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NSC

JUNE 2024
Vol 32 No 6

Cover Image
Woolwich Leisure Centre, London
Main client: Royal Borough of Greenwich
Architect: FaulknerBrowns Architects
Main contractor: Morgan Sindall Construction
Structural engineer: Buro Happold
Steelwork contractor: Elland Steel Structures
Steel tonnage: 1,650t

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Knowledge economy growth supported by sophisticated steel

Nick Barrett - Editor

Finding examples of benefits being delivered to developers and contractors by the selection of constructional steelwork as a framing solution is never difficult, the pages of NSC alone are regular proof of that. Sustainability is obviously, and with good reason, a major concern all along the supply chain, and steelwork contractors have been keen from the onset of the climate change battle to play an active part.

Flexibility of steel is emerging as a key sustainability feature that supports the UK's net-zero drive and the number of examples of that is growing apace. We see an outstanding example in this month's NSC, with a 42 storey office block at London's Canary Wharf being saved from demolition and being 'reimagined' to meet changing building user demands thanks to the use of steel. Nearly every floor was reconfigured during the extensive refurbishment. Adapting the building involved clever structural engineering, and careful thought from skilled and experienced steelwork contractors.

Those skills and experience are becoming more valuable almost by the day. The UK is facing a skills crisis, with warnings about the potentially severe consequences of not being able to source even lower skilled workers for the infrastructure building programmes that the UK seems about to embark on. Developers and main contractors will take note that an increasingly important part of the calculation about what framing material to use on a project will be availability of skilled labour.

The days of using materials that demand large numbers of diverse trades on site at the same time may be drawing to a close faster than they were before. Increasing automation and off-site production can only go so far in reducing the need for on site working for the traditional alternatives to steel. Steel construction on the other hand has always been a predominantly offsite activity, carried out in factory type conditions by a highly skilled and well paid workforce enjoying welfare and health and safety advantages to a standard denied to many site workers. Attracting workers to these relatively highly paid jobs has never been a limiting factor in ensuring that fabricated steelwork is delivered cost effectively, on time and to the highest quality standards.

Fabrication machinery is under constant development which helps ensure that fabricating remains a cost effective and speedy process that allows frames to be delivered to site for as required, minimising the space taken up on often congested sites. These highly sophisticated CNC machines are driven by software that is also being continuously improved. If artificial intelligence and increasing automation that we have read so much about recently have anything like their predicted benefits, then constructional steelwork will only become more and more cost effective as design and manufacturing capabilities expand.

Constructional steelwork is at the heart of an increasing sophistication in how buildings will be designed and built. Steel is also a key provider of the sustainable buildings in which digital and other advances will be made, as what is being called the knowledge economy grows. In this issue we report on a visit to No 3 Circle Square in Manchester, a speculatively built mixed use block aiming at BREEAM 'Excellent' and EPC A ratings in an area already known for its high number of technology and research based companies. This demonstrates high confidence in Manchester's potential as one of Europe's 'Top 20 digital cities'; as well as confidence that steel is the construction material for the future.

British Steel gets Scunthorpe EAF approval

British Steel's £1.25bn decarbonisation plan has been given a major boost after it was granted planning permission to build an Electric Arc Furnace (EAF) in Scunthorpe.

The company's application, which was approved by North Lincolnshire Council, follows Redcar and Cleveland Borough Council's green light for an EAF at Teesside.

The manufacturer's proposed £1.25bn transformation – its biggest in more than a century of steelmaking – is subject to appropriate support from the UK Government.

British Steel President and CEO Xijun Cao said: "We're extremely pleased to have received planning permissions to build Electric Arc Furnaces at our Scunthorpe and Teesside sites. It is a significant step forward in our journey to net zero and we thank everyone who has supported our plans.

"The proposed installation of EAFs in Scunthorpe and Teesside is central to our journey to a green future as they would help us reduce emissions of CO_2 by more than 75 per cent. However, it is crucial we now secure the backing of the UK Government."

Significant preparation works, including environmental and technical studies, and equipment selection, are underway to ensure the company's ambitious proposals can be delivered at the earliest opportunity, while discussions with the UK Government continue.

Both proposed EAFs would replace the aging iron and steelmaking operations at British Steel's Scunthorpe site, which are responsible for the vast majority of its CO_2 emissions. The company proposes maintaining current operations until a transition to electric arc steelmaking.

Groundbreaking for net zero carbon development in Darlington

Main contractor Winvic and Greenbox have celebrated, with a groundbreaking ceremony, the start of construction for a new net zero carbon logistics park in Darlington.

Developer Greenbox is a joint venture between Partners Group, a leading global private markets firm and Citivale, a specialist logistics developer and operator.

Work on the 24-acre Greenbox Darlington site, comprising three speculative industrial facilities totalling 37,300m², will be complete by the end of 2024.

The three units will each include office space and the entire development is aiming to achieve a BREEAM 'Excellent' and EPC A ratings.

The project is located on the A66, close to three junctions on the A1(M). It is said to be a proven manufacturing hub and 'last mile' location to the major urban areas of the North East.

Alex Reynolds, Development Director at Citivale, said: "Having acquired this planning-ready site at the end of 2023, in a thriving industrial and manufacturing area of the North East, it's great to have been able to move so quickly to this first milestone in the development."

Caunton Engineering is fabricating, supplying and erecting the steelwork for the project.

Work starts on Passivhaus Bristol school projects

Main contractor BAM has started work on a new project to deliver a primary and secondary school in Lyde Green near Bristol. The company said the new school buildings will be built to Passivhaus standards making them highly energy efficient and net zero carbon.

BAM will construct the new 420-place primary school, alongside a new, 900-place, 11-16 secondary school.

As well as modern new learning facilities, the school buildings have been designed to benefit the wider community, with a core area of purpose-built, shared-use sports facilities.

The construction appointment was made by South Gloucestershire Council, via the Southern Construction Framework (SCF).

BAM Regional Director Tim Chell, said: "As we begin construction, we're looking forward to delivering two highly sustainable schools.

"I am delighted that we are now able to see work getting underway and that funding has been secured to deliver these brand-new schools for the local community."

Both schools will be completed and ready to welcome new students, to begin learning onsite, in September 2026.

Work takes off for Leeds Bradford Airport terminal extension

Leeds Bradford Airport (LBA) has officially marked the start of construction work on its new terminal regeneration with a ground breaking ceremony.

The privately funded £100M development, known as LBA:REGEN, will transform the existing terminal building into a modern, efficient and sustainable facility, enhancing passenger experience and supporting the region's economic growth.

The scheme will deliver a 9,500m² three-storey steel-framed extension to the existing terminal, alongside a significant refurbishment of the current facilities.

Passengers will benefit from the creation of additional aircraft stands, more seating, faster security, new shops and eateries, a larger baggage reclaim area and immigration hall, and improved access for passengers with restricted mobility.

Farrans Construction is currently delivering Phase One of the project, which includes the construction of a new UK Border Force immigration facility and international baggage reclaim hall, as well as expanded retail and international departure lounge facilities. Phase 2 will include an enlarged central search and check-in areas, alongside a larger duty free, retail and arrivals areas.

Working on behalf of Farrans, Elland Steel Structures is fabricating, supplying and erecting the steelwork for the project. Both phases are expected to be complete by 2026.

Steelwork delivers new school facilities in Stretford

Project team members have celebrated the progress being made on the St John Vianney RC SEND school in Stretford, Manchester, with a steel signing ceremony.

Working on behalf of main contractor Kier, Leach Structural Steelwork is fabricating, supplying and erecting 300t of steelwork for the project.

The job is split into two phases, with the initial work consisting of a new 4,470m² teaching block. It will accommodate 160 pupils with special educational needs and disabilities (SEND). The school will cater for pupils from primary school age through to year 13.

The new building will include both primary and secondary SEND classrooms, information and communication technology (ICT) classrooms, design technology workshops, food technology classrooms, science studios, hair and beauty training salons and fitness rooms. There will also be medical treatment rooms, therapy rooms, quiet calming spaces and sensory rooms.

Once the first phase is complete, the existing school building will be demolished and a sports hall and hydrotherapy pool (phase two) will be

erected.

The project, which was procured through the Department for Education's new CF21 framework, started on site in September 2023 and is due to complete in August 2026

Redevelopment scheme arrives at Redcar station

Robertson Construction is set to start major redevelopment works at Redcar Central Station, converting an empty Grade II listed building into a welcoming town centre gateway.

The building will function as both a leisure and retail hub, as well as a key transport link, providing rail facilities including ticket machines, travel information and waiting rooms.

The project, which is funded by the Government's Levelling Up Partnership Fund, Welcome to Redcar and Cleveland, and the Railway Heritage Trust, will complete in late 2025.

Councillor Lynn Pallister, Cabinet Member for Growth and Enterprise, Redcar & Cleveland Borough Council, said: "Our residents have been looking forward to seeing some progress on the station, and I know they'll be pleased to finally see some being made.

"This is fantastic for local businesses, as it will give visitors a more welcoming first impression of the town.

Tees Valley Mayor Ben Houchen, said: "This pivotal work will restore Redcar Central Station to its former glory, while providing new, modern spaces for our brilliant leisure and hospitality businesses. It will encourage even more people to visit the town and see first-hand the great new entertainment spaces we have."

NEWS IN BRIEF

Mace has been appointed by Helical as the main contractor on the redevelopment of 100 New Bridge Street in the City of London. Located adjacent to City Thameslink station with views overlooking St. Paul's Cathedral and St Bride's Church, the 1990s building will be renovated to create 18,000m² of Grade A office space, 333m² of retail spaces and a 371m² terrace.

East Midlands-based **G F Tomlinson** has started work to transform Barnsley College University Centre into a world-class innovation hub for the region. On behalf of the South Yorkshire Institute of Technology (SYIoT), the 92-year-old art-deco building will undergo a refurbishment funded jointly by the Department for Education (DfE) regional investment and College capital funds.

Developer **Henry Boot** has won planning consent for a new 18,500m² Manchester city centre office scheme. Known as Colloco and located in the St John's district of Manchester, the project will comprise 16 storeys of high-quality offices, with EPC A and BREEAM 'Excellent' ratings being targeted.

Rolls-Royce has announced plans to almost double the size of its Raynesway site, creating hundreds of new jobs in Derby. Funded by the MoD, the site development is required to meet orders for the Royal Navy's new submarines as well as vessels destined for Australia.

Work has started on the multi-million-pound redevelopment of **Bradford's** Kala Sangam arts centre. The project will see the creation of a new theatre, five new dance studios, a new central staircase and a permanent home for volunteer-led community radio station Bradford Community Broadcasting (BCB). It is scheduled to reopen in Summer 2025, as a landmark moment in Bradford's year as UK City of Culture.

PRESIDENT'S COLUMN

Black box solution

If anyone read the article written by Hugo Rifkind entitled 'Horizon was 'computer says no' on a vast scale', which was published in The Times newspaper in January of this year, or indeed you remember my inaugural NSC column as Deputy President back in December 2022, then please accept my apologies because you will already be familiar with the concerns and arguments that I feel the need to reiterate below.

The recent Post Office scandal, where many staff were wrongly accused of malpractice and theft has now been proven to have been the result of a computer programme fault that was not adequately monitored or managed by humans. This, of course, currently ignores any suggestion that distant parties may have had remote access to every computer terminal, which would point to a very different human led crime.

The software, named Horizon, was developed and released by the very reputable and prominent company Fujitsu, and The Times article goes on to say that: "Horizon is an extreme example but not as an isolated problem." I find this somewhat concerning, as we start to rely on software solutions to many of our engineering challenges, including both simple and complex steelwork connection designs.

In our daily lives, when dealing with domestic issues, how many of us find ourselves listening to a computer-generated voice asking us to choose between option one to five, or listening to a pre-recorded message telling us that we can manage our issue on their user-friendly website or downloaded App?

There are increasing examples of individuals being asked to pay huge sums of money for implausible changes to household bills that are incomprehensible, other than the fact that the computer says 'yes'. And with no-one on the end of the phone with whom to discuss a logical solution for this situation.

Which leads me to my previous (Dec 2022) topic of over-reliance on computers.

The Post Office/Horizon issue happened in a completely different industry to ours, but does it create the same potential challenges? In their case, it related to people's livelihood and morality and in our case, it relates to competence and public safety. Some might argue that there is a measurable difference when it comes to safety, but I'm sure that those involved in the Post Office scandal would see it differently.

With the next generation of Eurocodes due to be published soon, in my opinion, it will become increasingly difficult to figure out the fact from the fiction, since many of the proposed design approaches and corresponding formulae are generated from academic studies rather than full-scale tests and historical experience. This will undoubtedly result in further software and AI releases and while there is no evidence to say that these approaches will be unsafe, they will be extremely difficult to measure and verify by the more traditional and conservative methods.

We need to be openly aware of the challenges that lie ahead with the introduction of AI and the increase in 'black-box' software solutions. Our current design solutions may indeed be conservative, but the many years of experience clearly demonstrate that they are both safe and reliable.

So, looking beyond the horizon, is it not time to introduce 'Computer-Free-Fridays' to engage our future engineers in the hands-on experience that is essential for proven, practical and safe design solutions?

Gary Simmons
BCSA President

Warehouse scheme celebrates with traditional Japanese ceremony

A traditional saki barrel breaking ceremony has been performed at the groundbreaking for a new warehouse facility for Japan-based Yusen Logistics.

Being constructed by Winvic Construction, the facility is located on the SEGRO Logistics Park in Northampton.

Severfield is fabricating, supplying and erecting the steelwork for the warehouse, which comprises 106,281m² of floor space with a 30,900m² mezzanine level.

Winvic will also construct and fit out the 3,326m² three-storey main office, which also has a roof terrace, and a single-storey hub office.

Designed to achieve a BREEAM 'Excellent' rating, which will reduce carbon to net zero during the construction, the building will feature an array of PV panels installed across the entire roof space.

David Goldsborough, Managing Director from Yusen Logistics, added: "This new facility sets a new logistics industry benchmark, and emphasises our commitment to providing sustainable logistics services by 2030. We are proud to share our organisation's Japanese heritage at the recent groundbreaking event and are excited to be a part of this project, which will help us to achieve our sustainability goals."

Trusses form North Wales pharmaceutical expansion

Structural steelwork is playing a leading role in the construction of a £75M expansion at the Ipsen plant in Wrexham.

The company undertakes research and development (R&D), and manufacturing to produce medicines to treat neurological conditions.

