures - Traffic loads on bridges
Will supersede NA to BS EN 1991-2:2003 (R13)

ISO 9712
Non-destructive testing. Qualification and certification of NDT personnel
Will supersede None

ISO PUBLICATIONS

ISO 2553:2019
Welding and allied processes. Symbolic representation on drawings. Welded joints
Will be implemented as an identical British Standard

ISO 8560:2019
Technical drawings. Construction drawings. Representation of modular sizes, lines and grids
Will be implemented as an identical British Standard

ISO 11484:2019
Steel products. Employer's qualification system for non-destructive testing (NDT) personnel
Will be implemented as an identical British Standard

ISO 14174:2019
Welding consumables. Fluxes for submerged arc welding and electroslag welding. Classification
Will be implemented as an identical British Standard

AD 431: Column web panel strengthening

The purpose of this Advisory Desk note is to draw attention to the contribution that full-depth stiffeners make to the shear resistance of column web panels.

SCI publication P398 covers the design of moment–resisting connections to Eurocode 3 and provides information on types of column strengthening in Table 2.1. Within this table, horizontal stiffeners are not credited with increasing the shear resistance of the web panel.

The special case of full depth stiffeners in both the tension zone and the compression zone is covered by clause 6.2.6.1(4) of BS EN 1993-1-8. This clause allows an additional contribution to the web panel shear resistance, based on the bending resistance of the flanges and the stiffeners which bound the web panel. The stiffeners and flanges can be envisaged as part of a Vierendeel truss, as shown in Figure 1.

If this additional contribution is to be utilised, the transverse stiffeners should be full depth and approximately the same width and thickness as the column flanges. The welds between the stiffeners and the flanges should be full strength, because the full plastic moment resistance of the stiffeners is assumed in the calculation.

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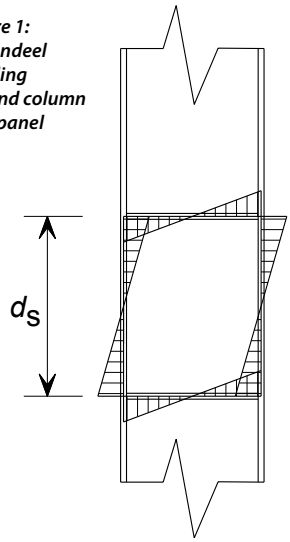


Figure 1: Vierendeel bending around column web panel

BUILDING WITH STEEL

Reprinted from Volume 5 No. 4
June 1969

Head office for Hearts of Oak Benefit Society

Model showing the whole concept

The Hearts of Oak Benefit Society, which operates within the framework of the Friendly Societies Act, has grown from humble beginnings in 1842 to become one of the foremost friendly societies in the country. It is appropriate, therefore, that the new Euston Road, London, Headquarters building should be a prestigious edifice and, because of the growth record, that every available square foot of the site should be used effectively.

A normal tower block was the ideal solution but the height necessary to achieve the required usable office space was unacceptable from a town planning viewpoint because of the proximity of St Pancras Church. The shape of the building as dictated by the Town Planning Authorities led the Society's Architects to design the building on the suspension principle so that there are no columns intruding on the office floor space, and with a podium of three storeys, inclusive of basement, which further compensates for the loss of space due to the reduction in height.

