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NSC

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Cover Image
River Witham Bridge, Lincolnshire
Main client: Lincolnshire County Council
Main contractor: Galliford Try
Structural engineer: WSP
Steelwork contractor: Cleveland Bridge
Steel tonnage: 1,400t

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Drawing a lesson from education

Nick Barrett - Editor

It shouldn't come as any surprise that immediately after a major event like the historic UK withdrawal from the European Community opinions are divided on what the future will hold. Glass half full and glass half empty opinions represent moderate views along a spectrum that includes economic disaster at one end and sunny uplands opening up at the other.

Uncertain times are not usually regarded as the best background for encouraging investment of the sort that leads to demand for new buildings, from offices to shops, sheds and schools, but there are some positive signs following a year of setbacks for most sectors of construction.

February's Deloitte annual crane survey, which examines commercial property development in the regions, showed 57 office, residential, hotel and student housing developments were started in the major cities like Belfast, Birmingham, Manchester and Leeds last year, which is a healthy pipeline but still well down on the 97 of a year earlier. Offices were down 12.2%, and student accommodation fell by around 16% amid fears of oversupply. The number of hotel beds under construction rose by almost 8%, mostly in Manchester.

This was quickly followed by the construction purchasing managers' index from IHS Markit/CIPS which rose to an eight-month high in December, better than economists had expected. The construction sector downturn lost intensity in January amid slower reductions in housebuilding, commercial developments and civil engineering. Manufacturing sentiment has also reportedly stabilised since the turn of the year.

Summing up, things have been bad, they have at least stopped getting worse and there are tentative signs of improvement. The steel construction sector's own sentiment remains positive and the latest annual market share survey from Construction Markets confirms that steel has increased its share in the key sheds market and in multi-storey offices (see News).

Reasons why steel dominates demand in key sectors of the construction market abound, with different sectors finding different combinations of benefits swinging the choice of framing material towards steel. Plenty of evidence for steel being the preferred material for the education sector can be found in the new publication Steel Construction - Education Buildings that comes with this issue of NSC and has been distributed with a range of other construction magazines. It is also available as a free download from *www.steelconstruction.info.*

It highlights that steel construction has proven its superior suitability for providing the education sector with modern, state-of-the-art buildings and extensions for many years and has a market share of over 60% as a result.

Steel is proving itself as the go-to solution for aesthetically pleasing, adaptable, cost-effective education buildings of all types, and the new publication contains real life examples of recently built primary and secondary schools across the UK, as well as teaching and research facilities for the higher education sector, innovative spaces for university students to study in, sports facilities and multi-storey student accommodation.

Steel construction looks forward to seeing healthy growth at least in line with the market, especially as sustainability and modern methods of construction are coming increasingly to the fore. There is a worthwhile lesson for other sector's in steel's achievements in education.

Steel gains share in key markets

The latest annual market share survey from Construction Markets confirms other reports that the construction market declined in 2019, but steel has increased its share with gains in the key sheds market and in multi-storey offices.

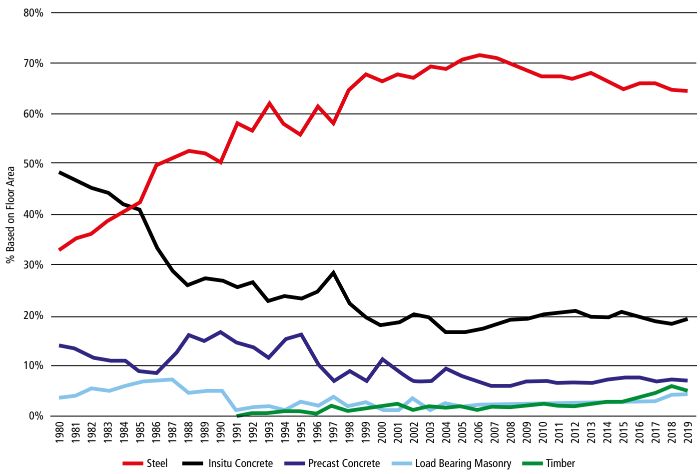
The survey carried out for Steel for Life is the latest in an unbroken run of independently produced reports stretching back to 1980 and shows the total market for sheds fell 1.4%, with steel's share rising slightly to 92.2%. The total multi-storey buildings market fell 5.8% but steel increased its share of offices - which accounts for almost 30% of multi-storey buildings - by almost 2%.

There was a sharp fall in single storey conventional braced frames of almost 9%, but a wide variance in performance of sub sectors, with a fall of some 20% in retail buildings offset by a rise of almost 15% in public health buildings.

The residential market fell slightly, by 0.4%, due mainly to a fall in houses and bungalows, but steel maintained its market share. There was a small rise in low rise apartments and steel's market share rose by a slightly larger amount. In the high rise apartments sector there was a fall in the overall market of 2.7%.

The total market for frames took in over 41Mm² of floor area in 2019, a 2.1% fall over 2018. Steel took the largest market share at over 42%.

The survey which relates to the five types of structural framing materials - insitu and precast concrete, load bearing masonry, and timber as well as steel - is based on 750 telephone interviews with architects, private house builders and public sector housing designers.



Market shares, total multi-storey buildings market, 1980 to 2019

East London bridge installed on Christmas Day

Civil engineering contractor Graham successfully installed a new pedestrian and cycle bridge in east London during the early hours of Christmas Day.

The 66m-long, 7.2m-wide and 350t steel Carpenters Land Bridge was installed as a key part of the infrastructure for East Bank, the new £1.1 billion culture and education district being created on Queen Elizabeth Olympic Park.

The new bridge will link museums, theatres, music studios and UAL's London College of Fashion with the new business district at International Quarter London.

While Father Christmas was busy delivering presents, Graham's construction team started their bridge installation work, which was completed in time for the Queen's speech at 3pm.

Taking advantage of the rail network shutdown to minimise disruption, the bridge was installed across three Network Rail lines, two DLR lines and Carpenters Road.

Leo Martin Managing Director of Graham's Civil Engineering Division said: "Our teams worked incredibly hard on this new link for East Bank.

"While many people were getting an early night in anticipation of enjoying the festivities during Christmas Day, our dedicated teams worked through the night to get the bridge in place – minimising disruption to the people who will reap the benefits once the work is complete.

"The team put the bridge in place using a self-propelled modular transporter rather than a more traditional crane typically used on similar projects. This provided greater certainty to the installation."

Steelwork contractor for the project was Briton Fabricators.

Responsible sourcing certification for Kloeckner Metals' sites

Kloeckner Metals UK has announced that its Leeds, Westok, London and Dudley sites have obtained BES 6001 certification for responsible sourcing of construction products.

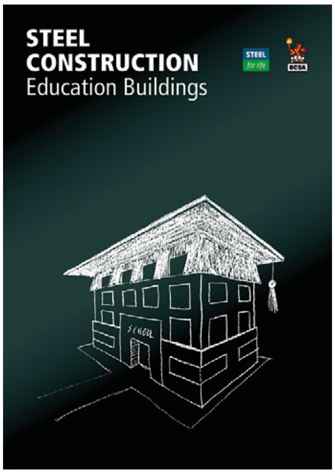
The company said this certification will help it ensure and demonstrate that its products have been made using materials that have been responsibly sourced and in a sustainable manner.

Developed by BRE (Building Research Establishment), the environmental and sustainability standard specifies requirements for organisational management, supply chain management and sustainability issues in order to allow companies to demonstrate an ongoing commitment to the principles of responsible sourcing in relation to the provision of products.

Kevin Maddison Kloeckner Metals UK Group Quality Manager said: "We are incredibly proud of this new certification as it reflects Kloeckner's ongoing commitment to improving its environmental and social impact.

'The new BES 6001 standard gives our customers further assurance that materials are of high-quality and sourced responsibly from ethical suppliers."

Education Buildings supplement available now



The Steel Construction – Education Buildings supplement, produced by Steel for Life and the British Constructional Steelwork Association (BCSA), is distributed with this issue of NSC and available online at: *www.steelconstruction.info*

The supplement gives an overview of the sector and is the latest in a series of supplements from the steel sector that aim to keep construction professionals abreast of developments that will help them in the design and construction of steel-framed buildings.

Using site reports of projects that are either under construction or recently completed, the reasons why steel frames are consistently the preferred market choice for education buildings are explained.

Speed of construction, cost-effectiveness, sustainability and future flexibility are just some of the reasons why steel frames are selected for around 60% of education buildings.

The steel construction sector has provided many of the finest educational buildings in the UK, from primary and secondary schools to leading research establishments for universities, as well as large student accommodation blocks, sports halls and other leisure facilities like swimming pools.

Big girders installed for Facebook offices

A series of 20m-long fabricated girders, which are all 2.9m deep and 1.1m-wide, have been installed to create the roof of a 600-seat theatre in London's King's Cross development.

The theatre will be housed in the P2 building, which is a 12-storey, steel-framed building that will also comprise office accommodation over its nine upper levels.

The building has been designed by Allford Hall Monaghan Morris and will also include a fifth-floor wraparound terrace.

The offices have been acquired by Facebook, as one of the company's three new sites in King's Cross.

A BREEAM 'Excellent' rating is expected to be attained by the building, which is expected to be completed in 2021.

Working on behalf of main contractor Kier, Severfield is fabricating, supplying and erecting 3,600t of steelwork and installing approximately 20,000m^2 of hollowcore planks for the project.

Main frame up for Snowdonia hotel

Working on behalf of main contractor H.H Smith & Sons, B D Structures has completed the erection of the main steel frame for the Hilton Garden Inn at Adventure Parc Snowdonia in North Wales.

The steel-framed four-storey hotel will offer 106-bedrooms spread over its upper three levels, while the ground floor will accommodate a conference suite, spa, restaurant/bar and the main reception area.

Later this month (February), B D Structures will return to site to erect two single storey elements attached to the front and back elevations of the hotel and these will house the conference and meeting rooms, and a kitchen and plant area.

The steel frame was designed by B D Structures and consists of composite downstand floor beams that support metal decked flooring for the structure's upper levels.

Founded on driven piles, some of which are up to 55m-deep, the steelwork for the three upper floors is arranged in a fairly regular column pattern, with just two rows of internal columns, which are positioned strategically to coordinate with corridors and riser shafts.

The ground floor is slightly different and has a higher floor-to-ceiling height as well as incorporating larger spans.

Located in the Conwy Valley at Dolgarrog, Adventure Parc Snowdonia offers a range of activities including what is said to be the world's first artificial surfing lake.

NEWS IN BRIEF

ArcelorMittal Europe has announced a CO_2 roadmap to reduce emissions by 30% by 2030. The roadmap to achieve the 30% target is said to be based on three distinct pathways: Clean power steelmaking, such as hydrogen-based steelmaking; Circular carbon steelmaking, enabling low-emission steelmaking by using waste biomass to displace fossil fuels in steelmaking; and Fossil fuel carbon capture and storage, enhancing current methods of steel production so carbon is captured and stored or re-used rather than emitted into the atmosphere.

Caunton Engineering has celebrated 50 years of business with a dinner dance attended by current and former employees. Half century ago, the company began its structural steelwork operations in a former blacksmith's shop and today it employs 250 men and women and has an annual turnover of £60M.

Wigan Council's planning committee has recommended that a new 140,000m^2 business park on the outskirts of Wigan be approved. Symmetry Park is a 134-acre site at Junction 25 of the M6 and could provide logistics space and create 1,650 high-quality jobs when operational.