The investment is funding a new state-of-the-art facility, said to be built using the latest in environmentally sustainable technologies that will enhance the production of Ipsen medicines in the UK.

Part of the three-storey steel-framed building is being formed with a series of 30t trusses, which have been lifted into place using two mobile cranes.

Rhyl-based EvadX is fabricating, supplying and erecting the steelwork for the project.

Manchester campus expands with more lab space

Work has begun on a new laboratory space building at Manchester Science Park, which is part of Europe's largest clinical academic campus.

Known as the Greenheys building, the project will offer a range of specialist CL2 labs with supporting office space ranging in size from starting from 232m² up to 2,043m².

An array of advanced technical features will be on offer, including increased vibration resistance, piped gas distribution systems, enhanced cooling and ventilation systems, high-security access, and 100GB superfast connectivity.

The BREEAM 'Excellent' development is said to reflect client Bruntwood SciTech's commitment to sustainability, with Greenheys set to become the first lab space in the UK to be 100% electric and net zero carbon in construction and operation.

Scheduled for completion in Summer 2026, Greenheys will span across six floors, with specialised laboratory spaces tailored for diagnostics, genomics, biotech and precision medicine businesses.

Sam Darby, Development Director, Bruntwood SciTech, said: "We are delighted to have main contractor Willmott Dixon on board for the Greenheys development. Their expertise aligns strongly with our vision for creating a facility that will serve as a catalyst for innovation in the life sciences sector, and become one of the most advanced and specialist life science spaces in the UK.

"With Willmott Dixon's commitment to quality and sustainability, we are confident that together we will deliver a world-class facility that meets the needs of the scientific community and contributes positively to the Manchester region."

ASD Westok introduces Cellbeam 10.4 update

Used throughout the UK and Ireland, ASD Westok has released an update to its popular Cellbeam software package.

Cellbeam 10.4 has been developed by the Steel Construction Institute (SCI) and is available as a free download at: *https://asd.ltd/westok-software*.

This latest upgrade is said to include a host of new features that will assist users in developing more carbon-friendly design solutions.

The updated software now includes a carbon calculator that allows the user to easily work-out and report the Modules A1-A5 and Module D embodied carbon values.

The company said, the feature is packaged in an easy-to-use format and can help engineers better understand and report the carbon savings associated with their Westok cellular beam designs.

Responding to the growing demand for sustainable and hybrid construction solutions, Cellbeam 10.4 also includes enhanced slab input options, facilitating Westok cellular beams with CLT (Cross-Laminated Timber) slabs.

The updates software has streamlined its reporting on fire performance, focusing on the critical failure temperatures of the web or flange, rather than the previous dual reporting format. This update is said to more accurately reflect the performance of the cellular beam in fire.

For more information visit Westok's website or contact the technical advisory service on +44 (0)113 205 5270 or at *westok.design@kloeckner.com*

Blackfriars high-rise commercial scheme gets the go-ahead

Developer Hines has secured a resolution to grant planning approval from Southwark Council to build a new, landmark office and residential development at 18 Blackfriars Road in south London.

The approval which was secured working with architects Foster + Partners, and Lipton Rogers, allows Hines to breathe new life into a two-acre brownfield site that has remained undeveloped for 20 years.

18 Blackfriars Road is designed to be fossil fuel free, 100% electric and net zero carbon in operation, with 95% of the site heat demand served by ground source heat pumps that share, store and offset energy.

Ross Blair, Senior Managing Director and Country Head of Hines UK, said: "Our plans will transform the site into much needed new homes and first class, sustainable and tech-enabled offices, built around a central hub which we hope will become a brand-new convening space for the local community."

The new scheme will consist of three buildings, two delivering over 400 new homes, with 40% being affordable. The third will create 74,300m² of office space featuring outdoor terraces on every third floor.

Plans also include 1,850m² of new affordable workspace for local and socially minded enterprises, assembly rooms for use by the local community, modern educational space with links to local institutions, children's play areas and a new, central public space with retail and food outlets situated at the heart of the development.

Green light for healthy living neighbourhood

Planning consent has been secured for Newcastle University's multi-million-pound Health Innovation Neighbourhood, which will promote longer, healthier lives.

Newcastle University, in partnership with Genr8 Kajima Regeneration, will transform the former 29-acre General Hospital site in Newcastle's West End into a world-class centre for research and innovation focused on ageing and living well.

The project will include 32,500m² of research and innovation facilities, a further 32,500m² of business, employment and education space, 9,200m² of NHS and other health-related facilities, and 1,250 new homes, up to 15% of which will be affordable.

The residential space will comprise houses as well as clustered living units, later-living residential units and supported living units. It will also include specialist housing for those living with dementia and traumatic injury.

Professor Chris Day, Vice-Chancellor and President of Newcastle University, said: "Our planned Health Innovation Neighbourhood builds on our world-leading expertise in healthy ageing and will be the first of its kind in the UK, tackling major health and social challenges with the aim of identifying solutions that will benefit people here in the North East and beyond.

"We are delighted that the detailed masterplan of our exciting development has been given the green light, to put ageing and health at the heart of a flourishing community which will bring together research, innovation, commerce and living."

Diary

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

Wednesday 19 June 2024
Hybrid Steel Frames with Mass Timber Floors
Free to all webinar.
This 'Free to All' Webinar will introduces hybrid steel frames with mass timber floors comprising steel-timber and steel-timber-concrete solutions. Solutions for downstand and shallow floor beams will be presented, as well as options to enable the composite behaviour between materials. Market challenges, available design guidance and the environmental benefits of such solutions will also be discussed.
https://steel-sci.webex.com/weblink/register/r9d24670c55bbbdf9b33ea3fd74dd288b

Tuesday 2 July 2024
Modular Construction
Webinar
This webinar will cover the various forms of modular construction and examples of projects in the residential, health and educational sectors. It will cover developments in high-rise modular buildings and hybrid steel frames and modules.

Thursday 18 July 2024
Design for Sustainable Construction
Online course
Engineers have a pivotal position in the globally important requirement to minimise embodied carbon. If construction is to proceed at all, a designer has a responsibility to design to minimise the demand for new steelwork – by adapting the existing structures, by reusing steelwork and by developing a structurally efficient design. This short 3hr course will challenge designers to develop solutions which minimise overdesign, and make the very best use of resources. The course aims to remind designers of the straightforward ways to demonstrate best practice measured in embodied carbon.

Assessing carbon emissions

The BCSA has updated its UK consumption-based average embodied carbon value for steel sections.

British Constructional Steelwork Association Sustainability Manager Michael Sansom, explains how to assess the UK consumption-based average embodied carbon emissions of open hot-rolled structural sections.

Assessing the embodied carbon emissions of a steel structure at the early design stage can be challenging. One reason for this is that there are a range of embodied carbon values for steel sections, manufactured by different steel production routes. Additionally, the steel maker or steel mill is generally not known or specified at the early design stage of a project.

The use of 'average' embodied carbon factors for steelwork is a simple way of addressing the variation in production routes and in 2021 the British Constructional Steelwork Association (BCSA) developed a UK consumption-based average, which reflects the mix of steel from the different production routes used in the UK [1].

The use of 'UK consumption-based averages' is the early design stage recommendation provided by RICS [2] and the IStructE [3] when assessing the embodied carbon of building structures.

IStructE plans to update its embodied carbon guidance [3] in 2024 and therefore the BCSA has recently updated its UK consumption-based average embodied carbon value for steel sections. The recently published RICS whole life carbon assessment standard published in 2023 [2], also references this BCSA consumption-based average value for early design phase assessment of Module A1-A3 carbon emissions.

The methodology for this 2024 update is based on a more robust methodology and dataset than before and is briefly described below.

UK import data for hot-rolled sections from 2018-2022 have been provided by the International Steel Statistics Bureau (ISSB), who also provided total UK demand data for hot-rolled sections over the same period.

For each country of origin, the steel mill and production route has been determined based on information provided by steel producers, stockholders and industry experts.

For each steel producer, embodied carbon emissions for Modules A1-A3 have been sourced from the company and product specific EPDs; where these are not available, conservative assumptions have been applied.

For countries where more than one producer exports sections to the UK (Germany, Spain and Turkey) weighted averages have been used.

For domestically produced hot-rolled sections, the current British Steel EPD [4] has been used.

The four-year (2019-22) UK consumption-based average embodied carbon (Modules A1-A3) for hot-rolled steel sections is calculated as 1.64 $kgCO_2e$ per kg. The corresponding average Module D value is -0.91 $kgCO_2e$ per kg.

For further information contact Michael Sansom, BCSA Sustainability Manager. ■

References

[1] *New Steel Construction* (NSC) April 2021

[2] RICS *Whole life carbon assessment for the built environment*. 2nd edition, Version 2, November 2023.

[3] IStructE *How to calculate embodied carbon*. 2nd edition, 2022.

[4] British Steel *EPD for steel rails and sections*, 2020.

Rugby scores with steel

Steelwork's speed of construction is ensuring the third phase at Symmetry Park Rugby, an important addition to the East Midlands' logistics park portfolio, will complete on time.

Forming part of the wider South West Rugby Urban Extension, the third phase of a large logistics park is under construction by developer Tritax Symmetry.

Known as Symmetry Park Rugby, it is situated on the M45/A45 and also in the heart of the so-called logistics 'Golden Triangle' network, an established distribution and manufacturing area of the East Midlands.

Demand remains high for warehousing and the sector is having another fruitful year. This applies not just to the East Midlands, but throughout the UK, as there are numerous schemes currently under construction and many more in the offing.

Otherwise known as the single-storey non-domestic building market (sheds), structural steelwork remains the framing material of choice for the sector.

Traditionally, steelwork has had a market share of more than 90%, proving that developers and contractors alike, rely on the material's speed and flexibility to form these large long-span structures efficiently and on time.

Highlighting the speed of construction that structural steelwork can help a project achieve, phase three at Symmetry Park Rugby started onsite in November 2023 and will complete in just 34 weeks.

Working on behalf of main contractor Winvic Construction, Caunton Engineering is designing, fabricating, supplying and erecting 3,200t of steelwork for this phase.

Aiming to achieve BREEAM 'Excellent' and EPC A+ ratings, the phase consists of three speculatively-built warehouses. They are an addition to the development's four existing units (all built by Winvic, with two erected by Caunton), which were completed between December 2023 and February 2024.

Like the majority of logistics parks, this project is located on a greenfield site, which required an extensive earthworks programme in order to prepare each plot for the steel frame erection. This involved a large-scale cut and fill operation that created the plateaus for the warehouse structures, good yards and car parks.

"We had a lot of rain during the winter that made the ground conditions, which are mix of clay and pockets of running sand, very challenging," says Winvic Construction Project Manager Charlie Caldicott.

"An extensive dewatering programme was required before we could install the deep drainage works for each unit."

Ground improvement was also undertaken, before a series of mesh reinforced concrete pad foundations were installed to support the steel frames.

Working in a sequential manner, the steel erection programme commenced with Unit 5, the largest warehouse in the phase. A week later, a second erection team started on the adjacent Unit 6. Once this initial warehouse is complete, this erection team will move across the site and begin working on the Unit 7, the smallest of the three structures.

Each of the three units is a steel portal frame, with perimeter columns spaced at regular 8m intervals and with a hit-and-miss internal column configuration. A tried and tested format, this is considered to be the most efficient design for warehouse structures requiring long-span column-free interiors.

Reaching a height of 17m to the underside of the haunch, Unit 5 is the tallest and largest of the new structures. It is a 36,296m² warehouse, measuring 240m-long x 144m-wide. The warehouse has four

FACT FILE
Symmetry Park, Rugby
Main client: **Tritax Symmetry**
Architect: **Stephen George Partners**
Main contractor: **Winvic Construction**
Structural engineer: **Tier**
Steelwork contractor: **Caunton Engineering**
Steel tonnage: **3,200t**

How the completed phase three will look.

Each of the three units has an internal two-storey office.

Steelwork erection progresses on the first two units.

36m-wide spans, each supporting a curved barrel-vault roof.

Preferred to the more commonly used pitched design, an architectural and client driven decision resulted in this type of roof featuring on all of the units.

The roofs are formed with three separate rafters, brought to site individually and spliced together on the ground before being lifted into place as a complete span. The centre rafter is horizontal and the two outer members are slightly cranked, which along with the purlin cleats being placed at different heights, supports the cladding to create a curved barrel-vault design.

The complete roof rafters typically weigh 2.8t each and are erected using two 70t-capacity mobile cranes.

Overall, the heaviest steel elements for Unit 5, are a series of 19.9m-tall columns, positioned at the gable ends and weighing 3t each. On the other two units, these columns are slightly smaller, measuring 17.5m-tall and weighing 2.5t.

An identical roof erection procedure will be carried out on Unit 6 and 7. These buildings measure 251m-long × 118m-wide and 168m-long × 89m-wide respectively. The former has four 29.5m-wide spans and the latter three 29.6m-wide spans.

Two-storey internal offices are located at the northern end of each unit, differing in size from 1,645m² in Unit 5 to 897m² in Unit 7.

"The steel programme began with the offices on each structure, with the erectors then working their way down the units in a southerly direction," explains Mr Caldicott.

"Our critical path dictated this, as we have far more fit-out work to complete in the offices and so they need to be erected first."

Precast cores provide lift and staircase access to the office upper levels. The floors are formed with steel beams that support metal decking and a concrete topping to create a composite flooring solution. The offices also have a compositely formed internal roof, designed with an office imposed load, they provide the flexibility for more useable space if tenants require it.

As well as the internal office space, Units 5 and 6 also have a connected external two-storey 374m² hub office. Other notable features consist of 36 docks and four loading doors in Unit 5, 30 docks and four loading doors in Unit 6, and 20 docks and two loading doors in Unit 7.

Summing up, Tritax Symmetry Development Director Joseph Skinner, says: "The current market demand in this strategic industrial location remains extremely robust. These buildings are being built to an extremely high specification and will attract sophisticated occupiers who are looking for an exceptional build in a well-connected location."

Portfolio Holder at Rugby Borough Council, Ian Picker, adds: "Tritax Symmetry is creating more highly sustainable space for business, which is excellent news for the Borough. We look forward to welcoming more organisations to the area." ■

Warehouse flexibility

Speed of construction and the ability to create efficient column-free spaces were two of the reasons why a warehouse scheme in north London chose a steel-framed solution

The narrower warehouse structure will accommodate four units.