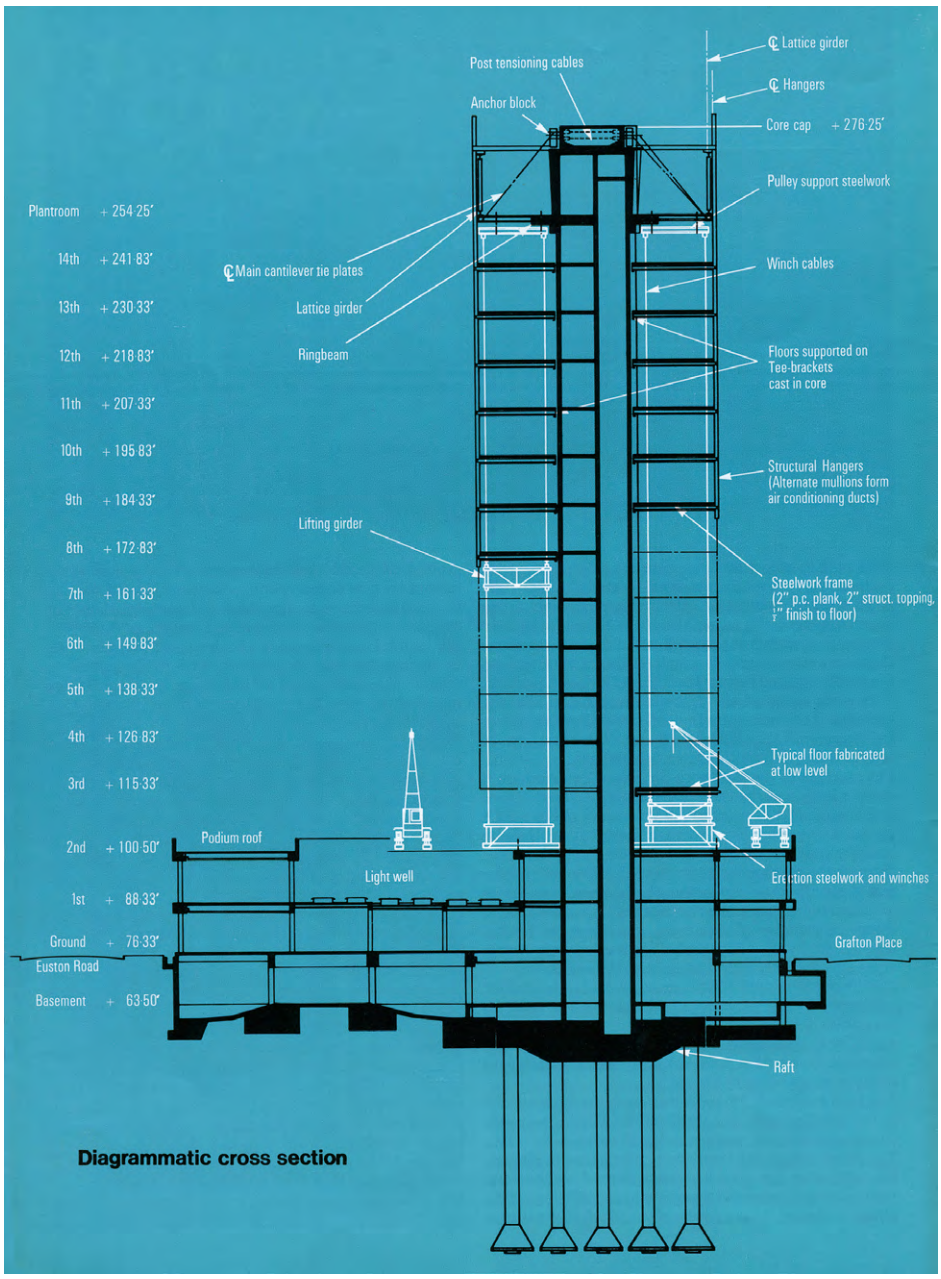
The new building is but the fourth of its type in the UK, the other three also being in London. Of the examples of tall suspended buildings elsewhere in the world, the architects and engineers visited those of the Common Market in Brussels, BP in Antwerp and Philips in Eindhoven. Valuable information was gained from each but the Philips building displayed principles most applicable to the Hearts of Oak development. Unlike the Philips building, however, which has the floors suspended only from the long sides of the core, the Hearts of Oak building has suspenders on all four sides. This was necessary to allow the east side of the building to overhang the existing pavement, for which, down to third floor level, agreement was reached with the Greater London Council. The suspended floors thus project the same amount on all sides from the central core to give plan dimensions of 58ft × 106ft. The core itself is 18ft 9in × 67ft 3in.

Construction

The construction of all buildings of this type follows the same principles. A concrete core is built to house stairs, lifts and other services and to act as a stiff member to transmit all horizontal forces to the foundations. Then an umbrella structure is cantilevered out at the top and from the periphery, the suspenders are hung to support the floors.

In the case of the Hearts of Oak building the concrete core, supported on a raft surmounting under-reamed piles reaching 40 to 50ft down into the London clay, was built by traditional methods with a vertical tolerance of only ±½in in some 200ft.

At the top of the core, eighteen specially constructed anchor blocks of high yield stress steel are built into the core cap. Opposite anchor blocks are connected with pairs of cables each consisting of thirty four 7mm wires, post tensioned in two stages to take loads of up to 120 tons per cable. The anchor blocks set diagonally at each corner of the core are held back by similar pairs of cables anchored to the core itself. During erection, the cables are protected against corrosion by a surface coating. They will be



Diagrammatic cross section

grouted up only after all umbrella steelwork is complete and the final tensioning has been carried out. The anchor blocks will then be completely encased in concrete.