Developer **St. Modwen** has successfully delivered its largest-ever speculative warehouse unit. The 30,000m^2 unit in Tamworth is located close to Junction 10 of the M42. Severfield fabricated and erected the steelwork for project.

PRESIDENT'S COLUMN

There's little doubt that climate change and sustainability are gaining momentum in our domestic lives as well as in industry. Greta Thurnberg argues that humanity is facing an existence crisis and that climate change is fast becoming the number one issue for the world. Perhaps the scale of the fires in Australia has shown us this in some way

This shift in emphasis towards carbon reduction has put it in the spotlight for us all. As it's not going away anytime soon, we'll also be under this spotlight. We may all have to change the way we live and work to reduce future carbon emissions otherwise extreme climate events will become more frequent and damaging.

The construction industry has a major part to play in this drive to net-zero carbon. We need to do more with less; maximise the efficient use of resources and move towards a truly circular economy. This is the Module D strategy, and the Paris Agreement brings carbon reduction into focus.

Steel is well-placed to play a crucial role in reducing the environmental impact of construction, and this shift in emphasis towards a reduction in carbon emissions is the major factor, and one most likely to have the best impact.

This characteristic that steel can be recycled or reused endlessly without detriment to its properties gives steel a high value at all stages of its life cycle. So it comes as no shock to find out that steel recycling is highly developed and highly efficient and has been in place for decades. Current recovery rates from demolition sites in the UK are 99% for structural steelwork and 96% on average for all steel construction products.

As you know, Steel is manufactured by two production routes, Basic Oxygen Steel (BOS) and Electric Arc Furnace (EAF), which together comprise a single global system of supply to meet world demand. Both production routes include significant recycled content.

Energy consumption and carbon dioxide emissions from European steelmaking have already been reduced by 50% and 60% respectively over the past 40 years. The by-products from steelmaking, which include sludges, slags and dust are beneficially used by the industry in a range of products including roadstone, lightweight aggregates and as cementitious material used as a substitute for Portland cement.

European steel manufacturers are also leading the way in developing breakthrough technologies that will support 'science-based targets' and enable a global transition to a low-carbon economy.

As well as minimising the emissions associated with its products, the steel construction sector is also supporting designers and architects by providing guidance on how to get the most out of those products. The steel sector website *steelconstruction.info*, for example, contains a wealth of guidance on efficient design and construction. I guess we have always strived for that, but such efficient use of resources within our built environment is perhaps now more important than ever.

Tim Outteridge
BCSA President and Jamestown Manufacturing

New Steel Construction Technical Digest now available online

New Steel Construction's (NSC) fourth Technical Digest, which brings together a year's worth of technical guidance, is now available for download at: *www.steelconstruction.info*

Helping to keep engineers and architects up-to-date with the latest steel construction related guidance, NSC's Digest compiles all the magazine's Technical Articles and Advisory Desk Notes from 2019, which can be downloaded as a pdf or viewed online.

Advisory Desk Notes reflect recent developments in technical standards or new knowledge that designers need to be made aware of. Some of them arise because a question is being frequently asked of the steel sector's technical advisers. They have always been recognised as essential reading for all involved in the design of constructional steelwork.

The longer Technical Articles cover more detailed insights into what designers need to know, often the result of legislative changes or changes to codes and standards.

Sometimes it is simply felt that it would be helpful if a lot of relatively minor changes, perhaps made over a period of time, were brought together in one place, so a technical update is needed.

Some of the topics covered in last year's Technical Articles include stability and second order effects on steel structures; design of crane girders; fatigue of bracing in buildings; and connection design in trusses.

Steel provides Cheshire with new power plant

A new steel-framed waste-to-energy facility, which will help the nation reduce its reliance on landfill sites for refuse disposal, is under construction in Cheshire.

The Hooton Bio Power Resource Recovery Centre is being built by Danish-based Burmeister & Wain Scandinavian Contractor (BWSC), with Caunton Engineering erecting the steelwork for the main structures, which consist of a boiler house, turbine hall, and a fuel unloading and handling building.

"It is a very tight site and the structures are all adjacent to each other on a relatively small footprint," Caunton Engineering Site Manager Robert Aitman said. "Site and erection logistics are playing a key role on this job as we have to work around the other trades, most notably the equipment installers."

During the steel erection process Caunton is leaving large openings in the roofs and elevations to allow BWSC's sub-contractors to install the plant's large boiler and processing equipment.

Once the majority of this equipment has been installed, Caunton will infill the remaining steelwork areas, with the entire steel package due for completion in May.

The project is said to be the first non-subsidised merchant gasification plant in the UK, as well as being the first time the UK market will realise a gasification centre of this size, based on fluidised bed technology provided by Japan's Kobelco.

The Hooton facility will gasify some 240,000t of waste per year, generating in excess of 200 GWh of electricity annually. It is expected to be operational by the end of 2021.

Monkey Island bridge installed over M4

Cleveland Bridge has installed an 82.4m-long, 400t steel bridge at Monkey Island as part of a major upgrade of the M4 motorway between junctions 3 and 12.

Working on behalf of Highways England, the job was carried out by main contractor, Balfour Beatty/Vinci Joint Venture (BBVJV).

The bridge forms part of a scheme that will eventually see a total of 11 bridges replaced along the M4 in Berkshire, as the highway is upgraded to a smart motorway.

Designed by Arcadis/Jacobs and fabricated by Cleveland Bridge, the bridge was delivered to site from Darlington in nine braced pairs, before being assembled and installed during a 54-hour road closure.

The name Monkey Island derives from Monks Eyot, meaning Monks' Island, after a monastery that existed nearby from 1197 until the dissolution of the monasteries in the 1530s.

Updated designs unveiled for West Midlands HS2 stations

New designs for the two new high-speed rail stations in the West Midlands have been unveiled, with HS2 aiming to create two of the most environmentally-friendly railway stations in the world.

The stations at Curzon Street (pictured) in Birmingham and Interchange in Solihull have been designed to focus on open space and landscaping. They will both be net zero carbon in operation and achieve a BREEAM 'Excellent' rating.

Both stations will adopt the latest eco-friendly design and sustainable technologies including capturing rainwater and sustainable power generation.

HS2 has been working with WSP and Grimshaw Architects on the design for Curzon Street and with Arup on the Interchange station in Solihull.

It is claimed that Curzon Street station in Birmingham city centre will be the first brand-new inter-city terminus station built in Britain since the 19th Century. Eventually, there will be nine trains per hour on the high-speed network in each direction from the station.

Interchange Station in Solihull will be a major new gateway for the region close to Birmingham Airport, Birmingham International station and the NEC.

Like the Curzon Street design, Interchange will be net zero carbon in operation, focusing on reducing energy use by maximising natural daylight and ventilation and using on-site solar panels. The station roof will capture and reuse rainwater and the new designs incorporate sunken rain gardens in the public plaza and an outdoor terrace to the station concourse.

Chris Hayter, WSP Project Director, said: "The new Curzon Street Station design harmoniously integrates architecture and engineering in the true tradition of our great railway stations, bringing the passenger experience up-to-date with modern traveller expectations, in keeping with Birmingham's ongoing transformation.

Kim Quazi, Arup's Lead Architect, said: "The design of HS2 Interchange Station has been influenced by its unique rural setting on the edge of a built-up, urban area and its glass facade will offer expansive views over the surrounding landscape. The striking roof design will maximise the use of natural daylight to create a light, bright and airy interior that is easy to navigate even during the busiest of periods. Passenger experience has been forefront in the way we have designed the station."

Plans in for Museum of London's Smithfield cultural centre

The Museum of London has submitted a planning application to the City of London Corporation to transform a campus of market buildings in West Smithfield into a world-class, 24-hour cultural destination.

The proposals seek to preserve much of the historic fabric of the old market buildings that make up the site, some of which date back to the Victorian era and have fallen into disrepair, by making relatively few contemporary interventions.

Designed by the architectural team of Stanton Williams and Asif Khan with Julian Harrap Architects, the aspiration for this new museum is for it to become one

of the top ten attractions in the capital, capable of welcoming over two million visitors a year.

If planning consent is granted the new Museum of London, one of the biggest cultural projects happening in Europe, would become one of the highlights of the City of London's Culture Mile. Located in the north-western part of the City, it will significantly contribute to the revitalisation of the Smithfield area by building on the opportunities presented by the new Elizabeth line at Farringdon Station.

Sharon Ament, Director of the Museum of London, said: "This is an important milestone for the project, as we formally set out our plans to transform the West Smithfield site and in doing so transform the idea of what a museum can be. It has been four years of hard work by a dedicated and talented project team in order to get here and, while we still have a while to go and money to raise before we open the doors to the new Museum, this is nevertheless a significant step forward to turning our vision into reality."

Mace issues multi-million-pound plans for Stevenage

Known as SG1, Mace has submitted a planning application for a multi-million-pound scheme to redevelop 14.5 acres of Stevenage town centre.

The proposals will provide more than 1,800 new homes, 3,500m² of retail and commercial floor space, a new public square, a park and a primary school.

Kevin Cowin, Director at Mace, said: "This is an ambitious and carefully crafted proposal that expresses our confidence in Stevenage town centre. We aim to revitalise the town centre by introducing new homes, vibrant activities, community facilities and inviting public spaces.

"Our vision is to deliver a thriving, successful and attractive heart to Stevenage which will serve the needs of local people and businesses for decades to come."

At the centre of the masterplan fronting onto the Town Square will be a new Public Services Hub for the people of Stevenage. The Hub will be the focal point for a wide range of public services, including NHS health facilities, a new public library, the voluntary sector and Council services.

Mr Cowin added: "During our consultation on the SG1 masterplan over the summer, one of the key things residents and town centre businesses told us was the importance of creating attractive welcoming public spaces where people can meet and relax. Our planning application responds to what local people have told us."

Diary

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

Wednesday 11 March 2020
Stability & second order effects on steel structures
This webinar will give an overview about stability and second order effects on steel structures according to Eurocode 3. Different methods for addressing member and global stability will be discussed, highlighting their differences and particularities

Thursday 19 March 2020
Portal Frame Design course
This course aims to provide in-depth coverage of the major issues surrounding the analysis, design and (crucially) the detailing of portal frames. The course covers frame design to BS EN 1993-1-1. Birmingham

Tuesday 21 April 2020
Floor Vibrations
This Webinar will cover: Theory of Vibration; Simple Methods; Finite Element Analysis; Special cases - Light Gauge and Hospitals and Mitigation Strategies

Thursday 23 April 2020
½ Day Straight to the Point in Eurocode Design course
This four hour course contains minimum theory and maximum hands-on member design – focusing on straight to the point practical design using the Eurocode Blue Book. The course is aimed at designers of orthodox structures where the resistance tables are the preferred way of selecting members. Birmingham

Thursday 23 April 2020
½ Day Wind Actions and Snow Loads to BS EN 1991 course
This short course will cover the calculation of wind actions and snow loads in accordance with the Eurocodes and the UK National Annexes. The presentation on wind actions will cover the recommended approach of considering quadrants around the site for hand calculations. The significant differences compared to the previous BS will be discussed. Birmingham

Offsite manufacturing in the frame

In this article, NSC focuses on lightweight cold formed steel products, a vital component for many steel construction projects.

Designers and specifiers have long recognised the benefits that structural steel offers the construction sector, noting that steel framing is the original offsite framing material. The drive for established offsite construction solutions has been bolstered further by government and the Construction Leadership Council who have earmarked offsite manufacturing and modular construction as a route to increase construction productivity and reduce costs.