Whether it's the speed and ease of construction or the long-span flexibility the material can efficiently provide, structural steelwork continues to be the framing solution of choice for industrial and logistics warehouses in the UK and Ireland.

Traditionally, steelwork has dominated the single storey non-domestic building (warehouses) market and during 2023 it had an impressive 94.6% market share.

According to the annual survey commissioned by Steel for Life and the British Constructional Steelwork Association, and conducted by independent market research consultants Construction Markets, this important sector accounts for almost 50% of the overall UK structural steelwork market by tonnage.

Attributes such as cost-effectiveness, adaptability and its contribution to the circular economy through reuse and recycling are all factors that continue to be valued by developers, contractors, designers and building users alike, making steelwork the go-to material for warehouses.

All of these factors have come to the fore on a project in north London, where Wilten Construction, working on behalf of Graftongate and Paloma Capital, is building seven speculative industrial warehouse units, which are aiming to achieve a BREEAM 'Excellent' rating.

Visualisation of the completed project.

Paloma Capital Director Charles Lunnon, says: "Warehousing remains the most attractive mainstream UK real estate sector and inner London has the greatest disconnect between supply and demand. This project presents a very rare opportunity to develop a high-quality logistics scheme to address demand."

Graftongate Development Manager Alex Thomason, adds: "Urban Logistics Tottenham will deliver first class logistics accommodation in a strategic location with exceptional transport links."

The site is a 30 minutes-drive time from central London and situated on the edge of the major regeneration scheme at Meridian water. It has direct access to the A406 North Circular and easy access to junction 25 of the M25.

Explaining the choice of steelwork, Wilten Construction Project Manager Mick Callcott, says: "We could have designed and built these units in another material, but using anything other than steel wouldn't be cost-effective."

"The construction programme for this scheme is 42 weeks and we could not achieve this without using a steel-framed solution."

FACT FILE
Urban Logistics Tottenham, London
Main Client: **Graftongate and Paloma Capital**
Architect: **Michael Sparks Associates**
Main contractor: **Wilten Construction**
Structural engineer: **PRP UK**
Steelwork contractor: **Adstone Construction**
Steel tonnage: **300t**

"The construction programme for this scheme is 42 weeks and we could not achieve this without using a steel-framed solution."

With a width of 28m, the larger warehouse structure was the first building to be erected.

Starting onsite in October 2023, Wilten Construction initially had to prepare the brownfield site, before the steel-framed structures could be erected.

Over the years, the site has had a number of uses, mostly industrial, and so a number of old buildings had to be demolished. Interestingly, a long-forgotten World War Two air raid bunker was discovered under part of the plot. This concrete structure had to be broken-out before the site was vibro-compacted and the foundations installed.

Supported on 2m-deep pads, the steelwork erection programme was completed in eight weeks. Adstone Construction fabricated, supplied and erected 300t of steelwork for the project.

Totalling approximately 5,570m², the seven warehouse units are arranged within two portal-framed structures, one housing three spaces and the other building accommodating four.

A steel frame design allows for considerable flexibility and this scheme is no exception. Although both buildings have provision for internal partition walls to be included, if there is a tenant requirement for a larger unit size, the walls can be omitted, without any adverse effect to the overall steel frame.

"Internal columns that support the partition walls can be removed to create larger units, as they are not structurally integral to the buildings," explains PRP UK Director Himanshu Patel.

Although they have different widths, both buildings are 81m-long structures. The first building to be erected was the larger 28m-wide structure that accommodates three units.

Its all-important internal column-free space is created by a series of 28m-long rafters that also form the duo pitched roof. Brought to site in halves, the rafters were assembled on the ground before the complete sections were lifted into place using a 50t-capacity mobile crane.

Operating within the footprint of each building, as the site is confined and space is at a premium, the same crane erected all of the project's steelwork.

The other building (accommodating units 4, 5, 6 and 7) has a similar portal-framed design, but is slightly narrower at 22m-wide. In a similar procedure to the first building, a series of rafters were again brought site in halves and spliced together before being erected as completed sections to create the open-plan internal space.

The smaller building originally had the same roof design as the other structure, but it now has a mono-pitched roof, that slopes down towards the rear of the structure. A planning requirement wanted this design alteration, in order to reduce the height of the structure that is nearest the residential properties, located close by.

Internally, both buildings feature a 4m-wide mezzanine level, offering office and additional warehouse space for each of the seven units. The raised levels are compositely formed, with steel beams supporting metal decking and a concrete topping.

Access to the office spaces is provided by stairs situated within precast concrete cores, while internal steel staircases serve the upper warehouse areas. Offices in units 1 and 3 are also served by lifts, while all of the other unit's mezzanines have provision for lifts to be installed if required.

The seven units are due to be complete and ready for occupation in August 2024. ■

Steelwork completes full circle

A 15-storey steel-framed speculative office block represents the final piece of Manchester's multi-million-pound Circle Square development.

FACT FILE
No. 3 Circle Square, Manchester
Main client: **Bruntwood SciTech**
Architect: **Bridge Architects**
Main contractor: **GMI Construction**
Structural engineer: **Curtins**
Steelwork contractor: **Billington Structures**

A sought-after new city centre neighbourhood in Manchester, known as Circle Square, is nearing completion as the steel frame for the final commercial scheme has now been completed.

The £750M mixed-use development offers office space, retail outlets, serviced apartments and private residential accommodation as well as a large centrally-positioned public space, known as Symphony Park.

The plot, which is close to Oxford Road station, was once the home of BBC North West, a facility which hosted the filming of many TV favourites, such as Question of Sport and Mastermind.

Today, the site is aligned with the wider Oxford Road Corridor Innovation District, which is already recognised as a leading European home for technology and research-based companies. Businesses based at Circle Square benefit from being part of this growing tech community as well as the city's extensive network of higher education institutions, including the University of Manchester and Manchester Metropolitan University.

Known as No. 3 Circle Square, this is the fourth large steel-framed structure to be built for the scheme, following on from office buildings 2 and 4 and the 1,031-space multi-storey car park (see *NSC* June 2019).

Commenting on this latest scheme, Bruntwood SciTech Managing Director Tom Renn, says: "The demand for workspace from science and tech businesses is undiminished and, as a result, this building, along with the wider Circle Square development, will play a significant role in cementing Manchester as one of Europe's top 20 digital cities."

Targeting BREEAM 'Excellent' and EPC A ratings, sustainability is said to be at the heart of No.3 Circle Square's design. Helping to reduce the embedded carbon of the project, much of the steelwork was sourced, by Billington Structures, from Electric Arc Furnace (EAF) production facilities.

Bruntwood SciTech was keen from the outset of the design process to have a significant recycled steel content within the building's frame.

Using 100% recycled steel, instead of iron ore, EAF production is also considered to be much greener and more efficient in terms of energy consumption.

Once complete, the building will benefit from an all-electric heating and cooling system with state-of-the-art air source heat pumps, as well as smart metering, roof mounted solar panels, a smart BMS and local MVHR units to maximise efficiency and fresh air control to occupants.

"As well as offering sustainability benefits, the structure was always going to be a steel-framed building, as the material offered the quickest programme and the best way of forming the desired

Aiming to achieve a BREEAM 'Excellent' rating, sustainability is at the heart of the building's design.

"The structure was always going to be a steel-framed building, as the material offered the quickest programme and the best way of forming the desired long internal spans."

The office block benefits from its close proximity to the previously completed steel-framed multi-storey car park.

long internal spans," says Curtins Director David Sandbrook.

Using the site's two tower cranes for all lifting duties, the steel frame was erected quickly and efficiently. The erection was carried out in a sequential programme, three floors at a time.

"For the erection of the lower floors, we were able to use some of our largest MEWPs positioned at ground level," explains Billington Structures Project Manager Russell Davies. "Further up the building, the sequential programme gave us the benefit of allowing our smaller MEWPs to be landed on the ENP-nailed decked floors."

Creating the desired open-plan floorplates, the steel frame has perimeter columns spaced at up to 7.5m centres, while internally there are spans of up to 15.5m long. Helping to create these long spans and maximise the office floorplates, the concrete core, which provides the stability for the steel frame, is offset and located along the southern elevation, instead of having a traditional central position within the building.

Supported on piled foundations, which are up to 14m-deep, the steelwork starts at ground level as the building has no basement. The ground floor is a double-height space with a 6m floor-to-ceiling height. It accommodates a mezzanine, covering roughly half of the structure's footprint and the reception lobby.

Located on the north-west corner of the building and directly opposite the development's centrepiece green space (Symphony Park), the main entrance is framed by two V-shaped columns. Extending to the underside of the first floor, these feature elements divert the loads from above and allow the entrance to be column-free.

This latest addition to the Circle Square neighbourhood will pay tribute to Manchester's Victorian and Edwardian architecture. To this end, the building will feature high quality and traditional red brick façades for the upper levels. The ground floor will have brick arches, a similar design to the adjacent multi-storey car park. The arches will be formed with precast units that will connect to brackets that have been shop welded to the ground floor columns.

Internally, the steel frame consists of cellular beams that accommodate the building's services within their depth, and support metal decking and a concrete topping for a composite flooring solution.

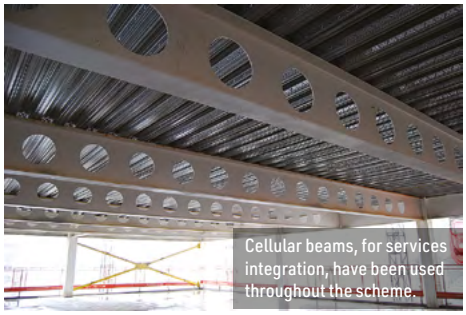
Specialist firm, SMD supplied and installed 31,105m² of metal decking, which required 86,000 shear studs.

Working on behalf of main contractor GMI Construction, Billington Structures fabricated the project's bespoke cellular beams from UB sections for the majority of the floors. The exception was the building's uppermost two levels that have been designed to incorporate a communal lounge, event space and two roof terraces, at either end of the building. Because these features impose additional loadings, plate girders have been used for these floors.

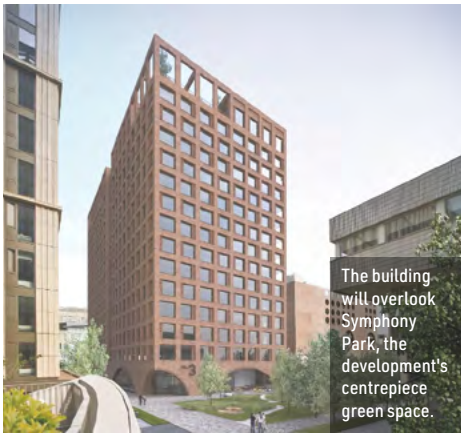
Summing up, Bruntwood SciTech Commercial Director Bradley Topps, says: "Our goal for Circle Square has always been to provide the perfect synergy between sustainable, high-quality workspaces and first-class amenities, and this latest development is in keeping with that ethos.

"Bolstering the digital ecosystem within the Oxford Road Corridor, the building will add vital capacity to Manchester's knowledge economy and showcase the wider region as a diverse international base for innovative science and tech firms to thrive."

No. 3 Circle Square is due to be complete in early 2025. ■



Cellular beams, for services integration, have been used throughout the scheme.



The building will overlook Symphony Park, the development's centrepiece green space.

Ground floor arches will be formed with panels supported by steel brackets.

FACT FILE
Office tower redevelopment, Canary Wharf, London
Architect: **WilkinsonEyre**
Main contractor: **Overbury**
Structural engineer: **HDR**
Steelwork contractor: **Bourne Steel**
Steel tonnage: **1,700t**

Steel refurb creates modern workspaces

New steelwork elements are helping to strengthen an existing frame, while also creating reconfigured floorplates for an extensive refurbishment project on a 42-storey office tower.

When it comes to refurbishment projects, they don't come any bigger or taller than the ongoing reimagining of an iconic office tower in London's Canary Wharf financial district.

Completed in 2001, the 42-storey steel-framed office block, which was the capital's second tallest building for a time, is being transformed into a workspace for the future, incorporating some of the highest standards of environmental design.

It is being refurbished to reflect the changing nature of work, with greater emphasis on shared spaces where colleagues can come together. The new design aims to maximise collaborative work spaces, supported by technology, to enable people to work flexibly and with maximum agility.

Work on the building involves reconfiguring nearly every floor of the steel-framed structure and one of the major aspects includes creating openings in the floorplates, which will link them into a series of 'workplace villages' or hubs.

The openings vary in width and are up to three-storeys deep. They will accommodate new staircases, to allow people to move between floors without using existing lifts.

WilkinsonEyre Director Yasmin Al Ani, says: "By opening up the existing slabs we are creating more generous volumes, dissolving segregation between floors and promoting more human interaction.

"Adding staircases encourages active circulation – in line with wellness principles – and reduces dependency on the existing infrastructure, avoiding a presumed need to add in new shafts."

But why refurbish the building? Why not start afresh with a completely new structure?

Discounting the fact that a large-scale demolition project in the heart of busy Canary Wharf would throw-up a host of challenges, the answer to both of those questions is simple and all about the environmental impact. The decision to refurbish and not demolish the tower is expected to save the release of an estimated 100,000 tonnes of embodied carbon, which is said to be the equivalent of running almost 22,000 cars for a year.

The project's environmental credentials are also being improved by updating the building's infrastructure and implementing efficiency measures to minimise electricity consumption and reduce water usage by 20%.

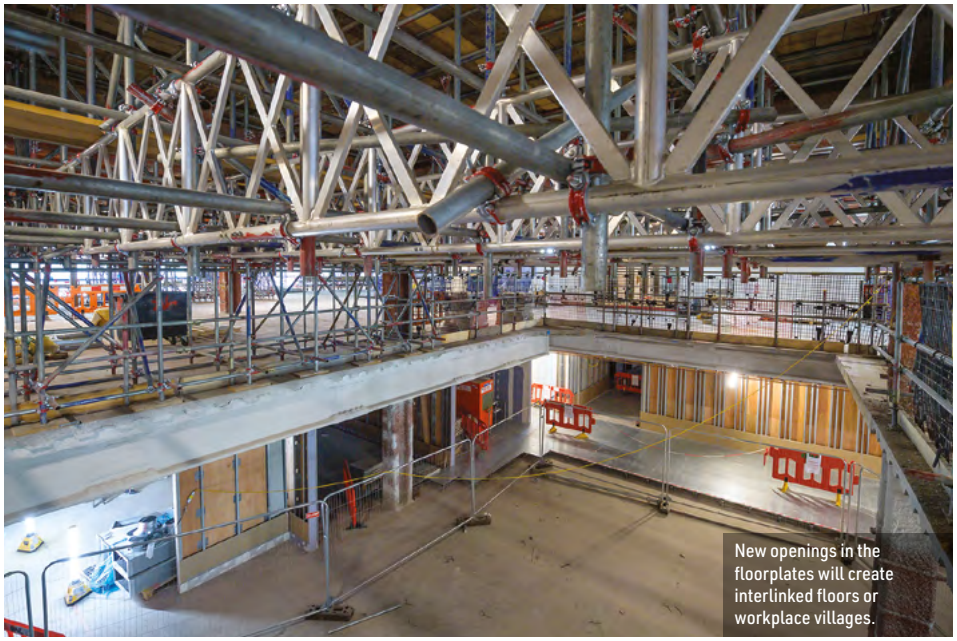
As the existing building is a steel-frame supporting a composite metal decked flooring solution, the use of structural steelwork for the refurbishment's alterations was an obvious choice.