With the core completed and the anchor blocks in position, erection of the steelwork, generally of high yield stress quality, could begin.

The main elements from which the floors are suspended are 15ft 1in deep lattice girders at the periphery of the building. These are supported at plant room floor level by a series of cantilever struts, consisting of four 17in × 4in channels built into a concrete ring beam on the outside of the core, which are in turn supported by ties from the anchorage blocks. Each tie comprises three 18in wide plates in parallel, the outer ones being ¾in thick, and the central one, 1½in thick. The top booms of the lattice girders are tied back to the core through plant room and roof steelwork.

The hangers, suspended outside the lattice girders, are at 8ft 1¼in centres around the building. At the four corners, 8in × 8in × 1in angles are used for the full length of 166ft 9in. All other hangers consist of two 9 × 5/8 in plates from the top down to 7th floor level and then they are single plates of the same section.

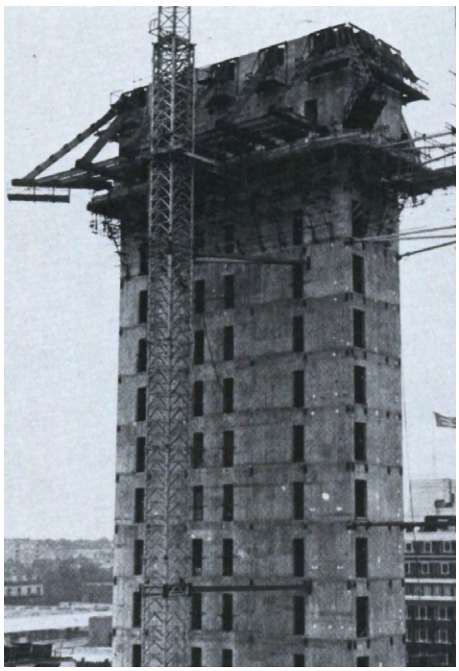
At the top of the building the hangers extend to a height of 3ft above the highest roof level to form a parapet. They are tied together on their inner edges by a parapet rail of rectangular hollow section. There is a similar extension below the 3rd floor (the bottom suspended floor). With the rectangular hollow section mullions placed centrally between them, the hangers form a uniform vertical feature.

In the design and fabrication of the hangers, account had to be taken of extensions due to loading and movements due to temperature changes. The components of each hanger were therefore laid out in the shops against a full length template, the splices are made with high strength turned barrel bolts., and the floor beams are connected to the hangers by a single 1¼in diameter pin of high yield stress steel to permit articulation.

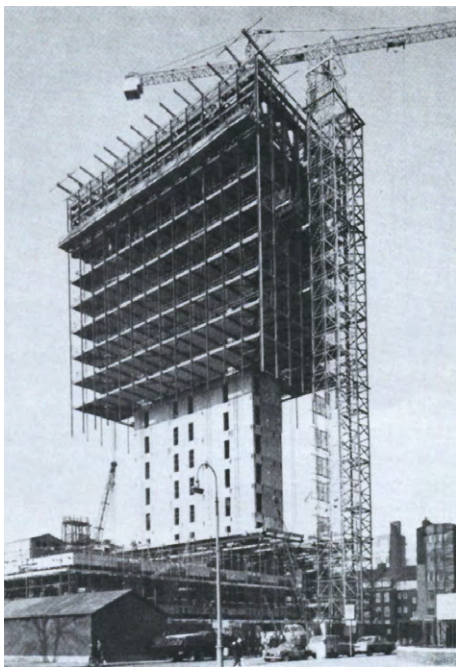
The floors consist of simple steel framing with 2in thick prestressed concrete planks surmounted by 2in of structural topping. Although erection proceeded from the top down, the floors were in fact prefabricated (except for the topping) in two halves on lifting rigs mounted on top of the podium and winched up. Erectors travelled on the completed half floors and fixing was a reasonably simple matter.

The steel floor beams trim into a fascia channel, which also serves to support cladding, at the outside and into another channel fixed to brackets set in the concrete core. The inner ends of the beams rest on rocker bearings so that, with the pinned connections to the hangers, articulation is possible at both ends.