Lightweight cold formed steel products play a key role in helping to deliver offsite and modular construction solutions. Whether it is purlins, side rails or steel framing system (SFS) walls and joists supporting cladding and facade solutions, light gauge steel products are utilised across multiple building sectors and light gauge framing producers are geared up to supply large quantities of repetitious products.

These steel products are also known to offer a range of construction-related benefits most notably; sustainability, speed of construction, cost-effectiveness and safety. Wall specifications are developed utilising non-combustible sheathing and insulation products. Cold formed steel sections are popular due to the products' unique lightweight characteristic which makes them easy and safe to handle both during fabrication and construction.

Light steel framing is an offsite manufacturing process that uses pre-fabricated wall panels and other elements to produce load-bearing structures. The basic components are cold formed steel C and Z sections that are rolled from galvanized

Modern SFS are cost-effective and can reduce environmental impact

strip steel in the order of 1.2mm to 3.2mm thickness.

The most common use for load-bearing light steel framing is residential type buildings of two to 14-storeys e.g. apartments, care homes, hotels and student accommodation. However, it is also used in housing, particularly two and three-storey houses with habitable roof space, and applications where its light weight is beneficial, such as mixed-use buildings, including residential space over supermarkets.

This enables the designers to reduce lead in periods for large schemes to acceptable durations by utilising 'just in time' manufacturing methods, typically a lead in period for a 10-storey hotel could be 10-14 weeks.

Stephen Ginger, Managing Director for Metsec Framing and Purlins says: "The general interest in offsite construction is at an all-time high. Cold rolled steel systems can deliver significant cost, quality, performance and reduced on site labour advantages. Cold rolled manufacturers must be able to provide evidence that their products have been designed to the appropriate BS / EN standards and will perform in terms of fire, acoustic and thermal performance.

"Metsec has undertaken significant testing over the last five years at the BRE at Watford with various sheathing, plasterboard and insulation products. The industry has rightly changed since the tragic events of the Grenfell tower and manufacturers must provide full evidence and supporting documentation of how cold rolled systems perform."

How are light gauge steel products produced?

A very wide range of lightweight structural sections are produced by cold forming thin gauge strip material to specific section profiles. These are often termed light gauge or cold formed steel sections. In most cases, galvanized steel strip material is used. The cold rolling process begins with coils of galvanized strip steel that are uncoiled, slit into appropriate widths and then cold roll-formed into the final product form.

Profile shapes and section sizes do vary but most sections use lips at free edges and indented profiles to provide stiffness and avoid premature failure by local buckling. Thicknesses for load-bearing products typically vary from 1.2mm to 3.2mm.

Light Gauge Steel products

Infill walling is used across many different construction sectors; health, education, commercial, residential and leisure and is the generic name given to external walls that are built between the floors of the

Lightweight steel is versatile and can be used to form long span trusses

primary structural frame of a building, and which provide support for the cladding system. Infill walls do not support floor loads but they do resist wind loads applied to the façade, and may be used within both steel and concrete-framed buildings.

Light gauge steel load-bearing walls are used in light steel-framed buildings and modular construction, supporting floor loads, loads from walls above and resisting lateral wind loads. They generally include bracing to provide lateral stability to the building. Light gauge steel load-bearing walls use vertical C sections of typically 90mm to 120mm depth. Both internal and external walls may be designed as load-bearing.

Wall panels are typically pre-fabricated as storey-high units or may be site assembled from C sections that are delivered cut-to-length, but this is less common

Composite cladding panels are used for the external envelope for a wide range of building structures including industrial, distribution, retail and residential. They provide an efficient building envelope with energy efficiency benefits. Composite panel cladding systems are produced as a sandwich construction comprising two profiled sheets bonded either side of an insulating core, generally mineral fibre or similar material. As the panels act compositely, shallow profiles can be used.

Purlins and side rails are often termed secondary steelwork and are available in a variety of shapes and a wide range of sizes. The depth of the section typically lies between 120mm and 340mm, with the profile thickness usually varying between 1.2mm and 3.2mm.

In single storey industrial buildings where steel commands over 92% of UK market share, the cladding panels or sheets are normally supported by a system of light gauge steel purlins and side rails spanning between the portal frame rafters and columns respectively.

> *"The general interest in offsite construction is at an all-time high."*

Light steel frame construction and installation

Scaffolding is an important requirement for the light steel frame installation process. Two lifts of scaffolding are generally required around the perimeter of the slab prior to beginning installation of the light steel framing. It is common for scaffolding to be tied to the light steel frame from level three onwards.

Load-bearing light steel framing uses storey high wall panels that are delivered to site appropriate for the build sequence. These are unloaded from the lorry and placed on the floors near to where they are to be installed.

One lorry can deliver 30 to 50 wall panels which are typically required to build two houses or four apartments. Wall panels on the first level are positioned on the foundation slab, if necessary, galvanized steel shims are used to level the panels.

Panels must be fixed to the adjacent panels. The fixings used are system specific and should be stated on construction drawings and comply with the structural calculations.

Floors in light steel frame buildings are generally either; light steel joisted floors with boarding, panelised floor cassettes or composite slab floors. The installation process for each of these floor types is appreciably different, with each having their own best practice considerations.

STEEL for life

Sponsors Light Gauge Steel

Gold: voestalpine Metsec plc

Dykes running parallel to the river meant a crane with a long reach was required

Complex crossing

The successful installation of a five-span bridge across the River Witham in Lincolnshire is testament to the capabilities of the project engineers and the benefits of collaborative working.

FACT FILE
River Witham Bridge, Lincolnshire
Main client: Lincolnshire County Council
Main contractor: Galliford Try
Structural engineer: WSP
Steelwork contractor: Cleveland Bridge
Steel tonnage: 1,400t

Forming an integral element of the 7.5km-long Lincoln Eastern Bypass, the River Witham Bridge has been delivered for Lincolnshire County Council by main contractor Galliford Try.

The overall project is part-funded by a £50m Central Government capital grant and will improve Lincoln's infrastructure, encourage growth, minimise traffic congestion and enhance the inner-city environment.

Cleveland Bridge was awarded the contract for the supply and installation of the 1,400t, 225m-long River Witham Bridge, which included substantial haunch girders, manufactured in weathering steel.

According to Cleveland Bridge, while the production process was straightforward, the challenges for the transportation and installation of the bridge components were many and varied, requiring extensive planning, close collaboration with suppliers and main contractor and the expertise of the steelwork contractor's highly experienced team.

The bridge girders had to be transported to site by road, a task that included travelling through the centre of the historic city of Lincoln. In order to reach the site, the delivery team also had to negotiate a restrictive road network close to the site, which meant that only relatively shorter girder lengths could be delivered to the north bank of the river.

To meet the County Council's objective to have the Lincoln Eastern Bypass open in 2020, construction of the structure on site was scheduled for autumn/winter 2019. This is a challenging time for any bridge installation due to the weather conditions and this project was further impacted by the location being on a flood plain.

This led to the site being inaccessible for sustained periods as a result of inclement weather conditions, further reducing the installation timescale afforded to the project team. The installation window was also minimised by activity on the River Witham, which is a busy waterway, preventing extended periods of closure.

The location presented numerous further challenges, which were successfully overcome through innovative and creative approaches. Most notably, for the installation, the project team had to manage a very wide workable area as a result of dykes running parallel on both sides of the river.

As a result, and primarily because the reach required and weight of the components would be so significant, Cleveland Bridge worked closely with cranage specialist Sarens for the use of a specialist 1,200t-capacity crane, which is one of only a handful in the UK.

In total the bridge consists of six (three pairs), 225m-long bridge girders, but these components had to be manufactured as smaller sections, due to the site having a very compact and restrictive assembly area.

Cleveland Bridge delivered the girders to site in 27 pairs, which varied in length from 16.7m to 31.6m. Each pair had its main cross member bracing installed in the factory as the girders were paired up, while the smaller bracing that links the pairs was installed after the steelwork was lifted into place.

Preparing the components for installation was complicated by the limited assembly area, requiring the use of self-propelled modular transporters, also provided by Sarens, to move the girders to the crane. The location of the crane on the site also brought challenges, with three pairs of girders placed at the top of an embankment, which required them to be transported down a steep slope in order to place them in position for installation.

To mitigate the issue of the long work area over the watercourses, including the span of the river and the dykes, the girders were installed in two sessions with the crane positioned on one bank of the river to install half of the bridge girders, and then transported to the opposite bank to erect the remaining girders.

This meant installation engineers only had to work over the water to join the central splices to compete the steel erection.

Due to the size of the crane and the weight of the required lifts, considerable preparatory works were undertaken, including piling, to withstand extremely large ground bearing pressures in close proximity to the river.

The weight of the lifts was increased significantly by the addition of the deck and parapet formwork, which was fitted to the spliced girders by Galliford Try prior to erection. However, this minimised further work at height and provided a safe working platform for the subsequent casting of the concrete deck slab.

Installation of the bridge was completed

In order to be installed, bridge girders were tranported to the crane by SPMTs

in December 2019, enabling the County Council to maintain its timescale for the opening of the Lincoln Eastern Bypass project later this year.

Cleveland Bridge Project Manager Dan Sowerby said: “Delivering this project with optimum efficiency is testament to the expertise and collaborative working employed throughout the process.

“It enabled the project team to overcome multiple challenges, particularly from the site location and the autumn/winter weather conditions, through an innovative approach to problem solving and the combined capabilities of the parties involved.

“The comprehensive working practices we employed on site, which was endorsed by Cleveland Bridge winning the 2019 Make UK award for Health, Safety and Wellbeing, ensured that the project was completed with no accidents, contributing to the company achieving more than one million hours with no reportable RIDDOR incidents and an Accident Frequency Rate of zero.”

The girders were delivered to site in 27 pairs

FACT FILE
Glass Works, Barnsley
Main client: Barnsley Metropolitan District Council
Architect: IBI Group
Main contractor: Henry Boot Construction
Structural engineer: Adept Consulting Engineers
Steelwork contractor: Billington Structures
Steel tonnage: 5,000t

Building a better town centre

The £35M Glass Works scheme, which includes retail and leisure facilities, will deliver an improved and redeveloped town centre for Barnsley.

Known as the Glass Works, which is a nod to the town's industrial heritage – this multi-million-pound project will revitalise central Barnsley and is being delivered over two phases, with the initial phase having been completed in early 2019.

IBI Group's Seamus Lennon says: "The regeneration of Barnsley will make a significant difference to the local people and open up the opportunity for further investment into the area."

"Acting as architects, planners and landscape architects on this project, we are working with the council to shape a place that is attractive, accessible and characterful – making a better Barnsley for future generations."

A central covered boulevard will separate the project's main structures

Currently underway, phase two includes a number of elements, all of which are steel-framed. These consist of a multi-storey car park that sits on top of a two-storey retail block, further retail units and a covered boulevard, a 13-screen cinema and a bowling alley that incorporates ground floor restaurants.

Local labour is at the heart of the project as Ryan O'Loughlin, Director of locally-based Henry Boot Construction, says: "We are delighted to be partnering with Billington Structures on phase two of The Glass Works project, which continues our commitment to investing in Barnsley-based businesses wherever possible.

"After a successful collaboration on phase one, we are confident Billington will deliver a high-quality scheme on programme and to budget, and awarding this contract ensures a significant amount is reinvested in local jobs and training opportunities for the people of Barnsley."