Working on behalf of main contractor Overbury, Bourne Steel is fabricating, supplying and erecting 1,700t of structural steelwork for the project.

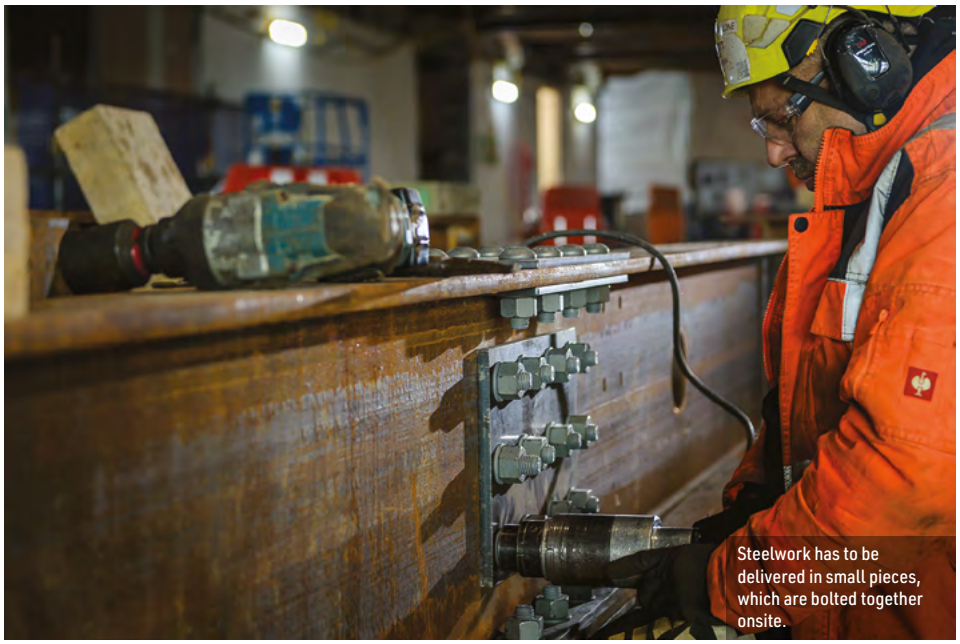
As the job has no tower crane, getting material onto the site and then to the correct floor is one of

A large refurbishment programme allows the project to gain a number of sustainability benefits.

Two of the many new steel beams to be installed inside the building.



New openings in the floorplates will create interlinked floors or workplace villages.



Steelwork has to be delivered in small pieces, which are bolted together onsite.

the main challenges for the scheme.

Bourne Steel Project Director Ian Sherry, explains: "Everything has to be transported up and down the building via an internal goods lift and so steelwork needs to fit and is delivered in 3m-long lengths."

"Consequently, we have a lot of steel sections arriving to site and then numerous bolted connections to make, as the beams that surround the openings are all more than 14m-long."

Following on behind the subcontractor responsible for cutting the openings into the existing slab, framing the voids with steel beams is one of the main elements of Bourne Steel's programme.

This cut and carve process required a lot of pre-planning for the designers as HDR Technical Director Thanos Tserkezis, explains: "With multiple openings on the majority of the floorplates, the steel frame losses robustness against sway.

"To combat this, we made use of the original structural drawings to build a new model via a software package that helped us identify areas ▸20

"Everything has to be transported up and down the building via an internal goods lift and so steelwork needs to fit and is delivered in 3m-long lengths."

A large beam, formed with three spliced sections, awaits to be installed.

▸19 of the steelwork that needed to be strengthened."

The strengthening of the frame has required steel plates, up to 100mm-thick and 900mm-wide, to be welded to the underside of existing beams. In some locations, a different approach is being undertaken, whereby the entire beam is removed and a new steel section installed in its place.

The plates can weigh up 2t each, and in a similar scenario to the rest of the steel package they must also be no more than 3m long.

With no available craneage, as all of the work is being undertaken indoors, manoeuvring and lifting large pieces of steelwork is another challenge for the steelwork team.

Getting steelwork in and out of the goods lift and then into position for lifting is being done with trolleys and small MEWPs. Bourne Steel has manufactured a bespoke lifting frame, assembled onsite - as the complete item would not fit into the goods lift - it is being used to erect steel beams and plates in conjunction with block and tackle.

As well as the structural openings, there are three other significant aspects to the refurbishment scheme, which new steelwork is helping to create. These consist of an atrium at level two, a winter garden between levels 17 and 20 and an internal garden at floors 41 and 42.

Planned to be one of the last areas to be completed, the atrium will require some considerable structural alterations, as the building's second floor slab will have to be partially removed to create the first-floor double height space.

"The remaining steel columns will need to be strengthened with 75mm-thick plates, as without the slab they will have less restraint, while still needing to support the 40 floors above," says Mr Tserkezis.

Towards the middle of the building, the winter garden will also require existing steel columns on the levels below (which are plant areas on floors 15 and 16) to be strengthened. The loading profile in this area will change as large planters will be added to these floors, exerting some significant forces.

As well as perimeter glazing, the winter garden will be separated from offices by a secondary internal glazing system. A lot of design work has gone into this area, to cater for the tight deflections from the two glazed areas. A design solution of hanging steel new beams from level 18, via a series of Macalloy bars will be employed.

Finally, at the top of the tower, an internal garden is being formed by infilling under-used terraces at level 41. By continuing the steel frame above these set-backs, an extra 7m-wide bay will be created, allowing more space for the garden area.

Some major structural alterations will also be required at level 42. As the glazing line will be moved back, some columns will be removed and replaced by new columns at the perimeter. Transfer beams will then need to be inserted, to carry the loads from above – there are two levels of plant deck on the roof – and this work will need large amount of temporary works to be installed.

The steelwork package will be completed in early 2025, and the entire refurbishment is expected to be finished later in the same year. ■

Strengthening existing steel structures

A tower block in Canary Wharf offers an extraordinary demonstration of how steel structures can be strengthened and adapted. David Brown of the SCI considers some of the issues.

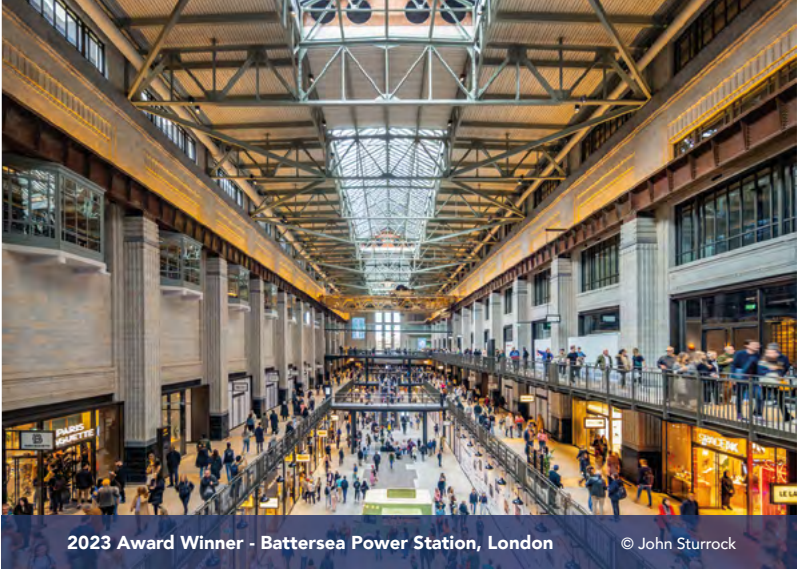
In today's world of minimising embodied carbon, strengthening and refurbishing an existing structure ticks all the correct boxes. The project also demonstrates that strengthening, though possible, is far from challenge-free. The maximum element length of 3m meant that members must be spliced – and to avoid unwelcome slip at the joints, the splices were completed with preloaded assemblies.

Joint designers should note that to achieve the highest slip coefficient (and thus reduce the number of bolts) the faying surfaces are shot blasted and masked – and must remain like that until assembly on site. Paint or other contamination will reduce the slip coefficient and must be avoided. Non-slip joints completed with pre-loaded assemblies are expensive – but necessary when slip is unwelcome. No one wants a beam comprised of three elements spliced together to look like a faceted member.

Splice design to BS EN 1993-1-8 has modified previous UK practice. According to the Eurocode, the web connection must be designed for the proportion of the moment that is carried by the web – even if it had been assumed that all the moment at the joint is carried by the flanges. The result is that web connections will perhaps be larger than traditionally expected – more bolts and larger plates.

This project also shows just what can be done with onsite welding, with careful thought. It may be straightforward to determine the required size of the strengthening plate, but moving a 100mm thick plate into position, holding it there and welding – to an existing beam – requires thought. The Responsible Welding Coordinator (RWC) has a key role here, to ensure the welds are completed without defect. Longitudinal welds between elements of a compound section are generally quite small, (designers will remember SAY/It) but even a small weld on a thick plate can be challenging because of the heat sink effect. If the heat can dissipate through the 100mm plate in both directions away from the weld, and into the member to be strengthened, the combined thickness is over 200mm. In these circumstances the experience and knowledge of the RWC is essential to prepare appropriate welding procedure specifications.

Finally, the Canary Wharf project utilised double angle cleats for at least some of the connections to the existing steelwork. Even though angle cleats were not included in the Eurocode "Green Book", they certainly have their place as a nominally pinned connection that offers some useful adjustment when connecting to existing frames. ■



2023 Award Winner - Battersea Power Station, London © John Sturrock

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Win two tickets to this years prestigious BCSA Structural Steel Design Awards

2023 Award Winner - One Centenary Way, Birmingham © Greg Holmes

2023 Award Winner - Stockingfield Bridge, Glasgow

A lucky respondent to our New Steel Construction (NSC) Reader Survey can win two tickets to the Structural Steel Design Awards event in London on 26 September 2024.

Simply scan the QR code to take part in the NSC survey and share your views about what you think we are getting right, and how you think NSC could be improved.

The BCSA is exploring whether you would like to continue receiving the NSC by post or join other sustainability-conscious readers in accessing it digitally via email. Your feedback and new ideas are welcome.

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Terms and conditions of the competition can be found at https://bcsa.org.uk/news/

FACT FILE
Woolwich Leisure Centre, London
Main client: **Royal Borough of Greenwich**
Architect: **FaulknerBrowns Architects**
Main contractor: **Morgan Sindall Construction**
Structural engineer: **Buro Happold**
Steelwork contractor: **Elland Steel Structures**
Steel tonnage: **1,650t**

Leisure centre stacks up

The leisure centre is part of a wider town centre development that also includes residential properties and shops.

Aiming to achieve a BREEAM 'Outstanding' rating and set to be one of the UK's largest urban facilities, structural steelwork has provided the Woolwich Leisure Centre with the required efficient column-free design.

Located within the Royal Borough of Greenwich, Woolwich has seen many changes over the years. Once renowned for its naval dockyard and the armaments produced at the Royal Arsenal (an establishment that also gave rise to the Premier League football team), this part of south-east London, like many other parts of the UK, has had to diversify as traditional industries have either closed down or moved elsewhere.

Numerous residential schemes have sprung up along the River Thames, on land once occupied by the naval yard, while a similar trend is now taking place in the town centre.

Sitting adjacent to Woolwich Arsenal railway station, 482 new homes are to be built, alongside shops, workspaces and a new community square. Anchoring this scheme and fronting General Gordon Square, a new exemplar leisure centre is under construction.

Four 25m-long girders span the main pool and support a second floor sports hall.

A major part of the wider regeneration of the town centre, the Woolwich Leisure Centre will attract visitors, create jobs, boost the local economy, while also providing an invaluable asset to local residents by encouraging them to be more active.

As with many town or city centre projects, space is at a premium on this job and so a stacked design has been chosen. In this way, the steel-framed 12,800m² centre is able to accommodate three floors of facilities within a relatively confined area.

The leisure centre's array of facilities will include a 25m, eight lane swimming pool; leisure pool with flumes and splash pad; a teaching/training pool; a spa; a six-court sports hall; a five-a-side football pitch; a two-level gymnasium; dance and spinning studios, and two squash courts.

The centre will also feature flexible and accessible community spaces, along with a commercial café, creche, and soft play area as well as two studios that will be linked to the neighbouring Tramshed theatre and community arts hub.

This type of stacked design is not uncommon, as main contractor Morgan Sindall Construction, alongside architect FaulknerBrowns and engineer Buro Happold have all previously worked on a similar leisure centre scheme in Hackney (see NSC April 2020).

Although the Woolwich project has its own unique challenges, many lessons have been taken on board from the previous job.

"The leisure centre requires long unsupported spans to provide large floor plates for the swimming pools, sports hall, fitness centre etc. The complexity increases when you undertake a stacked centre,

where vibration is a main consideration due to the dynamic load imposed on the spans from above," says Morgan Sindall Construction Senior Project Manager Mike Perera.

With so many different long-span areas to accommodate, a steel frame supporting precast flooring planks has been chosen as the best method to create these spaces, and dampen any potential vibration issues between the various areas of the building.

"With the use of vibration analysis software, we determined the structure's unique deflection and dynamics in order to optimise each steel member," explains Buro Happold Engineer Hannah Greene.

Approximately 50% of the frame's steel columns are founded at basement level. The subterranean level was dug out and formed following a demolition programme that removed the site's previous retail buildings.

The 1,800m² basement will accommodate some vital components, such as a substation; a plant room for the pools; filtration tanks, and an energy centre that will not only provide heat for the leisure centre, but also the adjacent Tramshed theatre and the residential scheme.