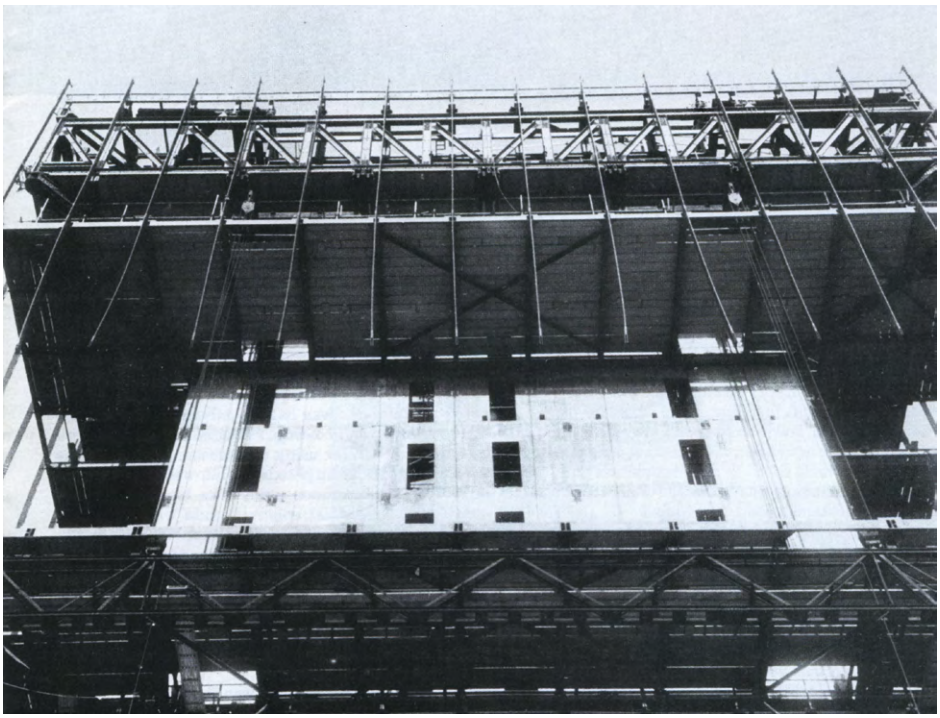
The floor steelwork, protected against fire by sprayed asbestos, will be concealed by a suspended ceiling above which air conditioning ducts and other services will be housed.



Completed core with anchorage and cantilever struts and ties in position



View at the halfway stage



Half floor being raised on the lifting rig

Cladding

The Hearts of Oak development is unique in that the hangers are external to the cladding. This has been done to obtain the maximum usable floor area and they achieve a prominent external architectural feature. All the hangers will be clad in stainless steel which will be shaped to form vertical tracks for the maintenance cradles. The intermediate mullions, likewise external to the enclosing envelope and clad in stainless steel, will also serve a dual purpose. In addition to supporting the glass and block granite infill panels, they will be used as air conditioning ducts and will thus help to conserve space inside the building. The glass itself is unusual; the type to be used has been specially chosen because of its anti glare and insulating properties so that occupants will be able to work in comfort and the air conditioning plant will be smaller because of the reduced refrigeration required.

Podium

This consists of a basement for parking cars and two floors for additional offices. The basement and the exterior beams above ground level are of reinforced concrete construction but all interior framing for the offices is of steelwork, high yield stress steel again being used to minimise weight and conserve space. Large circular holes in the webs of the floor beams throughout their length serve for the passage of services within a limited floor depth.

A roof garden is planned for the open area above the first floor, whilst the part under the suspended building will provide a covered concourse.

Architects for the development are Sidney Kaye, Eric Firmin & Partners, the Consulting Engineers are H L Waterman & Partners and Basil A Cohen & Partners are the Quantity Surveyors.

Construction of the core and podium commenced in June 1967 and it was topped out complete with core cap and anchorages in October 1968. The steel work erection took 24 weeks and the project is due for completion in late 1969.

Steelwork contractors for buildings

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

Lorraine MacKinder, Marketing and Membership Administrator,
The British Constructional Steelwork Association Limited, Unit 4 Hayfield Business Park, Field Lane, Auckley, Doncaster DN9 3FL
Tel: 020 7747 8121 Email: *lorraine.mackinder@steelconstruction.org*