As with many town or city centre projects, the steel erection programme for this scheme is being undertaken in a sequenced method. This is due to the confined nature of the site and the proximity of the existing and operating businesses, not least the recently completed market hall, which formed an integral part of phase one.

The majority of the project, consisting of the retail block (ZD), the cinema (ZB) and car park and retail structure (ZC), are centred around a 10m-wide covered boulevard, which separates the three buildings.

Spanning the boulevard and forming the glazed canopy is a series of galvanized rectangular hollow section (RHS) steel members that connect to the adjoining structures at second floor level.

These buildings and the boulevard, are

How the Barnsley town centre will look at the end of the year

The cinema block takes shape

built above a basement level, which will accommodate back-of-house facilities and storerooms. The steelwork for the basement generally follows the grid pattern of the retail zone, which is directly above.

Although the structures that sit above the basement are connected via this lower level, they are structurally-independent and either separated by movement joints or physical gaps.

Of the three structures, block ZD is entirely retail. Measuring 97m × 30m and consisting of two levels of shops, it abuts the market hall on one side and the boulevard on two elevations. Steelwork is based around an 8m × 9.25m grid pattern, although parts of the structure have an increased grid with beams spanning up to 12m.

Facing one elevation of the ZD retail block, structure ZC incorporates two levels of shops at ground and first floor, with a six-level multi-storey car park above.

The main part of this structure measures 73m × 37m, while the lower two-storey retail zone continues eastwards along the boulevard to create an extra 52m × 19m area.

In order to maximise the efficiency of this structure, two different grid patterns have been used for each of the functions. The lower retail levels are based around a column spacing of 7.5m × 9m, while the upper car park levels have a larger grid of 7.5m × 18m as one intermediate column is omitted. Because the car parking levels will be partially exposed to the elements, all of this steelwork is galvanized.

Vehicular access to the car park will be via a circular 28m-diameter rotunda structure, attached to one of the rear elevations.

The third of the structures that front the boulevard is the cinema block, which is said to have the most complicated steelwork design of all the buildings.

According to Billington's design team, it has a highly complex layout and design. On plan, it has two angled intersecting rectangles, 37m × 85m and 54m × 39m and consists of a ground floor retail level with multiple levels above, including cinema access, projection levels and escape routes. Roof level has a concrete-decked plant area running along the middle.

Because of the array of uses the upper cinema levels must accommodate, there is a transfer structure separating the regular retail grid pattern from the first floor's bespoke column layout.

Adding to the complicated nature of the column layout, most of the cinema screens are a different size. The largest is an IMAX screen with a maximum span of 24m. However, there is no beam spanning that distance, as two intermediate spine members have been added to ensure no beam is longer than 9m.

There are also extensive cantilever and transfer areas, particularly within the cinema access level, as well as around the upper projection rooms. A combination of trusses and beams have been used to act as transfer members in these areas.

A further challenging issue for the design of the cinema block is a culvert which crosses the site under the building's footprint. This has been bridged using five one-storey-high transfer trusses, which had to be brought to site in three sections.

According to Henry Boot Construction Contracts Manager Mathew Clarke, all the steelwork has to be brought to site in erectable loads so as not to exceed the 25t capacity of the site's tower cranes.

Delivering the steel to site in manageable loads will also play a key role in the final stages of the cinema block's construction programme. In order to help the follow-on trades get an early start on their work, some of the screen's internal steelwork such as terracing, which is formed by steel rakers, will be installed after the main steel frame is complete.

The rakers will be installed by manoeuvring them into the building via the ground floor and then positioning them with blocks and tackles.

Separated from the main boulevard section of the development by a new landscaped public space, the bowling alley building is a standalone structure (known as block ZA) measuring 59m × 35m.

Similar in design to the other structures, whereby the steel frame's stability is derived from bracing and a steel core, the building accommodates a bowling alley on its upper level, with the ground floor housing restaurants.

The Glass Works phase two is due to be complete by the end of 2020.

Phase one

The initial phase of the Glass Works consisted of the construction of a new public library and the refurbishment of Barnsley's indoor market building.

For the latter building Billington Structures fabricated, supplied and erected 450t of steelwork to strengthen the existing concrete frame to allow the hall to be reconfigured. New steelwork was also erected to form a new façade. The recently opened two-storey building accommodates a food market on the ground floor with cafes and eateries on the upper level.

Retain and enlarge

Terraces have been added to the building

A complex project that has included a partial demolition programme, strengthening of existing steelwork and the addition of new upper floors has extensively refurbished and reinvented an outdated steel-framed office block in the City of London.

FACT FILE
60 London Wall, London
Main client: LaSalle Investment Management
Architect: EPR Architects
Main contractor: Skanska
Structural engineer: Heyne Tillett Steel
Steelwork contractor: Severfield
Steel tonnage: 2,100t

What to do with outdated and inefficient city centre commercial buildings is a conundrum developers have been battling with for many years. Demolish the structure and start again with a new scheme is one option, but nowadays refurbishment is more commonly seen as a cost-effective and environmentally-friendly solution.

Each building has to be looked at individually and each option will have its own particular merits, although demolishing a high-rise building in a crowded city centre can be highly challenging.

To reuse an existing structure's fabric and foundations, reconfigure the building's internal layout, and in some cases, add extra floors, is a design solution many developers are opting for in order to create cost-effective, modern, efficient and high-quality work spaces.

This is the design option taken at 60 London Wall, where a 1990s steel-framed office building in the heart of the square mile is being extensively refurbished and reconfigured.

EPR Architects Project Director Jason Balls says: "We sought to reinvent the existing, outdated building, by repositioning the main core whilst adding large flexible floorplates and external terraces.

"Re-using and adapting the existing steel frame reduced the carbon footprint of the building, effectively saving the energy embodied in the existing fabric."

The building's fabric has been stripped back to its original steel frame, the cores have been removed, perimeter steelwork and slab around two elevations replaced for a new façade, and new floors added to the top of the structure, all of which has increased the overall floor space by more than 50%.

"The original building was a seven-storey office block with ground floor retail and a basement. We have removed the uppermost floor, as it didn't fit our new design, and then added five new levels increasing the structure to 11-storeys," explains Skanska Project Director Tony Boorer.

Main contractor Skanska began on-site during August 2017 and although much of the original building has been retained, the initial works included a large-scale reworking of the structure, which required a year-long demolition and enabling works programme.

Large amounts of temporary supports had to be installed to allow the removal of the four original concrete cores – one in each corner of the building. These areas were then subsequently infilled with new steelwork and metal deck flooring. Another central area of the building was then demolished in order to create space for a new stability-giving concrete core.

A 3m-wide section of the perimeter slab was also removed along the London Wall and Copthall Avenue elevations, to facilitate the installation of a new façade.

The design for the new scheme has maintained the original 7.5m × 7.5m column spacings, but along these elevations a much smaller 3m perimeter column spacing was originally in place to match the cladding system.

Perimeter columns that were on grid were retained and strengthened, while those that were deemed to be off grid, and would have disrupted the visual aspect of the project, where removed.

The original building had three atria, one has been infilled to create more floor space, while the other two have been reconfigured to create one new larger atrium in the centre of the building. This atrium has a glazed roof to allow natural light to penetrate the inner parts of the structure. Cantilevering breakout spaces, that are positioned at various points within the void, will give the space some architectural interest.

By opting to reuse as much of the existing steel frame as possible, a number of the original columns and beams had to be surveyed in order to determine whether they could carry the additional loads from the new floors.

"Only 60 of the existing columns, which equates to about 10%, needed to be strengthened to carry the additional loads," explains Heyne Tillett Steel (HTS) Engineer Jimmy Reading.

"While below ground, our investigations and detailed analysis helped us increase the allowable load capacity of the existing piles. The only area of the project that required new piles was for the new core."

Most of the steelwork, new and existing, will be left exposed within the new scheme, giving the office floors a modern industrial look. The old building's steelwork was encased in concrete and this had to be broken out in order to shot blast, prime and then apply a high-spec paint to the existing steelwork.

Because the steelwork will be exposed and on show in the final scheme, all of the strengthening work needed to be done with the upmost care and diligence.

Mr Boorer says: "Initially, the design for the building did not include exposed internal steelwork and so the columns that needed strengthening would have had extra plates welded between the flanges of the UC column, effectively turning a traditional column into a box section, which would have been easier to plasterboard over.

"Once the design changed, we decided to weld strengthening plates to the outside of the flanges, thereby keeping the column's original shape, which is a better option for steelwork that will be on show."

The majority of the reconfigured floors offer approximately 4,000m² of office space, however this decreases slightly floor-by-floor, as there are roof terraces from level six upwards along two elevations.

The new upper floors all have large landscaped outdoor terraces that are up to 10m-deep in places. Steelwork contractor Severfield had to install a series of large transfer beams, up to 10t in weight, in order to create the structural frame's steps and the subsequent change in column positions.

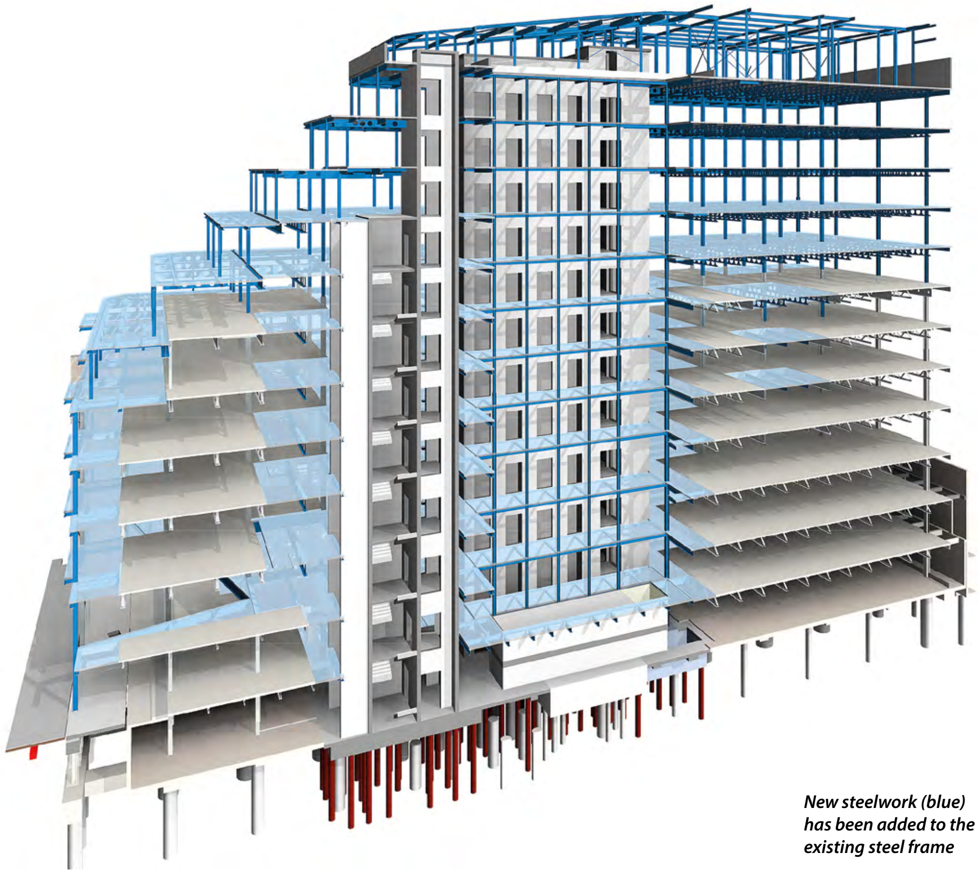
On top of the uppermost office floor, Severfield has also erected a large plant deck.