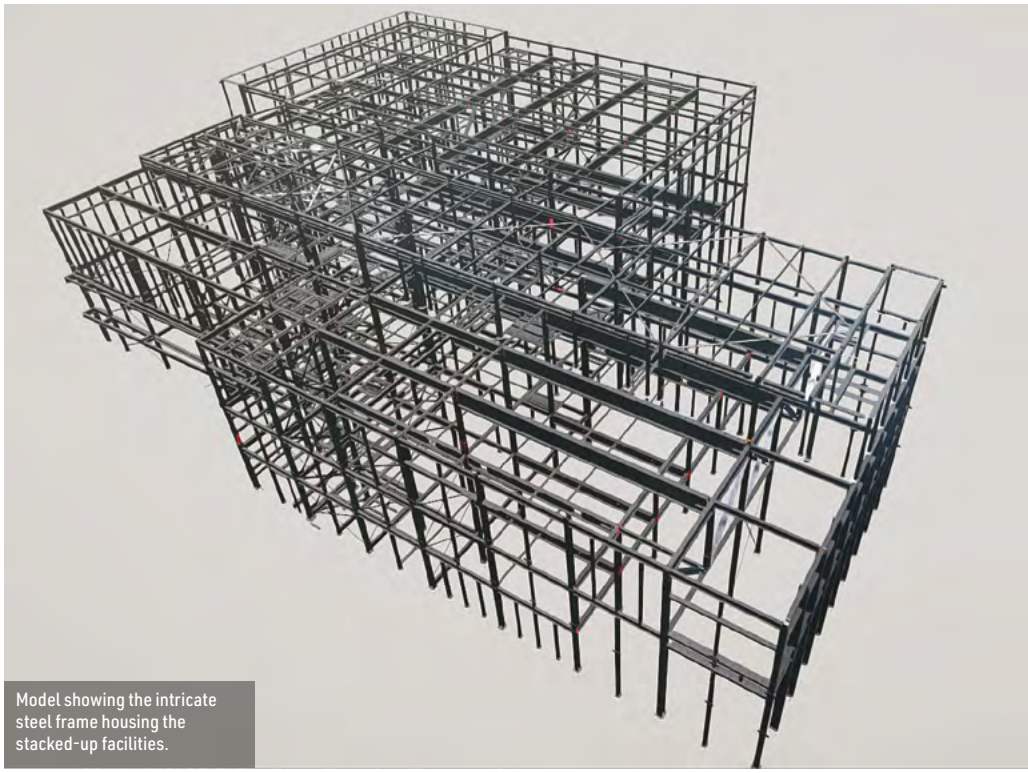
As well as constructing the basement and installing the foundations, the concrete works to form the pools were also completed prior to the steelwork erection kicking off.

The pools and changing rooms occupy the ground floor of the centre behind the main entrance. Consequently, there are a number of large steel elements spanning the necessary column-free aquatic zones and supporting the remaining facilities, which are located on the first and second floors.

Over the top of the main pool are a series of four 25m-long × 1.8m-deep plate girders, each weighing 29t. As well as creating the important double-height column-free pool environment, these large steel elements also support the perimeter columns that form the second-floor sports hall.

"The majority of the steelwork was erected via the site's two tower cranes, but we had to use a mobile crane to install these large plate girders," says Elland Steel Structures (ESS) Director Andrew Sutcliffe.

Similarly, the adjacent training pool is spanned by a series of 14m-long × 1m-deep beams that support the column line for first-floor fitness suite.



Model showing the intricate steel frame housing the stacked-up facilities.

Helping to absorb the loadings from the various spaces within the structure is a large storey-high truss, positioned within the middle of the building.

The longest steelwork element on the project, this truss is 32m-long × 7.4m-high. Following a trial erection at the ESS fabrication yard – conducted to make sure it fitted together perfectly - it was brought to site in a number of pieces and erected using one of the tower cranes. Because of the size, two temporary columns, located beneath its length, had to be installed during the erection process.

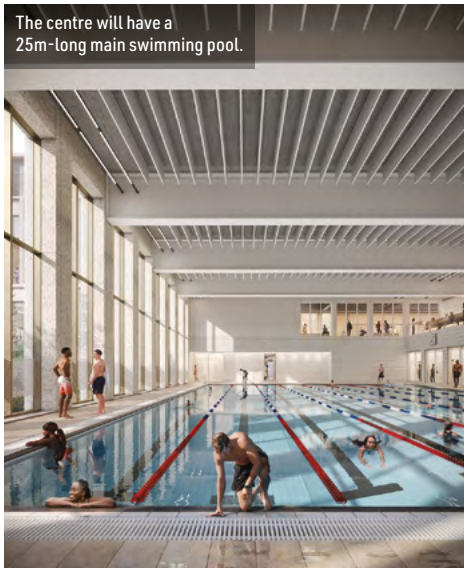
Possibly, one of the leisure centre's main attractions is the leisure pool, which is located on the ground floor, at the rear of the building. Standing in a 14m-high double-height space, two 457mm-diameter CHS columns support – via more than 90 cleats - the facilities two flumes, which have a combined length of 105m.

Adding some complexity to the project's stacked design, is a five-a-side football pitch. Unlike a traditional facility where it would be located outside, the Woolwich Leisure Centre has an indoor pitch. Located at first floor level, it is positioned above the leisure pool and spa, and supported by a series of 30m-long beams and a Vierendeel truss.

Finally, topping the building, the rooftop will carry a planted green roof and 1,700m² of photovoltaic (PV) panels to generate sustainable power for the leisure centre. Adding to its sustainable credentials, the project is targeting a BREEAM 'Outstanding' rating, which will make it only the second leisure centre in the country to attain this standard.

The Woolwich Leisure Centre is due to open in October 2025. ■

A drone video of the Woolwich Leisure Centre site, during the early stages of construction, is available to readers of the digital version of NSC and on the NSC website.



The centre will have a 25m-long main swimming pool.

A pool viewing gallery will be located at first floor.

Design of End-Posts to BS EN 1993-1-13: Beams with Large Web Openings

In a first article last month, Mark Lawson of the Steel Construction Institute presented an outline of the new BS EN 1993-1-13. This second article presents results of tests on end-posts in cellular beams at City, University of London.

In the recently published BS EN 1993-1-13 Beams with large web openings, a new method is given for the design of end-posts, which is the part of the web next to an end connection. This was missing in previous guidance to SCI P355. Often, it is necessary to introduce a half or full infill plate next to the connection to satisfy the dimensional limits and to achieve the required design shear resistance.

Two generic connection types may be considered:

- Bolted shear connections to the beam web either by fin plates or angles.
- Welded end-plate connections in which the end-plate is either connected only to the beam web (partial depth end-plate) or also to the flanges (full depth end-plate)

For end-plate connections, the end-plate strengthens the end-post in horizontal shear and bending, and also partly stabilises the end-post against buckling. Conversely, bolted fin-plate or angle connections lead to a reduction in the shear and bending resistance at the line of the bolt holes and may provide less restraint to end-post buckling.

The design method for end-post buckling given in BS EN 1993-1-13 was compared to the results of tests on cellular beams at City, University of London reported by Tsavdaridis et al. (2024). The tests were on symmetric cellular beam sections with various end-post details and the two connection types noted above.

Buckling of the end-post to BS EN1993-1-13

The design method for buckling of end-posts in EN1993-1-13 is based on an adaptation of the web-post buckling model. This strut action in the end-post is shown in Figure 1. The compression force, $N_{ep,Ed}$, acting on the strut is taken as equal to the shear force in the top Tee, which is $N_{ep,Ed} = 0.5V_{Ed}$ for a symmetric section, and the effective width of the equivalent strut is taken as $b_{eff} = 0.5s_e$, where s_e is the end-post width.

The minimum width of the end-post is given as $s_e \le 0.25a_o$ in the case of an adjacent circular opening of diameter, a_o, and $s_e \le 0.5a_o$ for an adjacent rectangular opening of length, a_o.

For an end-post next to a circular opening, the effective length of the equivalent strut is taken as the diagonal distance over half of the end-post width and half of the opening depth. The end-post relative slenderness is:

$$\bar{\lambda}_{ep} = 1.75\frac{(s_e^2 + a_o^2)^{0.5}}{t_w\lambda_1} \le \frac{2.45a_o}{t_w\lambda_1}$$

where $\lambda_1 = 3.14\,(E/f_y)^{0.5}$

The buckling resistance of the end-post is obtained from buckling curve 'a' to EN1993-1-1.

Modifications to this equation are given an end-post partly stabilised by a full depth end-plate connection, and for an end-post with notches. No guidance is given in EN 1993-1-13 for the use of half or full infill plates to form part of the end-post, although in principle the same theory may be used by replacing t_w by t_i where t_i is the thickness of the infill plate if this is thinner.

The buckling resistance of the end-post should exceed the compression force transferred from shear in the top Tee, which for a symmetric section is given by:

$$N_{ep,b,Rd} = \chi_{ep}0.5s_et_wf_y \ge 0.5\,V_{Ed}$$

Where χ_{ep} is the reduction factor due to buckling of the end-post using the relative slenderness in the above equation.

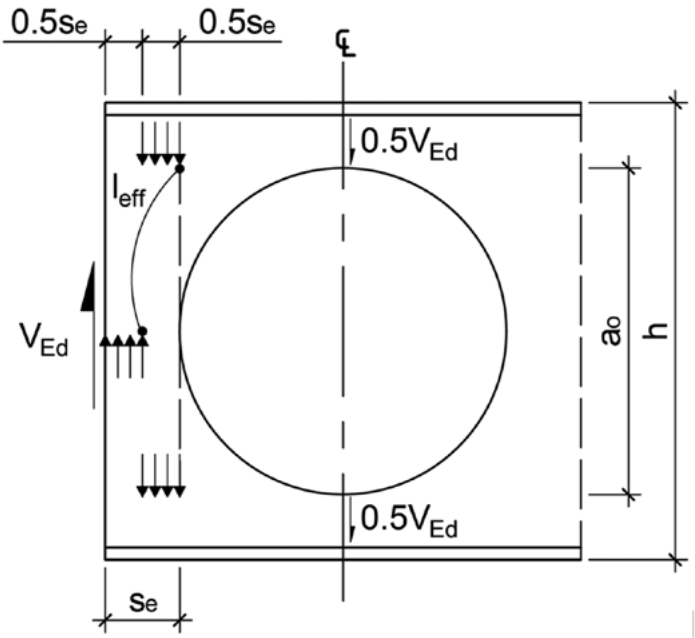


Figure 1 – Illustration of strut buckling model for an end-post in EN 1993-1-13

Example for a partial depth fin plate connection with s_e = 100mm and a_o = 400mm; t_w = 9.0mm; f_y = 355 N/mm²:

$\ell_{eff} = 0.5 \times (100^2+400^2)^{0.5} = 206$ mm

$\lambda_{ep} = 3.46 \times 206/ 9.0 = 79$

$\lambda_1 = 3.14 \times (210 \times 10^3/355)^{0.5} = 76$

$\lambda_{ep} = 79/76 = 1.04$

$\phi = 0.5 \times (1 + 0.21 \times (1.04 - 0.2) + 1.04^2) = 1.13$

$\chi_{ep} = [1.13 + (1.13^2 - 1.04^2)^{0.5}]^{-1} = 0.63$

Buckling resistance, $N_{b,Rd} = 0.63 \times 0.5s_et_wf_y = 0.63 \times 50 \times 9.0 \times 355 \times 10^{-3} = 100.6$ kN

For a symmetric section, it is required that $0.5V_{Ed} \le N_{ep,b,Rd}$, and so the maximum end shear force that may act at the connection is $V_{Ed} \le 201$ kN.

Comparison with tests on end-posts in cellular beams

A series of 3 cellular beams, each with two types of connections, was tested to compare with the design method for end-posts and these tests were reported by Tsavdaridis (2024). The test configuration is shown in Figure 2 (over page) and the details of the tests were:

- Cellular beams of h = 560mm depth using 406 × 178 × 67 kg/m UB sections.
- Opening diameter, a_o = 400mm (a_o = 0.71h).
- Beam span, L = 3.63m with jack loads applied at 0.82m from the supports.
- S355 nominal steel grade (measured as f_y = 393 N/mm²)
- Columns, 203 × 203 × 60 kg/m UC sections (1m high).

The two connection types were:

- End plate connections using a 12mm thick end plate with 2 × 4 no. M20 bolts to the column flange.
- Fin plate connection using a 12mm thick projecting welded plate of 440mm depth with 5 no M20 bolts to the beam web.