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

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

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

Notes

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

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

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
A & J Stead Ltd	01653 693742			●	●					●	●			●	●		3			Up to £400,000
A C Bacon Engineering Ltd	01953 850611			●	●	●	●				●			●			2			Up to £3,000,000
Access Design & Engineering	01642 245151					●				●	●			●	●	✔	4			Up to £4,000,000
Adey Steel Ltd	01509 556677	●		●	●	●	●	●	●	●	●			●	●	✔	3	✔	●	Up to £4,000,000
Adstone Construction Ltd	01905 794561			●	●	●	●									✔	2	✔	●	Up to £3,000,000
Advanced Fabrications Poyle Ltd	01753 653617				●	●	●	●		●	●			●	●	✔	2			Up to £800,000
AJ Engineering & Construction Services Ltd	01309 671919			●	●		●		●	●	●			●	●	✔	4		●	Up to £3,000,000
Angle Ring Company Ltd	0121 557 7241												●			✔	4			Up to £1,400,000*
Apex Steel Structures Ltd	01268 660828					●	●			●	●			●	●		2			Up to £3,000,000
Arminhall Engineering Ltd	01799 524510	●			●	●		●		●	●			●	●	✔	2			Up to £800,000
Arromax Structures Ltd	01623 747466	●		●	●	●	●	●	●	●	●	●		●	●		2			Up to £800,000
ASME Engineering Ltd	020 8966 7150				●	●	●	●		●	●			●	●	✔	4		●	Up to £4,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●	●	●			●	●			●	●	✔	2			Up to £1,400,000
Austin-Divall Fabrications Ltd	01903 721950				●	●	●	●		●	●			●	●	✔	2			Up to £1,400,000
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 £1,400,000
BHC Ltd	01555 840006	●	●	●	●	●	●	●			●	●		●	●	✔	4	✔	●	Above £6,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	●	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●		4			Up to £3,000,000
Bourne Group Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	●	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●		●	●	●	✔	4			Up to £6,000,000
Builders Beams Ltd	01227 863770			●	●	●	●			●	●			●	●	✔	2	✔		Up to £2,000,000
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●				●	●	✔	4		●	Up to £4,000,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●		●	●	●		●	●	✔	4	✔	●	Above £6,000,000
Cementation Fabrications	0300 105 0135	●			●		●	●			●		●		●	✔	3		●	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●		●	●	●			✔	4		●	Above £6,000,000
CMF Ltd	020 8844 0940				●		●	●		●	●				●	✔	4			Up to £6,000,000
Cook Fabrications Ltd	01303 893011			●	●		●			●	●			●	●		2			Up to £1,400,000
Coventry Construction Ltd	024 7646 4484			●	●	●	●		●	●	●			●	●	✔	4			Up to £1,400,000
D H Structures Ltd	01785 246269			●	●		●				●						2			Up to £40,000
D Hughes Welding & Fabrication Ltd	01248 421104				●	●	●	●		●	●		●	●	●	✔	4			Up to £800,000
Duggan Steel	00 353 29 70072	●	●	●	●	●	●	●	●		●				●	✔	4			Up to £6,000,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●	●	●	●	●			●	●	✔	3			Up to £3,000,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●	●	●	●	●	●		●	●	✔	4	✔	●	Up to £6,000,000
EvadX Ltd	01745 336413			●	●	●	●	●	●	●	●	●			●	✔	3		●	Up to £3,000,000
Four Bay Structures Ltd	01603 758141			●	●	●	●	●		●	●			●	●		2			Up to £1,400,000
Four-Tees Engineers Ltd	01489 885899	●			●		●	●	●	●	●		●	●	●	✔	3		●	Up to £2,000,000
Fox Bros Engineering Ltd	00 353 53 942 1677			●	●	●	●	●		●	●				●		2			Up to £2,000,000
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●				●	●	✔	2			Up to £1,400,000
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)
G.R. Carr (Essex) Ltd	01286 535501	●		●	●			●			●			●	●	✔	4			Up to £800,000
Gregg & Patterson (Engineers) Ltd	028 9061 8131			●	●	●	●	●				●		●		✔	3			Up to £3,000,000
H Young Structures Ltd	01953 601881			●	●	●	●	●						●	●	✔	2		🟢	Up to £2,000,000
Had Fab Ltd	01875 611711				●				●	●	●				●	✔	4			Up to £3,000,000
Hambleton Steel Ltd	01748 810598		●	●	●	●	●	●			●	●		●		✔	4		⚪	Up to £6,000,000