In summary, Severfield Project Manager David McGurk says: "Tying into an existing steel frame meant a substantial amount of new connections were required on site (either drilled or welded) to support the new framing.

"To get this right meant a heavy reliance on extensive site surveys and photographic information fed back to our drawing office, so that connections could be designed to adapt to the pre-existing steel framing.

"With that in mind, tying into the existing, 30-year old and partially demolished, steel frame meant that existing levels sometimes didn't marry up with new theoretical floor levels. The resolution to these issues required extensive collective input from Skanska, HTS, EPR Architects and ourselves to ensure the project was delivered on time and to the required specification."

60 London Wall is due to complete in June 2020.



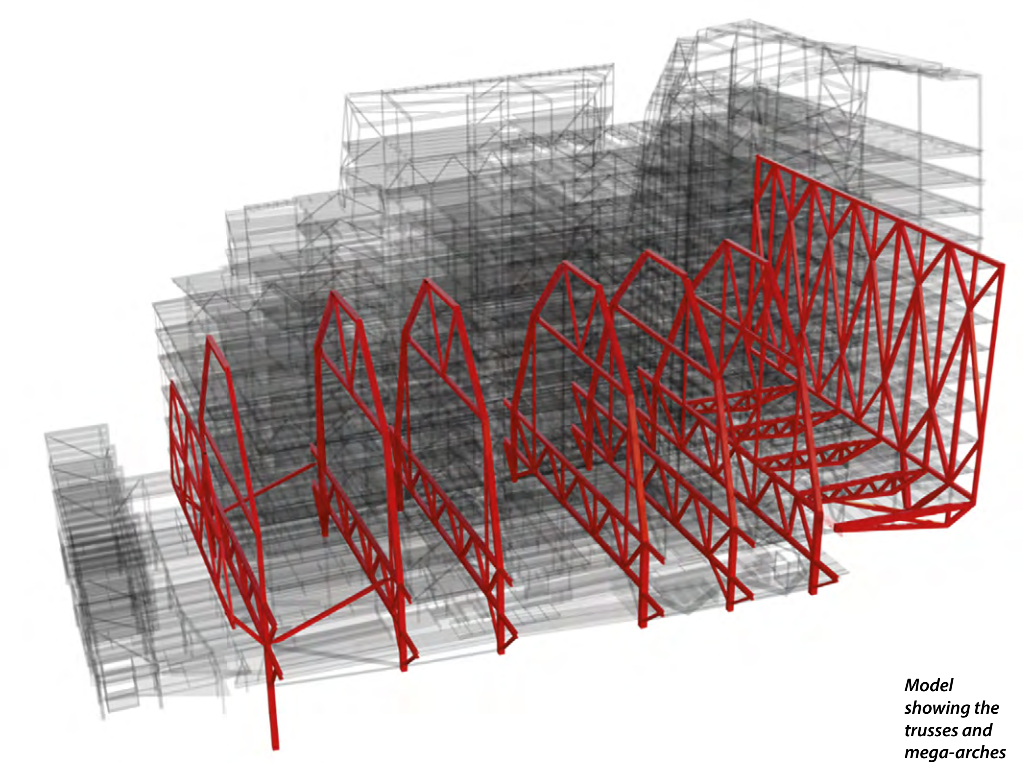
New steelwork (blue) has been added to the existing steel frame

New floorplates have been created by infilling atria

The new central atrium will have a glazed roof

Signature structure highlights regeneration

Spanning an important London underground station and featuring an architecturally-detailed exposed steel frame, 21 Moorfields is a feat of engineering. Martin Cooper reports.

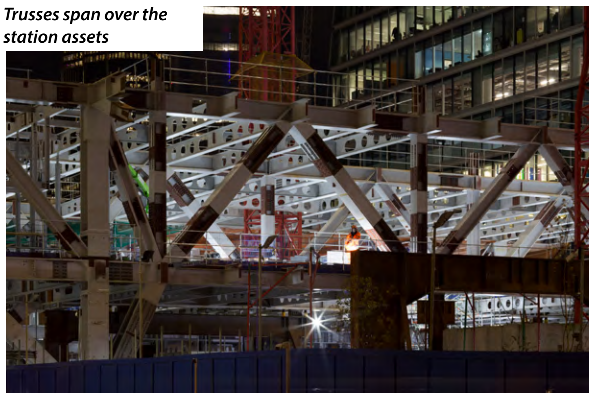


Model showing the trusses and mega-arches

Visualisation showing the numerous underground constraints

FACT FILE
21 Moorfields, London
Main client: Landsec
Architect: WilkinsonEyre
Main contractor: Sir Robert McAlpine
Structural engineer: Robert Bird Group
Steelwork contractor: William Hare
Steel tonnage: 17,000t

Trusses span over the station assets



Construction of the eagerly anticipated Crossrail (Elizabeth Line) scheme has been the catalyst for the regeneration of the previously undervalued Moorgate area of the City of London.

A number of new and recently completed commercial buildings have helped to breathe new life into the area, while the western ticket hall to Liverpool Street Elizabeth Line station, which is adjacent to Moorgate underground station, will ensure an increased footfall, once the rail scheme opens in 2021.

Located directly above Moorgate's underground and Crossrail assets, another commercial development known as 21 Moorfields is predicted to further regenerate the area, while also enhancing the urban landscape of this transportation hub with its eye-catching exposed steelwork design.

Pre-let to Deutsche Bank as its new London headquarters, the 17-storey building is also a complex engineering feat, with a steel frame that spans the full width of the station, a distance which is equivalent in length to the wingspan of a jumbo jet.

Prior to construction beginning, a number of design proposals had been put forward for the site, which had been vacant for a number of years. But as Robert Bird Group (RBG) Associate Director Chris Papanastasiou explains, the current design was the most viable.

Maximising the usable capacity of the existing slab, which is also the station roof, the structural design features six 7m-deep 'Launching Trusses', up to 55m in length, built up from, and subsequently spanning over, the station below to create temporary support for the floors above during the construction programme. In the building's completed form, the trusses revert to permanent features within the circulation spaces.

The building's first floor and main entrance level as well as a mezzanine (second floor) are accommodated within the truss depth. Below the trusses, the existing slab supports a basement, at ground floor level, for the building's back-of-house and plant equipment areas.

During construction, each truss facilitates the construction of a 10-storey steel fabricated box section mega arch, which in turn, once completed, enables the construction of the concrete floor slabs and the remaining steel frame.

The mega arches are integrated into the building's cores up to level 7, only exiting on to the floorplates at levels 7 to 10, thereby minimising the number of columns present within each 100m long, 60m wide floorplate to only six.

Above the mega arches, the structure continues upwards in a more traditional beam and column design to level 17, with

> "The complexity of the structure with limited points of support could only be delivered with a steel frame."

stability provided by braced steel cores, minimising dead weight on the foundations. Incorporated into these floors are terraces and set-backs to satisfy a number of rights to light issues, and historical sight paths to St Paul's cathedral.

"The combined solution of low-level temporary / permanent launching trusses, mega arches, and a construction methodology developed largely by RBG, offered an efficient solution to this heavily constrained site. One that allowed the building to work in terms of cost and floor area, whilst allowing the station to remain open throughout the construction programme, thereby providing the design's important viability," explains Mr Papanastasiou.

Before any steelwork could be erected on site, a piling conundrum had to be solved. There are a number of constraints below the site, including six London Underground lines, two Crossrail tunnels and a ticket hall, station services and a major sewer. All of which meant that locations for any new piles were extremely limited.

A total of 16 piles, each 2.4m or 1.8m in diameter and 60m-long, were threaded between the numerous under-site constraints. Each pile is working extremely hard, and according to RBG they are all working to their upmost capacity and there may not be any foundation solution in London that is working harder.

Finding the spaces for the piles was one challenge, but getting a piling rig onto site was another. The existing slab over the live Moorgate station did not have sufficient capacity to support a rig, so RBG, in conjunction with steelwork contractor William Hare, designed a 2,000t temporary steel grillage that covered most of the existing deck.

This temporary piling rig support was assembled onsite with numerous beams that supported 20mm-thick steel plate sections.

Once the piling had been completed, RBG and William Hare were able to reuse much of the grillage as temporary steelwork to support the launching truss installation, which contributed to reducing the carbon footprint of the building.

Each truss/arch system is connected to, and founded on, a pile at each end but, because of the limited locations, the spacing between each truss and the shape of each arch varies. The piles and their locations have consequently dictated the column lines for the entire superstructure.

"The longest grid spacing is 21m and the beams that span this gap had to be brought to site in two pieces as they were too long to be transported through the City of London," says William Hare Project Director Francisco Loureiro.

"All of the steelwork, including the trusses, has to be brought to site in sections that are within the tower crane's lifting capacity. To maximise the crane usage and to reduce the amount of pieces requiring site connections, the trusses were delivered in pieces of up to 25t."

Connected to the trusses is a series of large nodes that in turn connect to the arches and adjoining steelwork. With numerous connections, the nodes weigh up to 20t each and had to be brought to site on trestles.

"Because the site is very constrained with ▶20

The Moorgate façade will feature a seven-storey exposed truss

▶19 little room for manoeuvring the steelwork, each node was placed on a trestle in a position that allowed it to be lifted straight from the truck and into its final position," explains Mr Loureiro.

As well as the arches, the trusses also support columns along their width that form the upper levels of the scheme. The columns are arranged in a primary grid of 12m with a secondary grid accommodating spans of 13.5m up to 21m.

Maximising the project's footprint, the eastern façade (along Moorgate) cantilevers out over the Crossrail ticket office with a seven-storey, fully-exposed perimeter truss creating a signpost for the building's main entrance below.

The cantilever is created by a combination of tripod supports from foundations inboard of the perimeter, and a series of bowstring trusses, measuring 25m-long and each weighing 70t. The bowstring trusses are hung from the east face truss over the Crossrail station, while the building footprint is further cantilevered at either end by a tripod structure at the south-east corner and a large V-frame at the north-east end.

The underside of the bowstring trusses (soffit) will be lit up in the completed scheme, drawing people into the building and towards the main central full-height atrium.

Similar to many other steel elements on the project, the bowstring trusses were designed with the site's tower crane capacities in mind, and consequently they were detailed as compound sections and fabricated in six pieces, which were spliced together during the erection programme.

"The east truss, like much of the structure's steelwork, has been designed to be lean and efficient, with force paths reflected in the size and weight of sections. All of the detailing is expressed, as the entire truss will be exposed and so the connections are all flush. The nodes are also detailed to highlight the bolts as they will be on show," says WilkinsonEyre Associate Director Melissa Clinch.

The tripod is fabricated from box sections and, as the name suggests, it has three arms that radiate outwards from its 10m-high top. The base is founded on a concrete column, which is positioned within the Crossrail ticket hall and was designed and constructed as part of the rail project's package in preparation for an over-site development, completing the array of challenging site constraints.

Melissa Clinch says the project team along with the client – Landsec – trialled an enhanced procurement process, focussed on collaboration to find the most suitable suppliers to ensure maximum efficiency on this complex development.

"William Hare were brought on board at an early stage and this helped us work out how each piece of steel could be fabricated, detailed and, importantly, delivered to site."