▸26

Better credentials, better contracts, better working

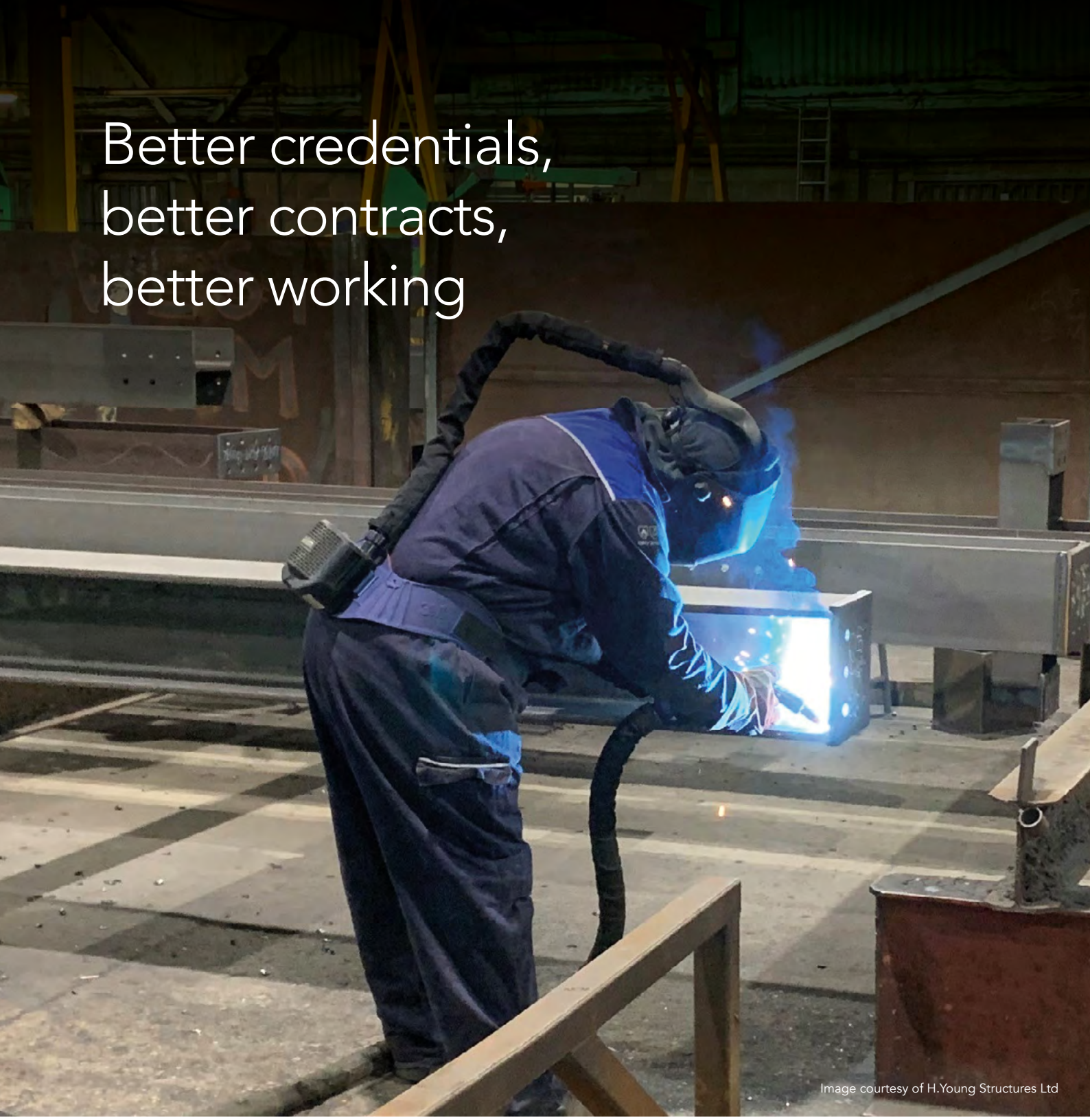


Image courtesy of H.Young Structures Ltd

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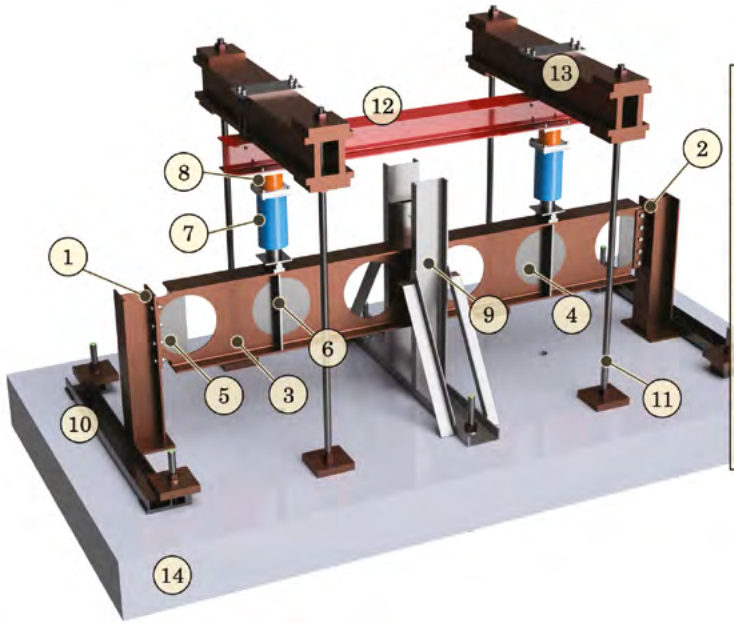

Figure 2 - Graphic of the loading system for the cellular beam tests (Tsavdaridis et al, 2024)

▸24 The three forms of end-post combined with the two connection types were:

- Narrow end-post of 90mm width ($s_e = 0.225a_o$).
- Narrow end-post with 90mm wide × 60mm deep notches to both flanges with a 20mm radius corner of the notch.
- End-post formed by 200mm wide half infill of 9mm measured thickness.

Full infills and web stiffeners were used at the loading positions.

The mode of failure of the narrow end-post next to the notched flange at a shear force of 298 kN is shown in Figure 3. The same beam with a half infill plate shown in Figure 4 failed at a shear force of 398 kN, in this case by buckling of the infill plate.

Test details	Connection type	Failure shear in test	End-post buckling to BS EN 1993-1-13	Mode of failure
90mm wide end-post	Fin plate	325 kN	188 kN	End-post bending
	Full depth end-plate	331 kN (+2%)	197 kN	Vierendeel bending at opening
90mm wide end-post with 90x60mm notches	Fin plate	279 kN	178 kN	Buckling at notch
	Partial depth end-plate	298 kN (+7%)	193 kN	Lateral movement of flange at notch
Half infill plate (200mm wide) with 90x60mm notches	Fin plate	398 kN	263 kN	Buckling of half infill plate
	Partial depth end-plate	417 kN (+5%)	279 kN	

Table 1 - Test shear failure loads of end-posts and comparison with the design predictions using the measured steel strength

Figure 3 - Buckling at narrow end post for the notched cellular beam

Figure 4 - Buckling of the half infill plate due to the transfer of shear from the top Tee

The test shear failure loads are presented in Table 1 in comparison to the prediction of the design to BS EN 1993-1-13 using measured material strengths. The ratio of the test failure shear to the design prediction was in the range of 1.54 to 1.73 for the four tests with narrow end posts. This shows that the proposed method is conservative, probably because of redistribution of shear forces from the compressed top Tee to the bottom Tee in tension after buckling at the notch had occurred.

For the test with half infill plates, the ratio of the failure load to the design prediction was 1.49 and 1.51 and shows that the model for buckling of the infill plate is reasonably accurate.

It is concluded that the design method for end -posts to BS EN 1993-1-13 is relatively conservative when applied to symmetric cellular beams and some improvements could be made based on a parametric study of various end-plate geometries. Based on the test results, the minimum width of an end-post in cellular beams may be potentially reduced to $0.2a_o$ as a Nationally Determined Parameter. ■

Acknowledgements

The tests were performed in the Heavy Structures Laboratory at City, University of London and the test work was sponsored by ASD Westok Ltd who also fabricated the test beams, columns and their connections.

References

Tsavdaridis, K.D., McKinley, B., Corfar, D-A, Lawson, R.M. (2024)
Cellular Beam End-posts with Two Connection Types, End Notches and Infill Plates. Journal of Constructional Steel Research, 215, article number 108547.

AD 530:
Countersunk head bolts

Countersunk head bolts may be manufactured with a slot (for a screwdriver), see Fig. 1, or a hexagonal socket (for an allen key driver), see Fig. 2. This AD is to advise that countersunk bolts with a hexagonal socket may have reduced tensile resistance due to the reduced section at the head-to-shank location and should be used with care.

This note only applies to non-preloaded countersunk head bolts. Countersunk head bolts used as a preloaded assembly are manufactured to BS EN 14399-7, have a screwdriver type slot and have full loadability. Preloaded countersunk head bolts to BS EN 14399-7 may be used without preloading.

Requirements for non-preloaded countersunk head bolts are specified in BS 4933. The Note to Table 8 of BS 4933:2010 permits the forming of a feature to prevent rotation at the choice of the manufacturer. The note goes on to state that the feature should not reduce the "loadability" of the fixing when subject to an axial tensile force. The note provides a forward reference to BS EN ISO 898 for further guidance.

BCSA produce a Model specification for the purchase of structural bolting assemblies and holding down bolts which currently (14th edition) requires that countersunk bolt assemblies subject to tensile loads, or combined shear and tensile loads should only be supplied with a screwdriver slot, unless an alternative can be demonstrated to not adversely affect the bolt loadability.

BS EN ISO 898-1:2013 specifies mechanical properties for fasteners in carbon and alloy steel. The scope recognises that certain fasteners might not fulfil the tensile requirements because of the geometry of the heads, including those with a countersunk head. Clause 8.2 of BS EN ISO 898-1:2013 identifies the geometric reasons why a fixing might have reduced loadability, including a countersunk head with an internal driving feature

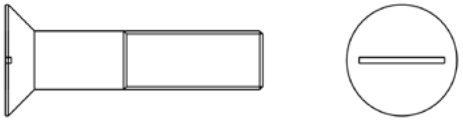

Figure 1: Countersunk headbolts with a slot

Figure 2: Countersunk headbolts with a hexagonal socket

(a hexagonal socket).

Despite the possible inference in the scope that reduced loadability fasteners are not covered, BS EN ISO 898-1:2013 specifies testing requirements for reduced loadability fasteners in Table 10, requiring that (among other things) the fastener achieves at least the minimum ultimate tensile load in the product standard.

The product standard for countersunk fasteners with socket heads is BS EN ISO 10642:2019, including hexagonal socket countersunk head screws with reduced loadability, up to M20. The minimum ultimate resistance is given as 80% of the value for fixings with full loadability.

Clause 5 of BS EN ISO 898-1:2013 requires fasteners with reduced loadability to be marked with a zero preceding the normal property class designation. A reduced loadability property class 8.8 fastener becomes 08.8.

Countersunk bolts with a hexagonal socket head may also be specified to DIN 7991. This is a withdrawn standard and does not specify a loadability test. It is recommended that countersunk head bolts are not specified to this standard.

BCSA's Model specification for the purchase of structural bolting assemblies will be reviewed later this year (to be issued as 15th edition) to omit a reference to DIN 7991 and to reflect the advice in this AD about the use of bolts with reduced loadability.

Design tension resistance of countersunk head bolts with a hexagon socket

If countersunk head bolts with a hexagonal socket are to be used, their design tension resistance should be reduced by applying a 0.8 factor to the calculated resistance given in BS EN 1993-1-8:2005. It should be noted that the values given in the "Blue Book" and similar resources are applicable only to countersunk heads with a screwdriver slot.

In addition when specifying or using countersunk heads with a hexagonal socket:

- The fixings should be specified in accordance with BS EN ISO 10642:2019,
- The mechanical properties should meet the requirements of BS EN ISO 898-1:2013,
- The fixing should be correctly marked with a zero preceding the normal property class.

It should be clear that if a joint design using countersunk head bolts has been based on the design resistances calculated in accordance with Table 3.4 of BS EN 1993-1-8:2005, only countersunk head bolts with a screwdriver slot should be used, unless the design is verified for reduced loadability socket head fasteners.

If a design is completed using the reduced value of tensile resistance, countersunk head bolts to either BS 4933:2010 (with slots) or BS EN ISO 10642:2019 (with sockets) may be used.

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Email: **advisory@steel-sci.com**

New and revised codes and standards

From BSI Updates May 2024

BRITISH STANDARDS WITHDRAWN

BS EN 813:2008
Personal fall protection equipment. Sit harnesses.

BS EN 12841:2006
Personal fall protection equipment. Rope access systems. Rope adjustment devices.

BS EN ISO 15610:2023
Specification and qualification of welding procedures for metallic materials. Qualification based on tested welding consumables.
superseded by BS EN ISO 15610:2024

BS EN PUBLICATIONS

BS EN 1991-1-2:2024
Eurocode 1. Actions on structures. Actions on structures exposed to fire.
supersedes BS EN 1991-1-2:2002

BS EN 1993-1-2:2024
Eurocode 3. Design of steel structures. Structural fire design.
supersedes BS EN 1993-1-2:2005

BS EN 1993-1-3:2024
Eurocode 3. Design of steel structures. Cold-formed members and sheeting.
supersedes BS EN 1993-1-2:2005

BS EN 1993-1-5:2024
Eurocode 3. Design of steel structures. Plated structural elements.
supersedes BS EN 1993-1-5:2006+A2:2019

BS EN 1993-1-8:2024
Eurocode 3. Design of steel structures. Joints.
supersedes BS EN 1993-1-8:2005

BS EN 1993-1-13:2024
Eurocode 3. Design of steel structures. Beams with large web openings.

BS EN 813:2024
Personal fall protection equipment. Sit harnesses.

BS EN 12841:2024
Personal fall protection equipment. Rope access systems. Rope adjustment devices.

BS EN ISO 15610:2024
pecification and qualification of welding procedures for metallic materials. Qualification based on tested welding consumables.
supersedes BS EN ISO 15610:2023

DRAFT BRITISH STANDARDS FOR PUBLIC COMMENT

24/30478219 DC
EN 1991-3 Eurocode 1. Actions on structures. Actions induced by cranes and machines.

24/30480926 DC
BS ISO 965-4 ISO general purpose metric screw threads. Tolerances. Limits of sizes for hot dip galvanized external threads to mate with internal threads made to tolerance position H or G after galvanizing.

24/30473060 DC
BS ISO 18878 Mobile elevating work platforms. Operator (driver) training.

NEW WORK STARTED

ISO/TR 19961
Cranes. Safety code on mobile cranes.

EN ISO 15608
Welding. Grouping system for metallic materials.

BRITISH STANDARDS REVIEWED AND CONFIRMED

BS EN 10059:2003
Hot rolled square steel bars for general purposes. Dimensions and tolerances on shape and dimensions.

BS EN 10060:2003
Hot rolled round steel bars for general purposes. Dimensions and tolerances on shape and dimensions.

BS EN 10061:2003
Hot rolled hexagon steel bars for general purposes. Dimensions and tolerances on shape and dimensions.

BS EN 10092-1:2003
Hot rolled spring steel flat bars. Flat bars. Dimensions and tolerances on shape and dimensions.

BS EN 10092-2:2003
Hot rolled spring steel flat bars. Ribbed and grooved spring leaves. Dimensions and tolerances on shape and dimensions.