Harry Marsh (Engineers) Ltd	0191 510 9797			●	●	●	●			●	●				●	✔	2			Up to £1,400,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●	✔	2			Up to £3,000,000
Intersteels Ltd	01322 337766	●			●	●	●	●		●				●	●	✔	3			Up to £2,000,000
J & A Plant Ltd	01942 713511				●	●									●		4			Up to £40,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●				●	●		●			4			Up to £6,000,000*
Kiernan Structural Steel Ltd	00 353 43 334 1445	●		●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	🟡	Up to £6,000,000
Kloeckner Metals UK Westok	0113 205 5270												●			✔	4			Up to £6,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●					✔	2		⚪	Up to £6,000,000
Legge Steel (Fabrications) Ltd	01592 205320			●	●		●		●	●	●			●	●		3			Up to £800,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●				●	✔	4		🟢	Up to £2,000,000
M J Patch Structures Ltd	01275 333431				●					●	●				●	✔	3			Up to £1,400,000
M&S Engineering Ltd	01461 40111				●				●	●	●			●	●		3			Up to £2,000,000
Mackay Steelwork & Cladding Ltd	01862 843910			●	●		●			●	●			●	●	✔	4			Up to £1,400,000
Maldon Marine Ltd	01621 859000				●	●			●	●				●		✔	3			Up to £1,400,000
Mifflin Construction Ltd	01568 613311			●	●	●	●				●						3			Up to £3,000,000
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
Newbridge Engineering Ltd	01429 866722	●	●	●	●	●	●	●	●		●	●		●	●	✔	4		⚪	Up to £2,000,000
North Lincs Structures	01724 855512			●	●					●	●				●		2			Up to £400,000
Nusteel Structures Ltd	01303 268112						●	●	●	●				●		✔	4		🟡	Up to £3,000,000
Overdale Construction Services Ltd	01656 729229			●	●		●	●							●		2			Up to £400,000
Painter Brothers Ltd	01432 374400	●			●				●	●	●				●	✔	3			Up to £6,000,000*
Peter Marshall (Steel Stairs) Ltd	0113 307 6730									●					●	✔	2			Up to £800,000*
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●		3			Up to £1,400,000
Robinson Structures Ltd	01332 574711			●	●	●	●				●			●	●	✔	3			Up to £6,000,000
S H Structures Ltd	01977 681931	●			●	●	●	●	●	●	●	●			●	✔	4	✔	🟡	Up to £2,000,000
SAH Engineering Ltd	01582 584220			●	●	●				●	●			●	●		2			Up to £800,000
SDM Fabrication Ltd	01354 660895	●	●	●	●	●	●				●			●	●	✔	4			Up to £2,000,000
Severfield plc	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	🟡	Above £6,000,000
SGC Steel Fabrication	01704 531286				●					●				●	●	✔	2			Up to £200,000
Shaun Hodgson Engineering Ltd	01553 766499	●		●	●		●			●	●			●	●	✔	3			Up to £800,000
Shipley Structures Ltd	01400 251480			●	●	●	●		●	●	●			●	●		2			Up to £3,000,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●	●	●	●			●				●		2	✔		Up to £1,400,000
South Durham Structures Ltd	01388 777350			●	●	●				●	●	●			●		2			Up to £1,400,000
Southern Fabrications (Sussex) Ltd	01243 649000				●	●				●	●			●	●	✔	2			Up to £1,400,000
Steel & Roofing Systems	00 353 56 444 1855			●	●	●	●				●	●		●	●	✔	4			Up to £3,000,000
Structural Fabrications Ltd	01332 747400	●			●	●		●	●	●	●			●	●	✔	3		⚪	Up to £1,400,000
Taunton Fabrications Ltd	01823 324266				●	●				●	●			●	●	✔	2		⚪	Up to £2,000,000
Taziker Industrial Ltd	01204 468080	●		●	●		●			●	●		●	●	●	✔	3			Above £6,000,000
Temple Mill Fabrications Ltd	01623 741720			●	●	●	●			●	●			●	●	✔	2			Up to £400,000
Traditional Structures Ltd	01922 414172			●	●	●	●	●	●		●			●	●	✔	3	✔	⚪	Up to £2,000,000
TSI Structures Ltd	01603 720031			●	●	●	●	●			●			●			2	✔		Up to £2,000,000
Underhill Engineering Ltd	01752 752483				●		●	●	●	●	●			●	●	✔	4	✔		Up to £3,000,000
W I G Engineering Ltd	01869 320515				●					●					●	✔	2			Up to £400,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✔	4			Above £6,000,000
Westbury Park Engineering Ltd	01373 825500	●		●	●	●	●	●	●	●	●				●	✔	4		🟢	Up to £800,000
William Haley Engineering Ltd	01278 760591				●	●	●									✔	4		🟡	Up to £4,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	🟡	Above £6,000,000
WT Fabrications (NE) Ltd	01642 691191			●	●	●	●				●			●	●	✔	4			Up to £40,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)