Summing up, Sir Robert McAlpine Project Director Bob Kay says: "This project demonstrates what is possible if you really put your mind to it. The complexity of the structure with limited points of support could only be delivered with a steel frame.

"21 Moorfields could well prove to be a template for numerous over-site developments in London and shows that they can be used to create some fantastic architecture and valuable assets."

21 Moorfields is due to be complete in early 2021.

Site welds

David Brown of the SCI comments on the site welds to be completed at 21 Moorfields

One of the themes at 21 Moorfields is the sense of magnitude. Long spans, "mega" arches, with load focussed on a small number of piles – a theme which continues with the connections.

The connections shown (in picture right) are very large site welds between the members and the fabricated node. The plates on the faces are temporary, used to align the members and hold them in position whilst the welding is completed. Some appreciation of the very large welds can be seen by looking closely at the size of the preparation on the members – the welds are huge.

Welded details like this demand specialist expertise, which will be provided by the Responsible Welding Coordinator (RWC), a required role for CE Marked steelwork. Although these welds at 21 Moorfields are unusually large, the same principles apply to all welds. Welding procedures will be prepared, designed to avoid cracking in the weld and heat affected zone. The weld procedures reflect the Carbon Equivalent Value (CEV) of the parent material and the combined thickness at the weld, which is the total thickness of material in each direction at the joint. More material means a larger heat sink, allowing faster cooling, which increases the risk of cracking. Similarly, a higher CEV increases the risk of cracking. The RWC will specify a welding consumable with a particular hydrogen scale (less hydrogen reduces the risk of cracking). The RWC will also specify the welding parameters – the electrical parameters, consumable size and travel speed, which affect the heat input – another variable to be carefully managed.

Designers will find the figures in BS EN 1011-2 educational and useful background, as the figures relate CEV, hydrogen scale, heat input and combined thickness to necessary preheat temperatures. Designers should treat this as educational only – the responsibility lies with the RWC, for all welds, not just the welds at 21 Moorfields.

The individual completing the welds will be appropriately qualified, and for certain, the welds will be tested on completion. All of these issues are addressed in Section 7 of BS EN 1090.

The site welds at 21 Moorfields are completely different in scale and significance to the common 6 mm or 8 mm fillet welds, but demonstrate that with careful thought, planning and expert input, even the large site welds shown can be completed successfully.

Further reading

Guide to site welding (SCI publication P161)
SIGNS SN08, SN46
Typical welding procedures (BCSA publication 58/18)

Made to measure

A 30-strong workforce of skilled costume makers have been temporarily relocated, while the Royal Shakespeare Company redevelops its workshops with the aid of steel construction. Martin Cooper reports from Stratford-upon-Avon.

A steel frame provides the required open spans

For more than 60 years the Royal Shakespeare Company (RSC) has employed a team of specialists in dress and garment-making, millinery, armoury, jewellery production and shoemaking, in short, a production line to make more or less everything worn or carried by actors performing at its world-famous venues in Stratford-upon-Avon.

"We have the largest in-house costume-making department of any British theatre, but unfortunately the premises were no longer fit-for-purpose as they consisted of a collection of run-down buildings that have been added to and altered over the years," explains RSC Technical Director Stephen Rebbeck.

The project, which has been funded by public contributions and a National Lottery grant, includes demolishing most of the old costume department, with the exception of two listed buildings and constructing a new three-storey steel-framed building that will connect into the retained structures to provide new costume workshops, a maintenance workshop and an exhibition space.

All of this work is being carried out in an extremely confined site, sandwiched between a row of RSC-owned cottages, usually rented out to actors, a Grade II-listed 1887 former scene dock which was built for the original Shakespeare Memorial Theatre and the RSC's Headquarters building.

Interestingly, the old scene dock, which is set in the middle of the row of cottages is being converted into an entrance hub, not

The site is sandwiched between a number of existing and listed buildings

just for the new costume department, but also for the HQ. Another important aspect of the project is to ensure the new premises are visitor friendly, with plenty of corridor space to allow tour groups to be shown around without disturbing the workers.

Working on behalf of the RSC, main contractor Stepnell started on site in February 2019. As well as demolishing large parts of the old costume workshop, the company also excavated a new lower ground floor. Originally the site's footprint was sloped, and the new lowest level matches the front elevation and its new entrance.

The excavation programme meant Stepnell had to underpin the two retained structures and the surrounding cottages, to make sure they remained structurally stable throughout the works.

The new lower level necessitated the installation of a sheet pile retaining wall around two sides of the site's footprint. This sheet pile wall, in conjunction with traditional concrete pads, forms the foundations of the new steel superstructure.

The old scene dock building is being converted into the workshop's entrance

The RSC has the UK's largest in-house costume making department

The steel frame has been designed with braced bays and moment frames to provide lateral stability in two orthogonal directions. The new building has suspended slabs at first and second floor levels, which are constructed with concrete cast onto a total of 750m² of profiled metal decking.

Topping the new build, the roof profile is blended into its traditional surroundings, taking the form of a succession of steeply pitched slate tiled roofs. The steel design has utilised A-shaped trusses, to span the full width of each of the five building portions to give open-plan, column-free spaces at first and second floor levels. The roof trusses are tied at eaves level and use Macalloy tension rod bracing across their double height roof spaces.

Using a steel solution for the project offered the team a number of advantages, including a relatively easy way of forming the 10m-long open spans, according to Stepnell Project Manager Will Smith.

"A steel frame solution is also well suited to the size and confined nature of the site, while being ideal for the repeating pitched roof configuration.

"The challenging project delivery programme also dictated the use of a structural steel frame."

As the site is surrounded by historic and sensitive buildings, a significant project challenge was accessing and feeding the site, and working within the limited erection working space.

There is only one confined access route onto site, and this meant lay-down areas and craneage space became progressively tighter as steelwork contractor Coventry Construction erected the new structure.

All of these challenges were exacerbated by the fact that there is no machine access to the building perimeter so all of the steel erection had to be carried out from within the building footprint.

"We did think about having a tower crane on site, but there isn't enough room and so the steel frame for the new structure was erected over a four-week period using a single 30t-capacity mobile crane," says Mr Smith. "In addition, the new steel structure abuts the retained fragile historic buildings, prompting the need for a delicate and precise erection procedure."

As well as the scene dock building, which is being converted into an entrance with two new steel-framed floors, the other retained historic structure is a former stables block. This structure originally formed part of the costume workshop cluster and will be amalgamated and connected into the new scheme.

Structural steelwork is being further utilised within these retained historic buildings, to form stability bracing to the existing delicate traditional brick and timber roof structures.

The final steelwork element of the project was the erection of a single storey link building that joins the new build costume workshops to the RSC HQ, creating the new access route from the entrance hub.

The new costume workshops are scheduled to be complete by July, when the RSC's team of specialist workers will be able to return from their temporary premises. The first tours of the site will then begin in January 2021.

FACT FILE
Royal Shakespeare Company costume workshop, Stratford-upon-Avon
Main client: Royal Shakespeare Company (RSC)
Architect: Aedas Arts Team
Main contractor: Stepnell
Structural engineer: HSP Consulting
Steelwork contractor: Coventry Construction
Steel tonnage: 130t

"My heart is true as steel." William Shakespeare, A Midsummer Night's Dream

Joint stiffness calculation

The UK National Annex to BS EN 1993-1-8 discourages the use of numerical methods to calculate joint stiffness, relying on previous satisfactory practice. Despite this, interest in joint stiffness is increasing. Richard Henderson of the SCI illustrates the joint stiffness calculation process set out in the standard and discusses some of the issues.

Introduction

Traditionally, the UK has relied on successful past practice to classify orthodox connections – usually either nominally pinned or nominally rigid. The UK National Annex to BS EN 1993-1-8 endorses that approach and discourages the use of the numerical methods in the standard. The NA also indicates that frame design methods which utilise semi-continuous connection behaviour (the "wind-moment" method, for example) should not use a numerically calculated value, but the connection behaviour should be supported by test evidence or previous satisfactory performance.

Designers are paying increasing attention to connection stiffness, possibly because software is readily available which makes the calculation possible even for unorthodox arrangements. For a limited range of connections, BS EN 1993-1-8 presents a process to calculate the connection stiffness, utilising the same basic connection components which are used to calculate the moment resistance of the joint.

For designers not using software, this article demonstrates the numerical approach given in the standard. The example uses an existing connection design from P398[1], where the basic connection components are already established, shortening the process.

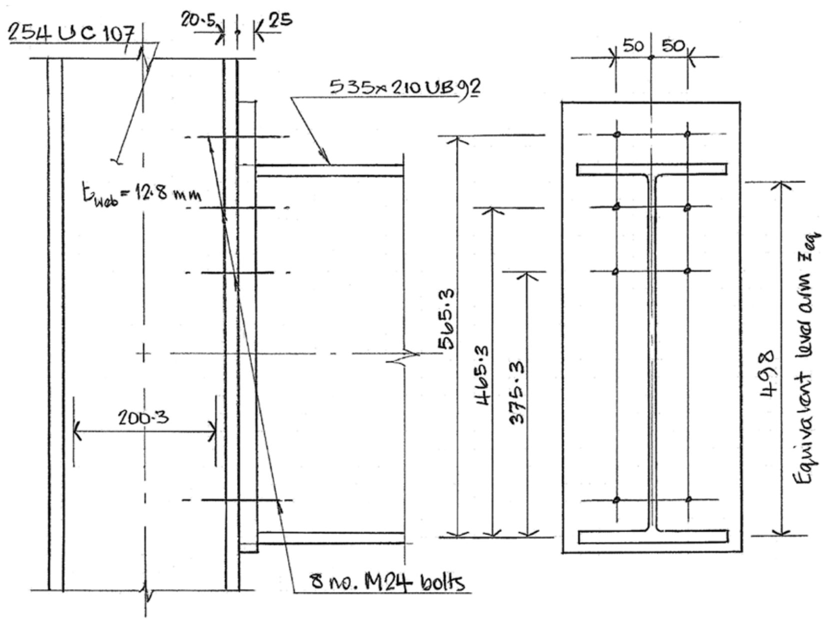


Figure 1: Joint arrangement

Numerical example

Example C2 from the Green Book for moment connections, SCI publication P398, has been used as a convenient bolted beam to column connection to illustrate the method of calculating joint stiffness. According to the UK National Annex to BS EN 1993-1-8, this joint is nominally rigid, simply because it has been designed in accordance with the Green Book.

The expression for the joint stiffness S_j is given in clause 6.3.1(4) as:

$$S_j = \frac{Ez^2}{\mu \Sigma_i \frac{1}{k_i}}$$

where: z is the lever arm defined in para 6.2.7 which depends on the type of joint and the arrangement of the bolts;
μ is the stiffness ratio defined in para 6.3.1(6);
k_i is the stiffness coefficient for basic joint component i.

The stiffness ratio, the ratio of the initial joint stiffness to the stiffness under load, is unity if the applied joint moment $M_{j,Ed}$ is less than 2/3 of the joint resistance $M_{j,Rd}$. For higher moments, the value of μ is given by:

$$\mu = (1.5\, M_{j,Ed}/M_{j,Rd})^{\psi}$$

The exponent ψ depends on the type of connection and is given in Table 6.8.

Example C2 in P398 is a bolted beam to column joint. The arrangement and member sizes are shown in Figure 1. The moment resistance of the joint is given as 416 kNm.