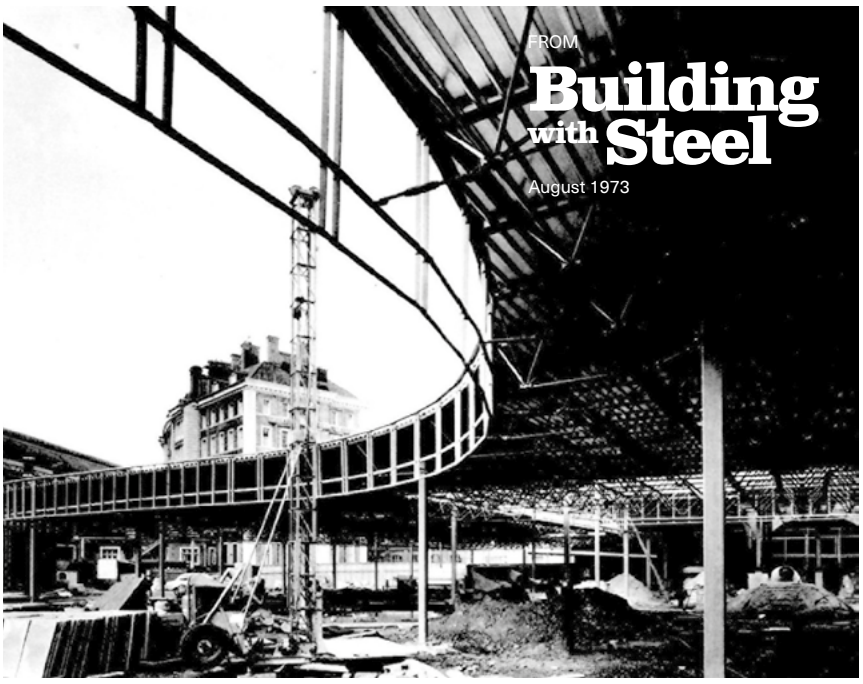
BS EN ISO 14554-1:2013
Quality requirements for welding. Resistance welding of metallic materials. Comprehensive quality requirements.

BS EN ISO 14554-2:2013
Quality requirements for welding. Resistance welding of metallic materials. Elementary quality requirements.

ISO PUBLICATIONS

ISO 15610:2024
Specification and qualification of welding procedures for metallic materials. Qualification based on tested welding consumables.

BR's first space station



Among the new improvements taking place at King's Cross station is the development of the passenger facilities. A new concourse was opened on 25 June by Mr Richard Marsh, MP, Chairman British Railways Board. The roof of the concourse is assembled from space frame units from Space Decks Ltd proving that this type of unit can be used for building plans far from rectangular. These notes briefly describe the building and the role of the space frame units.

In the brief to the architects British Rail required a number of facilities to be included in the new concourse at King's Cross. Amongst these was a new Travel Centre which was to be better placed than the then existing facilities and to be suitably related to the Underground, bus services, taxis and private cars. The Travel Centre was required to be able to provide all rail services including Inter City and suburban tickets, reservations, information, etc. Also to be included were shops to sell to passengers and to the Euston Road, basement heating and switchgear rooms with access from the existing subway, a taxi circulating system with allowance for offpeak parking, a lay-by for buses off Euston Road (not eventually provided), access to the existing station for newspaper vans and ambulances, a Telephone Information Bureau and access to the large ventilator owned· by London Transport together with a new access shaft to a transformer chamber.

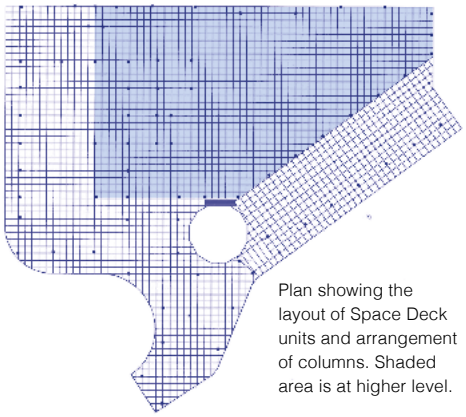
As is well known King's Cross station is one of the early London termini and as such it has earned a place in railway and architectural history. This surprisingly modern looking building was designed by Lewis Cubitt and built in 1852 and is listed by the Department of the Environment. For this reason the façade had to be as little disturbed as possible and in addition it was not to be too obscured by the new construction. Because of these considerations a model was made at the earliest possible time and a number of consultations took place on site with representatives from the Royal Fine Arts Commission, the Planning Officer of the Borough of Camden and the Historic Buildings Board of the Greater London Council. In order to pre-· sent as much of the original building as possible the first design was for a single storey structure over the whole area. As a result of the various consultations the first design was modified in a number of ways and in the agreed version included dual roof levels, an extension of the taxi canopy over the Euston Road subway entrance and the inclusion of a long roof light area in the concourse roof through which it is possible to see the original station elevation.

Other modifications were to the telephone area and it became necessary to raise the height of the London Transport ventilation structure for functional reasons. As mentioned above the bus lay-by was no longer needed and the area was paved over; however it could easily be incorporated should requirements change.

The site itself imposed a number of constraints on the design and programming. These included the need to keep in use at all times the access and subway for the London Transport system beneath. The ventilator had to be free to work at all times and access to it had to be provided. Another constraint which was unknown when design work started was a 6ft thick slab of reinforced concrete which was a relic of war-time Underground air-raid precautions. This had to be partly removed.

The first operation on the sub-structure was to expose and reinforce the top of the Fleet sewer with purpose made cast-iron units. This was followed by the formation of a temporary lining to the existing subway while the sub-structure work was being carried out.

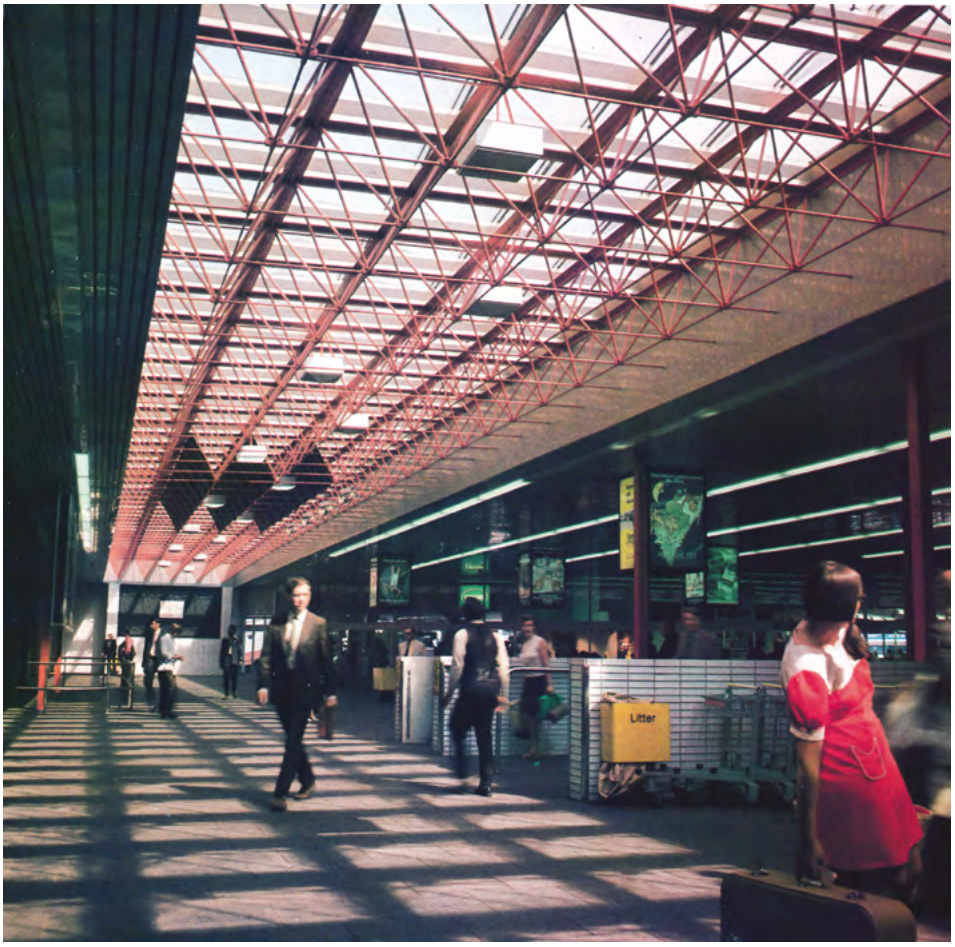
The basic framing of the super-structure consists of a Space Deck double layer grid constructed from factory produced pyramidal steel units, which are connected together on site to provide one- or two-way spanning structures. The philosophy on which the system is based is one of component standardization. Variation in strength is achieved by unit arrangement rather than by alteration of the units themselves. Left- and



Plan showing the layout of Space Deck units and arrangement of columns. Shaded area is at higher level.

right-hand threads on unit bosses and tie bars permit adjustment to form roof cambers for disposal of rainwater. As the system is factory produced under controlled conditions a large stock of units is held offering in many cases 'off the shelf' delivery. On this particular project British Rail architects made use of practically all the benefits obtainable from this unique system. Initially the planning problems were reduced to a minimum by the acceptance of the general modular-disciplines of the system and the inherent ability of the space-frame concept to accept structural support from a random column layout. The flexibility of the design method permitted the use of temporary column support where the foundations for permanent columns could not be constructed until after the roof had been erected and waterproofed. The units were bolted together on the ground and then lifted by crane to the RHS columns in fairly large assemblies. Once in position they were adjusted for camber in order to ensure that there were adequate falls in the roof. The decking consists of steel sheet units supporting impregnated insulation board and a white hypalon plastic membrane for the finish.

It can be seen from the photographs that many materials have contributed to the attractive interior of the concourse, but it is of interest to note the applications of steel. Standard steel counter units have been used for the Suburban and Inter-City ticket offices as has also the larger area provided for Information, Reservations and other facilities. In addition stainless steel has been extensively employed particularly for durability, hard-wearing properties and appearance. Among the applications are: Protection for the Train Indicator, shelving in the Pay-In Lobby, turntables in the ticket offices, trim to the counters, counter tops in the Inter-City office and Reservations area and as trim in the Travel Centre.



RQSC | The Register of Qualified Steelwork Contractors Scheme **Buildings**

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BCSA

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- **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
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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, ● = Bronze, ● = Certificate

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	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
A C Bacon Engineering Ltd	01953 850611			●	●	●	●				●			●		✔	2			Up to £6,500,000
Adey Steel Ltd	01509 556677	●		●	●	●	●	●	●	●	●			●	●	✔	3		●	Up to £3,400,000
Adstone Construction Ltd	01905 794561			●	●	●	●	●								✔	2	✔	●	Up to £3,400,000
AJ Engineering & Construction Services Ltd	01309 671919			●	●		●		●	●	●			●	●	✔	4		●	Up to £3,400,000
Angle Ring Company Ltd	0121 557 7241												●			✔	4			Up to £1,200,000
Arminhall Engineering Ltd	01799 524510	●			●	●		●		●	●			●	●	✔	2			Up to £2,400,000
Arromax Structures Ltd	01623 747466			●	●	●	●	●	●	●	●				●		2			Up to £1,200,000
ASD Westok Ltd	0113 205 5270	●	●	●	●	●	●			●	●	●	●		●	✔	4		●	Up to £6,500,000
ASME Engineering Ltd	020 8966 7150	●		●	●	●		●	●	●	●		●	●	●	✔	4		●	Up to £5,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●	●	●			●	●			●	●	✔	2			Up to £1,200,000
B D Structures Ltd	01942 817770			●	●	●	●				●	●		●	●	✔	2	✔	●	Up to £2,400,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✔	4	✔	●	Up to £2,400,000
Barnshaw Section Benders Ltd	0121 557 8261												●			✔	4			Up to £1,200,000
BHC Ltd	01555 840006	●	●	●	●	●	●	●	●	●	●	●		●	●	✔	4	✔	●	Above £10,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●		●		●	●	●		✔	4	✔	●	Above £10,000,000
Bourne Group Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	●	Above £10,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●		●	●	●	✔	4		●	Up to £10,000,000
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●						●	✔	4		●	Up to £6,500,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●		●	●	●		●	●	✔	4	✔	●	Above £10,000,000
Cementation Fabrications	0300 105 0135	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	3		●	Up to £10,000,000
CMF Ltd	020 8844 0940				●		●	●		●	●				●	✔	4			Up to £6,500,000
Coventry Construction Ltd	024 7646 4484			●	●	●	●		●	●	●			●	●	✔	4			Up to £1,200,000
D H Structures Ltd	01785 246269			●	●		●				●						2			Up to £500,000
Duggan Steel	00 353 29 70072	●	●	●	●	●	●	●	●		●				●	✔	4			Up to £10,000,000
D Hughes Welding & Fabrication Ltd	01248 421104				●	●	●	●	●	●	●		●	●	●	✔	4			Up to £1,200,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●	●	●	●	●			●	●	✔	4		●	Up to £5,000,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●	●	●	●	●	●		●	●	✔	4	✔	●	Up to £10,000,000
EvadX Ltd	01745 336413		●	●	●	●	●	●		●	●	●			●	✔	3		●	Up to £5,000,000
Four Bay Structures Ltd	01603 758141			●	●	●	●	●		●	●			●	●	✔	2			Up to £1,200,000
Four-Tees Engineers Ltd	01489 885899	●		●	●		●	●	●	●	●		●	●	●	✔	3		●	Up to £2,400,000
G.R. Carr (Essex) Ltd	01286 535501	●		●	●			●			●			●	●	✔	4			Up to £1,200,000
BCSA steelwork contractor member	**Tel**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**Q**	**R**	**S**	**QM**	**FPC**	**BIM**	**SCM**	Guide Contract Value (1)