Steelwork contractors for bridgeworks

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

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

- **FB** Footbridges
- **CF** Complex footbridges
- **SG** Sign gantries
- **PG** Bridges made principally from plate girders
- **TW** Bridges made principally from trusswork
- **BA** Bridges with stiffened complex platework (eg in decks, box girders or arch boxes)
- **CM** Cable-supported bridges (eg cable-stayed or suspension) and other major structures (eg 100 metre span)
- **MB** Moving bridges
- **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	FB	CF	SG	PG	TW	BA	CM	MB	RF	AS	QM	FPC	BIM	NHSS 19A	NHSS 20	SCM	Guide Contract Value (1)
AJ Engineering & Construction Services Ltd	01309 671919	●			●	●	●	●	●	●	●	✓	4				●	Up to £3,000,000
Bourne Group Ltd	01202 746666	●			●	●				●	●	✓	4	✓		✓	●	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	●	●	✓	4			✓		Up to £6,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●	●	●	●		●	●	✓	4			✓	●	Up to £4,000,000
Cementation Fabrications	0300 105 0135	●		●	●	●	●				●	✓	3			✓	●	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	●	Above £6,000,000
D Hughes Welding & Fabrication Ltd	01248 421104	●		●		●			●	●	●	✓	4			✓		Up to £800,000
Donyal Engineering Ltd	01207 270909	●		●						●	●	✓	3			✓	●	Up to £1,400,000
ECS Engineering Services Ltd	01773 860001	●			●	●	●		●		●	✓	3					Up to £3,000,000
Four-Tees Engineers Ltd	01489 885899	●			●	●	●		●	●		✓	3			✓	●	Up to £2,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●				●				●	●	✓	4	✓		✓	●	Up to £6,000,000
M Hasson & Sons Ltd	028 2957 1281	●	●	●	●	●	●	●	●	●	●	✓	4			✓	●	Up to £2,000,000
Millar Callaghan Engineering Services Ltd	01294 217711	●						●		●	●	✓	4			✓		Up to £1,400,000
Murphy International Ltd	00 353 45 431384	●	●	●	●	●	●				●	✓	4			✓		Up to £1,400,000
Nusteel Structures Ltd	01303 268112	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	●	Up to £4,000,000
S H Structures Ltd	01977 681931	●	●	●	●	●	●	●	●	●	●	✓	4	✓		✓	●	Up to £2,000,000
Severfield (UK) Ltd	01204 699999	●	●	●	●	●	●	●	●	●	●	✓	4	✓	✓	✓	●	Above £6,000,000
Shaun Hodgson Engineering Ltd	01553 766499									●	●	✓	3			✓		Up to £800,000
Structural Fabrications Ltd	01332 747400	●		●	●	●	●			●	●	✓	3				●	Up to £1,400,000
Taziker Industrial Ltd	01204 468080	●		●	●	●	●	●	●	●	●	✓	3		✓	✓		Above £6,000,000
Underhill Engineering Ltd	01752 752483	●	●	●	●	●				●	●	✓	4	✓		✓		Up to £3,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	✓	4	✓	✓	✓	●	Above £6,000,000
Non-BCSA member																		
Allerton Steel Ltd	01609 774471	●	●	●	●	●	●	●		●	●	✓	4			✓	●	Up to £4,000,000
Centregreat Engineering Ltd	029 2046 5683	●		●	●	●	●	●	●	●	●	✓	4					Up to £2,000,000
Cimolai SpA	01223 836299	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓		Above £6,000,000
CTS Bridges Ltd	01484 606416	●	●	●	●	●	●	●	●	●	●	✓	4			✓	●	Up to £1,400,000
Ekspan Ltd	0114 261 1126	●				●			●	●	●	✓	2					Up to £400,000
Francis & Lewis International Ltd	01452 722200									●	●	✓	4			✓	●	Up to £2,000,000
Harrisons Engineering (Lancashire) Ltd	01254 823993	●		●	●	●	●	●	●	●	●	✓	3		✓			Up to £1,400,000
Hollandia Infra BV	00 31 180 540 540	●	●	●	●	●	●	●	●	●	●	✓	4					Above £6,000,000*
HS Carlsteel Engineering Ltd	020 8312 1879									●	●	✓	3			✓		Up to £200,000
IHC Engineering (UK) Ltd	01773 861734	●									●	✓	3			✓		Up to £400,000
In-Spec Manufacturing Ltd	01642 210716									●	●	✓	4			✓		Up to £400,000
Lanarkshire Welding Company Ltd	01698 264271	●		●	●	●	●	●	●	●	●	✓	4		✓	✓	●	Up to £2,000,000
Total Steelwork & Fabrication Ltd	01925 234320	●		●		●				●	●	✓	3			✓		Up to £3,000,000
Victor Buyck Steel Construction	00 32 9 376 2211	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	●	Above £6,000,000