The relevant stiffness coefficients are identified in Table 6.10 of BS EN 1993-1-8 and for a single sided connection with two or more bolt rows in tension are listed as k_1, k_2 and k_{eq}. Para 6.3.3.1(4) indicates that the equivalent stiffness k_{eq} is based on k_3, k_4, k_5 and k_{10}. The joint components these stiffnesses refer to are given in Table 6.11 in the code and are listed in Table 1.

Stiffness coefficient	Component	Expression
k_1	Column web panel in shear	$0.38A_{VC}/\beta z$; (z_{eq} gives a more accurate value, see Fig 6.15)
k_2	Column web panel in compression	$0.7b_{eff,c,wc}t_{wc}/d_c$; ∞ if stiffened
k_3	Column web panel in tension	$0.7b_{eff,t,wc}t_{wc}/d_c$; ∞ if stiffened
k_4	Column flange bending	$0.9l_{eff}t_{fc}^3/m^3$
k_5	End-plate in bending	$0.9l_{eff}t_p^3/m^3$
k_{10}	Bolts in tension	$1.6A_s/L_b$

Table 1: Relevant stiffness coefficients

▶26

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▶24 The quantities are defined in Table 2, taken from the example in P398.

Item	Description	Value
A_{VC}	shear area of column	3810 mm²
β	transformation parameter (Table 5.4)	1.0
z_{eq}	lever arm	498 mm
b_{eff}, l_{eff}	effective width or length	various
t	component thickness	12.8, 20.5, 25 mm
d_c	clear depth of web	200.3 mm
m	distance of bolt centre to root radius or weld toe	various
A_s	Tensile area of bolt	353 mm²
L_b	Bolt length	70.5 mm

Table 2: Values of parameters

The first challenge in calculating the stiffness components appears to be the determination of the equivalent lever arm for the column web stiffness coefficient k_1. However, the parameter depends on the effective stiffness for each bolt row r, and the height of the bolt row relative to the centre of compression of the beam flange so the calculation of the effective stiffnesses is in fact the real task. The effective stiffness for each bolt row must be calculated from the stiffness components k_i for that bolt row, given by:

$$k_{eff,j} = \frac{1}{\Sigma_i \frac{1}{k_{i,r}}}$$

The equivalent lever arm is given by:

$$z_{eq} = \frac{\Sigma_r k_{eff,r} h_r^2}{\Sigma_r k_{eff,r} h_r}$$

To complete the list of expressions for stiffness, the equivalent stiffness is given by:

$$k_{eq} = \frac{\Sigma_r k_{eff,r} h_r}{z_{eq}}$$

Using the data from Examples C1 and C2 in P398, the relevant effective widths of plate or lengths of T-stub can be determined. The value corresponds to the effective width or length which gives the lowest resistance for that component in the determination of the resistance of the joint. Where the lowest resistance is for several bolt rows acting as a group, the value for each bolt row is the total length divided by the number of bolt rows in the group, leading to the stiffnesses corresponding to each bolt row. The values are given in Table 3

Stiffness	minimum b_{eff}, l_{eff} (mm)	b_{eff}, l_{eff} (mm)	$k_{i,1}$	$k_{i,2}$	$k_{i,3}$
$k_{3,r}$	$r_1 + r_2 + r_3$	422/3	6.3	6.3	6.3
$k_{4,r}$	$r_1 + r_2 + r_3$	422/3	6.3	6.3	6.3
$k_{5,1}$	r_1	125	30.6	-	-
$k_{5,r}$	$r_2 + r_3$	379/2	-	46.5	46.5
k_{10}	-	-	8.01	8.01	8.01
$k_{eff,r}$	-	-	2.10	2.15	2.15

Table 3: Stiffness values

As an example calculation for the first bolt row,

$$k_{eff,1} = \frac{1}{\frac{1}{6.3} + \frac{1}{6.3} + \frac{1}{30.6} + \frac{1}{8.01}} = 2.10$$

The heights of the bolt rows above the centre of compression are shown in Figure 1 and finally the value of z_{eq} can be determined. The value is:

$$z_{eq} = \frac{1.439 \times 106}{2994} = 498$$

The value for the equivalent stiffness is then:

$$k_{eq} = \frac{2994}{498} = 6.01$$

The remaining stiffnesses can also be calculated and the values are $k_1 = 2.91$ and $k_2 = \infty$ because of the presence of the compression stiffener.

The joint stiffness can now be calculated as follows:

$$S_j = \frac{210 \times (533.1 - 15.6)^2}{\mu\left(\frac{1}{2.91} + 0 + \frac{1}{6.01}\right)} = \frac{102}{\mu} \text{ MNm/radian}$$

The effect of the stiffness ratio μ is shown in Figure 2. For the bolted joint being considered, the value of ψ from Table 6.8 is 2.7. If the design bending moment is greater than two thirds of the bending resistance of the joint, the stiffness is reduced as indicated, to a value of about one third of the maximum stiffness when the applied moment approaches the joint resistance. It should be noted that UK practice is often to optimise the design, so a high utilisation might be expected.

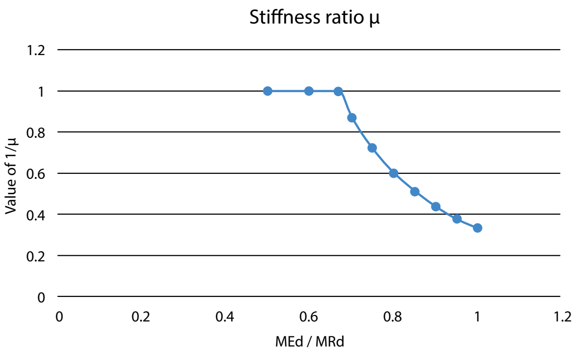

Figure 2: Stiffness ratio, µ

Joint stiffness

Joint classification boundaries on the basis of stiffness are given in clause 5.2.2.5 and Figure 5.4 of BS EN 1993-1-8. The length of the beam and some understanding of the overall frame stiffness is needed, so some assumptions must be made. With reference to Figure 5.4, assuming a 9 m long beam and $k_b = 8$ (for frames with bracing), the requirement for the rigid classification is then $S_{j,ini} \geq k_b \, EI_b / L_b$.

Substituting values, $k_b \, EI_b/L_b = 8 \times 210000 \times 55200 \times 10^4 / 9000 = 1.03 \times 10^{11}$ or 103 MNm/radian which is greater than the stiffness calculated in section 2.0, unless $\mu = 1.0$. This assessment would therefore conclude that the joint can only be assumed to be rigid if the design moment is 2/3 of the bending resistance of the joint, or smaller. For unbraced "other frames" where the beams are at least 10 times as stiff as the columns, $k_b = 25$. So for the rigid classification, the initial stiffness must be at least 322 MNm /radian so the joint would be classified as semi-rigid.

Effects of joint flexibility

BS EN 1993-1-1 clause 5.1.2(1) allows the analysis assumption of perfectly pinned or perfectly rigid, as long as the real joint behaviour does not have a 'significant' effect. As an illustration of the effects of the joint stiffness, the same beam was modelled using finite elements with rotational springs at the supports with stiffness equal to the maximum value calculated. The model is unrepresentative because no columns are included in the model. A 9 m span beam is assumed with a uniform load of 41.1 kN/m, giving a free bending moment of 416 kNm. The choice of load is arbitrary. From classical beam theory, a beam with encastré ends will have a support moment of 2/3 of the free bending moment ie 277 kNm and a mid-span moment of 139 kNm. The mid-span deflection will be 1/5 of the simply supported deflection, calculated to be 30.5 mm due to bending alone (no shear deflection). In a braced frame the joint detailed above can be classified as rigid when carrying a design bending moment of 277 kNm or less.

The FE analysis results give a support moment of 130 kNm and a mid-span moment of 286 kNm, with a maximum deflection (including shear deflection) of 20.9 mm. The support moment is about 47% of the encastré value and the deflection 3.4 times the encastré value. The introduction into an analysis model of joint stiffnesses calculated using BS EN 1993-1-8, although classified as "rigid" clearly has a profound effect on the behaviour of the structure and a decision to adopt a structural scheme that relied on frame stiffness and bolted beam to column joints would need to be considered carefully. The "wind-moment" method was shown to be adequate by frame analysis incorporating connection stiffness demonstrated by test, thus meeting the requirements of the UK National Annex.

Traditional approaches to unbraced frame deflection calculations have assumed that joints are rigid and deformation of the members is the source of overall building deflections, unless joints between members are of significant size relative to the member lengths. Such assumptions may need to be reconsidered for certain structures.

Conclusions

If joint stiffness is to be considered at all:

1) The manual calculation of stiffness is very laborious and it would be unrealistic to try to design a real structure in this way. Design software to calculate the joint stiffness is essential for projects of any significant size.
2) The sequence of design and sizing is likely to be iterative because the joint arrangements could affect both the serviceability and strength limit states.
3) Flexibility of bolted end-plate joints in beam to column connections in unbraced frame structures could have significant effects on the stability of the structure.

[1] Joints in steel construction: Moment-resisting joints to Eurocode 3

AD 437: Curtailment of transverse bar reinforcement in composite beams with steel decking designed using Eurocodes

The purpose of this Advisory Desk Note is to provide guidance on the curtailment of transverse bar reinforcement in slabs on composite beams with steel decking, designed to EN 1994-1-1. Such information was previously presented in AD 325, for design to BS 5950-3.1, but the provisions in EN 1994-1-1, and the clauses in EN 1992-1-1 to which it refers, give more explicit coverage of this topic than the BS rules. The approach to transverse bar curtailment is therefore different.

The transverse reinforcement is provided to transfer longitudinal shear force from the steel beam, via the shear connectors, out into the effective breadth of the slab. Transverse bar reinforcement may be needed to supplement the resistance of the mesh in the slab, and these bars must extend a sufficient distance from the beam centreline.

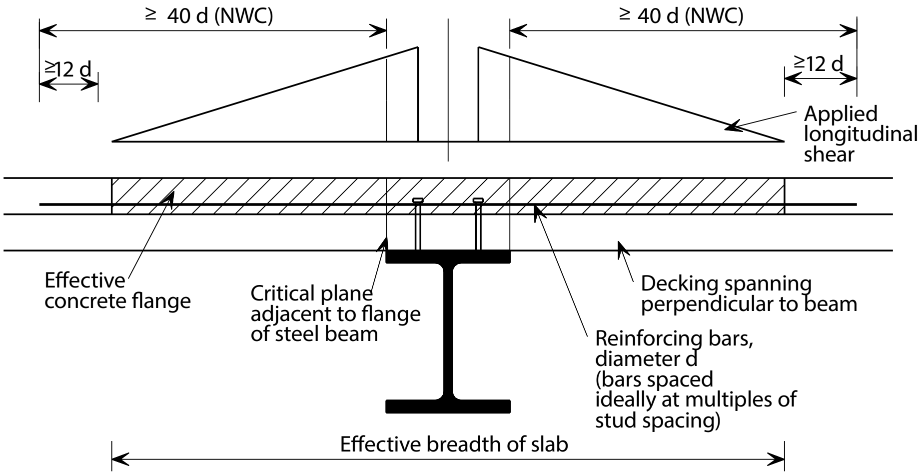

Figure1: Assumed pattern of transverse shear stresses and anchorage lengths, beam with transverse decking

Internal beams

A fundamental difference between EN 1994 and BS 5950 is that the former adopts a so-called 'strut and tie' model, through which shear resistance is determined from consideration of concrete struts in compression and reinforcement ties in tension. A component of the force in the struts resists longitudinal force in the slab, and the component transverse to the beam axis is resisted by the reinforcement.