BCSA steelwork contractor member	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●	●			●	●	✔	3			Up to £1,200,000
H Young Structures Ltd	01953 601881			●	●	●	●	●			●			●	●	✔	4	✔	●	Up to £3,400,000
Had Fab Ltd	01875 611711				●		●	●	●	●	●			●	●	✔	4			Up to £6,500,000
HBE Services Ltd	01525 854110				●	●				●				●	●	✔	2			Up to £1,200,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●	✔	2			Up to £3,400,000
Hillcrest Structural Steel Ltd	023 8064 1373			●	●	●	●	●		●	●			●	●	✔	3		●	Up to £3,400,000*
Integrated Water Services Ltd	01282 777739									●	●			●	●	✔	2			Up to £1,200,000
Intersteels Ltd	01322 337766	●			●	●	●	●	●				●	●	●	✔	3	✔		Up to £5,000,000
Jamestown Manufacturing Ltd	00 353 45 434 288		●	●	●	●	●	●	●	●		●	●			✔	4			Up to £10,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445			●	●	●	●	●		●	●	●	●	●	●	✔	4	✔	●	Above £10,000,000
Leach Structural Steelwork Ltd	01995 642000			●	●	●	●	●			●					✔	3		●	Up to £6,500,000
Legge Steel (Fabrications) Ltd	01592 205320			●	●					●	●			●	●		2			Up to £600,000
Littleton Steel Ltd	01934 311670			●	●	●				●	●			●	●	✔	3			Up to £1,200,000
Loaninghill Fabrications Ltd	01506 858466				●			●	●	●				●	●		3			Up to 600,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●			●	●	✔	4		●	Up to £1,400,000
M&S Engineering Ltd	01461 40111				●				●	●	●				●	✔	3			Up to £2,400,000
Mackay Steelwork & Cladding Ltd	01862 843910			●	●		●			●	●			●	●	✔	4		●	Up to £2,400,000
Midland Structures Limited	01384 411201				●	●	●	●	●	●	●		●	●	●		2			Up to £5,000,000
Murphy International Ltd	00 353 45 431384	●		●	●	●	●	●	●	●	●			●	●	✔	4		●	Up to £6,500,000
Nationwide Structures Ltd	01924365883			●	●	●	●				●					✔	4			Up to £10,000,000
Newbridge Engineering Ltd	01429 866722	●	●	●	●	●	●	●			●	●				✔	4		●	Up to £2,400,000
North Lincs Structures	01724 855512			●	●					●					●		2			Up to £600,000
Painter Brothers Ltd	01432 374400				●				●	●	●			●	●		3			Up to £5,000,000*
Peter Marshall (Steel Stairs) Ltd	0113 307 6730				●	●				●	●				●	✔	3			Up to £2,400,000*
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●		3			Up to £3,400,000
REIDsteel	01202 483333			●	●	●	●		●			●			●	✔	4		●	Above £10,000,000
SAH Luton Ltd	01582 805741			●	●	●				●				●	●		2			Up to £600,000
SDM Fabrication Ltd	01354 660895	●	●	●	●	●	●			●	●			●	●	✔	4			Up to £3,400,000
Severfield plc	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	●	Above £10,000,000
Shaun Hodgson Engineering Ltd	01553 766499	●		●	●		●			●	●			●	●	✔	3			Up to £1,200,000
Shipley Structures Ltd	01400 251480			●	●	●	●		●	●	●			●	●	✔	3			Up to £2,400,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●	●	●	●			●				●		3	✔		Up to £3,400,000
Southern Fabrications (Sussex) Ltd	01243 649000				●	●				●	●			●	●	✔	2			Up to £1,200,000
Stage One	01423 358001				●		●	●	●	●					●	✔	2			Up to £6,500,000
Steel & Roofing Systems	00 353 56 444 1855	●		●	●	●	●				●	●		●	●	✔	4			Up to £10,000,000
Taziker Industrial Ltd	01204 468080	●		●	●		●	●		●	●		●	●	●	✔	3		●	Above £10,000,000
Temple Mill Fabrications Ltd	01623 741720			●	●					●	●				●	✔	2			Up to £600,000
TSI Structures Ltd	01603 720031			●	●	●	●	●			●			●			2	✔		Up to £3,400,000
W I G Engineering Ltd	01869 320515				●					●	●			●	●	✔	2		●	Up to £600,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✔	4		●	Above £10,000,000
Westbury Park Engineering Ltd	01373 825500	●		●	●	●	●	●	●	●	●				●	✔	4		●	Up to £1,200,000
William Haley Engineering Ltd	01278 760591			●	●	●	●				●		●			✔	4			Up to £5,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	●	Above £10,000,000

Non member	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
Eden Fabrications	02825 821000			●	●	●	●	●		●	●		●		●	✔	3			Up to £1,200,000

| Non member | Tel | C | D | E | F | G | H | J | K | L | M | N | Q | R | S | QM | FPC | BIM | SCM | Guide Contract Value (1) |

RQSC

The Register of Qualified Steelwork Contractors Scheme **Bridgeworks**

Steelwork contractors for bridgeworks

BCSA

The Register of Qualified Steelwork Contractors Scheme for Bridgeworks (RQSC – Bridgeworks) is open to any Steelwork Contractor who has a fabrication facility within the UK or 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
SRF Site-based bridge refurbishment
FRF Factory-based 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 ● = Bronze ● = Certificate

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	SRF	FRF	AS	QM	FPC	BIM	NHSS 19A	NHSS 20	SCM	Guide Contract Value (1)
Adey Steel Ltd	01509 556677	●	●	●	●	●	●			●	●	●	✓	3			✓	●	Up to £3,400,000
AJ Engineering & Construction Services Ltd	01309 671919	●		●	●	●	●	●	●	●	●	●	✓	4				●	Up to £3,400,000
Beaver Bridges Ltd	01204 668773	●		●	●	●	●	●	●	●	●	●	✓	4					Up to £3,400,000
Billington Structures Ltd	01226 340666	●		●	●	●	●					●	✓	4	✓	✓	✓	●	Above £10,000,000
Bourne Group Ltd	01202 746666	●		●	●	●				●		●	✓	4	✓		✓	●	Above £10,000,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	●	●	●	✓	4			✓	●	Up to £10,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●	●	●	●		●	●	●	✓	4			✓	●	Up to £6,500,000
Cementation Fabrications	0300 105 0135	●	●	●	●	●	●	●	●	●	●	●	✓	3			✓	●	Up to £10,000,000
Centregreat Engineering Ltd	02920 226088	●		●	●	●	●	●	●	●	●	●	✓	4		✓			Up to £3,400,000
D Hughes Welding & Fabrication Ltd	01248 421104	●		●		●			●	●	●	●	✓	4			✓		Up to £1,200,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●		●			●	✓	4				●	Up to £5,000,000
Four-Tees Engineers Ltd	01489 885899	●	●	●	●	●	●		●	●	●	●	✓	3			✓	●	Up to £2,400,000
Jamestown Manufacturing Ltd	00 353 45 434 288	●	●	●	●	●	●					●	✓	4			✓		Up to £10,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●		●	●	●						●	✓	4	✓		✓	●	Above £10,000,000
M&S Engineering Ltd	01461 40111	●		●		●	●	●		●	●	●	✓	3					Up to £2,400,000
M Hasson & Sons Ltd	028 2957 1281	●	●	●	●	●	●	●	●	●	●	●	✓	4			✓	●	Up to £1,400,000
Millar Callaghan Engineering Services Ltd	01294 217711	●	●	●	●	●	●	●	●	●	●	●	✓	4			✓		Up to £1,400,000
Murphy International Ltd	00 353 45 431384	●	●	●	●	●	●			●	●	●	✓	4			✓	●	Up to £6,500,000
Nusteel Structures Ltd	01303 268112	●	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	●	Up to £6,500,000
REIDsteel	01202 483333	●			●	●	●		●			●	✓	4				●	Up to £10,000,000
Severfield plc	01845 577896	●	●	●	●	●	●	●	●	●	●	●	✓	4	✓	✓	✓	●	Above £10,000,000
Taziker Industrial Ltd	01204 468080	●	●	●	●	●	●	●	●	●	●	●	✓	3		✓	✓	●	Above £10,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●	✓	4	✓	✓	✓	●	Above £10,000,000
Non-BCSA member																			
Allerton Steel Ltd	01609 774471	●	●	●	●	●	●	●	●	●	●	●	✓	4	✓		✓	●	Up to £5,000,000
AmcoGiffen	01226 243413	●	●	●	●	●	●		●	●	●	●	✓	4			✓		Up to £1,200,000
Carver Engineering Services Ltd	01302 751900	●		●	●	●	●		●	●	●	●	✓	4			✓		Up to £5,000,000
Cimolai SpA	01223 836299	●	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	●	Above £10,000,000
CTS Bridges Ltd	01484 606416	●	●	●	●	●	●	●	●		●	●	✓	4			✓		Up to £600,000
Donyal Engineering Ltd	01207 270909	●		●						●	●	●	✓	3		✓	✓		Up to £2,400,000
Eiffage Metal	07511 177815	●	●		●	●	●	●	●	●	●	●	✓	4			✓		Above £10,000,000
Harrisons Engineering (Lancashire) Ltd	01254 823993	●	●	●	●	●	●	●	●	●	●	●	✓	3		✓	✓		Up to £3,400,000
Hollandia Infra BV	00 31 180 540 540	●	●	●	●	●	●	●	●	●	●	●	✓	4					Above £10,000,000*
HS Carlsteel Engineering Ltd	020 8312 1879			●						●	●	●	✓	3			✓		Up to £2,400,000
J&D Pierce Contracts Ltd	01505 683724	●	●		●	●	●	●	●			●	✓	4			✓		Above £10,000,000
Kelly's Welders & Blacksmiths Ltd	01383 512 517											●	✓	2			✓		Up to £350,000
Lanarkshire Welding Company Limited	01698 264271	●	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓		Up to £5,000,000
North View Engineering Solutions Ltd	01325 464558											●	✓	3					Up to £1,200,000
Shaw Manufacturing Ltd	01642 210716			●						●	●	●	✓	4			✓		Up to £1,200,000
Total Steelwork & Fabrication Ltd	01925 234320	●		●		●				●	●	●	✓	4			✓		Up to £5,000,000
Victor Buyck Steel Construction	00 32 9 376 2211	●	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	●	Above £10,000,000

BCSA

Corporate Members

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

Company name	Tel
Bonham and Brook North Ltd	020 3523 9125
Gene Mathers	0115 974 7831
Griffiths & Armour	0151 236 5656
Highways England Company Ltd	0300 123 5000
Keiths Welding Limited	07791 432 078

Company name	Tel
Magna Inspections Ltd	01377 229632
MMCEngineer Ltd	01423 855939
Paul Hulme Engineering Ltd	07801 216858
Sandberg LLP	020 7565 7000
Solent Commercial Management Limited	07852 309104

Company name	Tel
Structural & Weld Testing Services Ltd	01795 420264
SUM ADR Ltd	07960 775772
Thames Welding Ltd	07912 691704

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.

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
NHSS National Highway Sector Scheme

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

SCM
Steel Construction Sustainability Charter
● = Gold ● = Silver
● = Bronze ● = Certificate

SfL
Steel for Life Sponsor

Structural components

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
Albion Sections Ltd	0121 553 1877	✓	M	4			
Cellbeam Ltd	01937 840600	✓	M	4	20		
Composite Profiles UK Ltd	01202 659237		D/I				
Construction Metal Forming Ltd	01495 761080	✓	M	3			
Daver Steels Ltd	0114 261 1999	✓	M	3			
Farrat Isolevel	0161 924 1600	✓	N/A				
Hadley Industries Plc	0121 555 1342	✓	M	4		●	
Hi-Span Ltd	01953 603081	✓	M	4		●	
Kingspan Structural Products	01944 712000	✓	M	4		●	
MSW UK Ltd	0115 946 2316		D/I				
Prodeck-Fixing Ltd	01278 780586	✓	D/I				
Structural Metal Decks Ltd	01202 718898	✓	M	4			
Stud-Deck Services Ltd	01335 390069		D/I				
Tata Steel – ComFlor	01244 892199	✓	M	4			
voestalpine Metsec plc	**0121 601 6000**	✓	**M**	4			**Gold**

Computer software

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
Autodesk Ltd	01252456600		N/A				
Fabsec Ltd	01937 840641		N/A				
IDEA StatiCa UK Ltd	**02035 799397**		**N/A**				**Silver**
StruMIS Ltd	01332 545800		N/A				
Trimble UK Limited	0113 887 9790		N/A				

Steel producers

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
British Steel Ltd	01724 404040	✓	M		3B		
Tata Steel – Tubes	01536 402121	✓	M		3B		

Manufacturing equipment

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
Behringer Ltd	01296 668259		N/A				
Ficep (UK) Ltd	**01924 223530**		**N/A**				**Silver**
Kaltenbach Ltd	01234 213201		N/A				
Lincoln Electric (UK) Ltd	0114 287 2401	✓	N/A				
Peddinghaus Corporation UK Ltd	01952 200377		N/A				
Voortman (UK) Ltd	**+31 (0)548 536 373**		**N/A**				**Silver**

Membership services

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
Deconstruct UK Ltd	02035 799397	✓	N/A				
Keltbray Holdings Ltd	0207 643 1000	✓	N/A				

Protective systems

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
Forward Protective Coatings Ltd	01623 748323	✓	N/A				
Hempel UK Ltd	**01633 874024**	✓	**N/A**				**Silver**
Highland Metals Ltd	01343 548855	✓	N/A				
International Paint Ltd	0191 469 6111	✓	N/A				
Jack Tighe Ltd	01302 880360	✓	N/A		19A		
Joseph Ash Galvanizing	**01246 854650**	✓	**N/A**				**Silver**
PPG Architectural Coatings UK & Ireland	01924 354233	✓	N/A				
Sherwin-Williams UK Ltd	01204 521771	✓	N/A				
Vale Protective Coatings Ltd	01949 869784		N/A				
Wedge Group Galvanizing Ltd	**01902 601944**	✓	**N/A**				**Gold**

Safety systems

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
Easi-Edge Ltd	01777 870901	✓	N/A				
TRAD Hire & Sales Ltd	01614 304666	✓	N/A				

Steel stockholders

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
ASD Metals UK	0113 254 0711	✓	D/I	4	3B	●	
AJN Steelstock Ltd	01638 555500	✓	M	4			
Arcelor Mittal Distribution - Scunthorpe	**01724 810810**	✓	**D/I**	**4**	**3B**		**Headline**
Barrett Steel Services Limited	**01274 682281**	✓	**M**	**4**	**3B**		**Headline**
British Steel Distribution	01642 405040	✓	D/I	4	3B		
Cleveland Steel & Tubes Ltd	**01845 577789**	✓	**M**	**3**	**3B**		**Gold**
Dent Steel Services (Yorkshire) Ltd	01274 607070	✓	M	4	3B		
Dillinger Hutte U.K. Limited	01724 231176	✓	D/I	4		●	
Duggan Profiles & Steel Service Centre Ltd	00 353 567722485	✓	M	4			
European Metal Recycling Ltd	01925 715400	✓	N/A				
Murray Plate Group Ltd	0161 866 0266	✓	D/I	4	3B		
NationalTube Stockholders Ltd	**01845 577440**	✓	**D/I**	**4**	**3B**		**Gold**
Rainham Steel Co Ltd	01708 522311	✓	D/I	4	3B		
The Alternative Steel Co Ltd	01942 826677	✓	D/I				

Structural fasteners

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
Advanced Bolting Solutions Limited	0116 251 2251	✓					
BAPP Group Ltd	01226 383824	✓	M		3		
Cooper & Turner Ltd	0114 256 0057	✓	M		3		
Lindapter International	01274 521444	✓	M				

Welding equipment and consumables

Company name	Tel	QM	CA	FPC	NHSS	SCM	SfL
Air Products PLC	01270 614167		N/A				

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