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
Control Energy Costs Ltd	01737 556631
Gene Mathers	0115 974 7831
Griffiths & Armour	0151 236 5656
Highways England Company Ltd	08457 504030
Inspire Insurance Services	02476 998924
Kier Construction Ltd	01767 640111
McGee Group (Holdings) Ltd	020 8998 1101
Sandberg LLP	020 7565 7000
Structural & Weld Testing Services Ltd	01795 420264
SUM Ltd	0113 242 7390

Industry Members

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

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		
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 Ltd	01724 404040				●						M		
British Steel Distribution	01642 405040								●		D/I		
BW Industries Ltd	01262 400088	●									M		
Cellbeam Ltd	01937 840600	●									M		
Cleveland Steel & Tubes Ltd	01845 577789								●		M		
Composite Metal Flooring Ltd	01495 761080	●									M		
Composite Profiles UK Ltd	01202 659237	●									D/I		
Cooper & Turner Ltd	0114 256 0057									●	M		
Cutmaster Machines (UK) Ltd	01226 707865					●					N/A		
Daver Steels Ltd	0114 261 1999	●									M		
Daver Steels (Bar & Cable Systems) Ltd	01709 880550	●									M		
Dent Steel Services (Yorkshire) Ltd	01274 607070								●		M		
Duggan Profiles & Steel Service Centre Ltd	00 353 567722485	●							●		M		
easi-edge Ltd	01777 870901							●			N/A	●	
Fabsec Ltd	01937 840641	●									N/A		
Farrat Isolevel	0161 924 1600	●									N/A		
Ficep (UK) Ltd	01924 223530					●					N/A		
FLI Structures	01452 722200	●									M	●	
Forward Protective Coatings Ltd	01623 748323						●				N/A		
Hadley Industries Plc	0121 555 1342	●									M	●	
Hempel UK Ltd	01633 874024						●				N/A		
Highland Metals Ltd	01343 548855						●				N/A		
Hi-Span Ltd	01953 603081	●									M	●	

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM	BIM
International Paint Ltd	0191 469 6111						●				N/A	●	
Jack Tighe Ltd	01302 880360						●				N/A		
Jamestown Manufacturing Ltd	00 353 45 434288	●									M		
John Parker & Son Ltd	01227 783200								●	●	D/I		
Joseph Ash Galvanizing	01246 854650						●				N/A		
Jotun Paints (Europe) Ltd	01724 400000						●				N/A		
Kaltenbach Ltd	01234 213201					●					N/A		
Kingspan Structural Products	01944 712000	●									M	●	
Kloeckner Metals UK	0113 254 0711								●		D/I		
Lincoln Electric (UK) Ltd	0114 287 2401					●					N/A		
Lindapter International	01274 521444									●	M		
MSW UK Ltd	0115 946 2316	●									D/I		
Murray Plate Group Ltd	0161 866 0266								●		D/I		
National Tube Stockholders Ltd	01845 577440								●		D/I		
Peddinghaus Corporation UK Ltd	01952 200377					●					N/A		
PPG Architectural Coatings UK & Ireland	01924 354233						●				N/A		
Prodeck-Fixing Ltd	01278 780586	●									D/I		
Rainham Steel Co Ltd	01708 522311								●		D/I		
SDS/2 Ltd	07734 293573		●								N/A		
Sherwin-Williams Protective & Marine Coatings	01204 521771						●				N/A	●	
Structural Metal Decks Ltd	01202 718898	●									M		
StruMIS Ltd	01332 545800		●								N/A		
Stud-Deck Services Ltd	01335 390069	●									D/I		
Tata Steel – Tubes	01536 402121				●						M		
Tata Steel – ComFlor	01244 892199	●									M		
Tension Control Bolts Ltd	01978 661122						●			●	M		
Trimble Solutions (UK) Ltd	0113 887 9790		●								N/A		
voestalpine Metsec plc	0121 601 6000	●									M	●	
Wedge Group Galvanizing Ltd	01909 486384						●				N/A		
Wightman Stewart (WJ) Ltd	01422 823801					●					N/A		