For composite beams with decking spanning perpendicular to the longitudinal axis of the beam, the critical transverse shear plane is adjacent to the steel flange. However, for decking running parallel to the beam the critical plane is normally in the nearest crest in the decking to the shear connectors (see Figures 1 and 2).

When considering the need for bar anchorage beyond these critical planes, for design to BS 5950, AD 325 made certain assumptions (with both a simplified and rigorous model) about how the force in the slab decreases across the effective width. The Eurocodes remove the need for such assumptions by providing explicit guidance:

1. EN 1994-1-1, 6.6.6.2 makes reference to EN 1992-1-1, 6.2.4
2. EN 1992-1-1, 6.2.4 (7) states that the reinforcement should be anchored beyond the strut requirement (see EN 1992-1-1, Figure 6.7)
3. EN 1992-1-1, 8.4.4 defines how to determine anchorage length

With reference to Point 2, determining the location that corresponds to 'beyond the strut requirement' is not obvious, particularly given that different angles can be chosen for the struts in what can be an iterative procedure. As a (slightly) conservative simplification, the point beyond which anchorage is needed may be assumed to be the critical planes, as defined above. This also results in an approach that is common to that used in design to BS 5950.

Point 3 refers to clauses that consider the tensile strength of the concrete, the strength of the reinforcing bars, and a number of other parameters. For typical bars in typical concrete the result will be a need for an anchorage length similar to the familiar value of 40 *d* (where *d* is the bar diameter). When lightweight concrete is used greater anchorage lengths are required, as a function of the concrete oven-dry density (see EN 1992-1-1, 11.3.1). Should larger bars be chosen than are necessary, such that they are stressed below yield, shorter anchorage lengths will suffice.

Although the Eurocode methodology makes no reference to the effective breadth of slab in the context of transverse shear resistance, this nevertheless remains an area of concrete subject to significant in-plane stresses. In the absence of a more rigorous analysis where a number of planes are considered rather than just the critical plane (which would most likely show that mesh alone is sufficient in the outer reaches of the effective breadth), we therefore recommend that the bars extend at least 12 *d* beyond the effective breadth. This is also in keeping with BS 5950 practice (AD 325 Simplified Method)

It is important to note that when the decking is perpendicular it may contribute to the transverse reinforcement needed, but when the decking is parallel it cannot be taken into account (it has no 'in-plane' tensile resistance so cannot contribute in a strut and tie model).

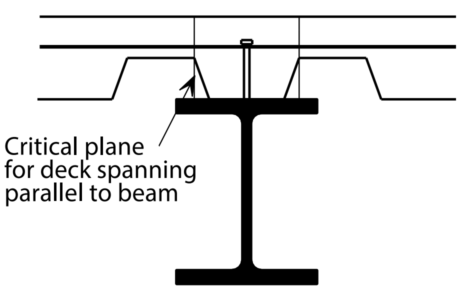

Figure2: Critical plane for deck spanning parallel to beam

Edge beams

Notwithstanding differences in the definition of anchorage length, EN 1994-1-1, 6.6.5.3 contains detailing guidance for edge beams that aligns with that given in BS 5950-3.1:

- If the edge of slab from the centreline of the nearest shear connectors is less than 300 mm then place U-bars around the shear connectors
- Where headed studs are used, the U-bars must have a diameter not less than half that of the studs, and the distance from the edge of the slab to the centreline of the nearest studs should not be less than 6 d_s (where d_s is the stud diameter)

Contact: **Eleftherios Aggelopoulos**
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New and revised codes & standards

From BSI Updates January 2020

BRITISH STANDARDS

BS 7121-3:2017+A1:2019 – TC
Tracked Changes. Code of practice for safe use of cranes. Mobile cranes

BS 7883:2019
Personal fall protection equipment. Anchor systems. System design, installation and inspection. Code of practice.
Supersedes BS 7883:2005

BS EN PUBLICATIONS

BS EN ISO 8504-2:2019
Preparation of steel substrates before application of paints and related products. Surface preparation methods. Abrasive blast-cleaning
Supersedes BS EN ISO 8504-2:2001

BS EN 10025-3:2019 – TC
Tracked Changes. Hot rolled products of structural steels. Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
No current standard is superseded

BS EN 10025-4:2019 – TC
Tracked Changes. Hot rolled products of structural steels. Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels
No current standard is superseded

BS EN 10025-5:2019 – TC
Tracked Changes. Hot rolled products of structural steels. Technical delivery conditions for structural steels with improved atmospheric corrosion resistance
No current standard is superseded

BS EN 10025-6:2019 – TC
Tracked Changes. Hot rolled products of structural steels. Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition
No current standard is superseded

BS EN ISO 15614-1:2017+A1:2019 – TC
Tracked Changes. Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc and gas welding of steels and arc welding of nickel and nickel alloys
To be completed.

BRITISH STANDARDS REVIEWED AND CONFIRMED

BS ISO 834-10:2014
Fire resistance tests. Elements of building construction. Specific requirements to determine the contribution of applied fire protection materials to structural steel elements

BRITISH STANDARDS WITHDRAWN

BS EN ISO 8504-2:2001 (BS 7079-D2:2000)
Preparation of steel substrates before application of paints and related products. Surface preparation methods. Abrasive blast cleaning
Also numbered BS 7079-D2:2000. Superseded by BS EN ISO 8504-2:2019

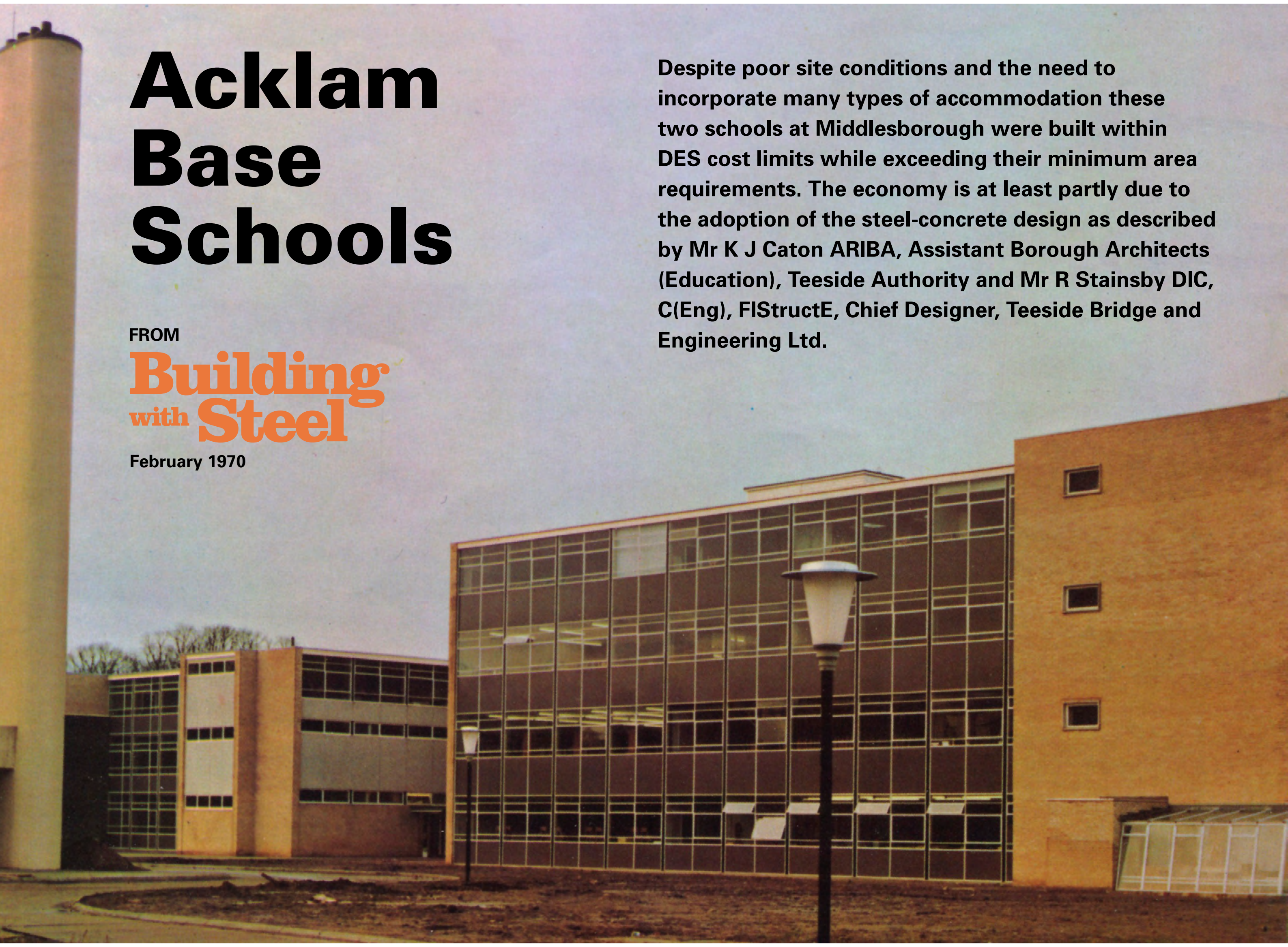
NEW WORK STARTED

ISO 24658-1
Cranes. Principles of safety management for wind by users. General
Will supersede None

Acklam Base Schools

Despite poor site conditions and the need to incorporate many types of accommodation these two schools at Middlesborough were built within DES cost limits while exceeding their minimum area requirements. The economy is at least partly due to the adoption of the steel-concrete design as described by Mr K J Caton ARIBA, Assistant Borough Architects (Education), Teeside Authority and Mr R Stainsby DIC, C(Eng), FIStructE, Chief Designer, Teeside Bridge and Engineering Ltd.

FROM
Building with Steel
February 1970



School blocks and the boiler house flue stack associated with the sports block

This project is planned as a couple of buildings forming two 8-form-entry secondary schools for 2,400 students aged 11 to 16 years and the first stage of this development so far erected and occupied serves 1,800 students.

Each school, with an upper and lower school, has the shared facilities of a sports block containing two gymnasia, a teaching swimming pool and a sports hall along with the communal use of the base playing fields. They will eventually share in the second stage of the development, a hexagonally shaped drama theatre with an associated closed-circuit television studio. The latter will be the hub of a system which, alongside the national circuits, will enable programmes to be mounted from a number of specialist areas within the complex.

The upper schools have been planned to provide for the full operation of a 'house system' where pastoral care and corporate feeling may be achieved with the smaller grouping of students who have opted to continue their studies at these schools rather than transfer at the age of 13 to one of the high schools for continued study through the 6th form courses.

The poor site conditions of silty-sandy substrata with a high water table necessitated the use of the well-point dewatering system for the construction of foundations and the erection the swimming pool above ground level rather than as an excavated construction. The 70ft high over flue stack from the central boiler house consists of a glass fibre casing stiffened by an internal steel lattice frame considerably reducing the ground load. Roofs generally are decked with 3in channel reinforced wood wool slabs which, to single storey buildings and the top floor of 2, 3 and 4 storey blocks are left exposed and decorated. These, along with the relatively light-weight concrete upper floors and insulated steel section curtain walling, have contributed to the necessary aim of reducing foundation loading.

At an early stage, the decision was made to use steel floor beams designed to act compositely with the 4in deep precast floor units. Insitu concrete filling local to the beam made the necessary solid section for composite action.

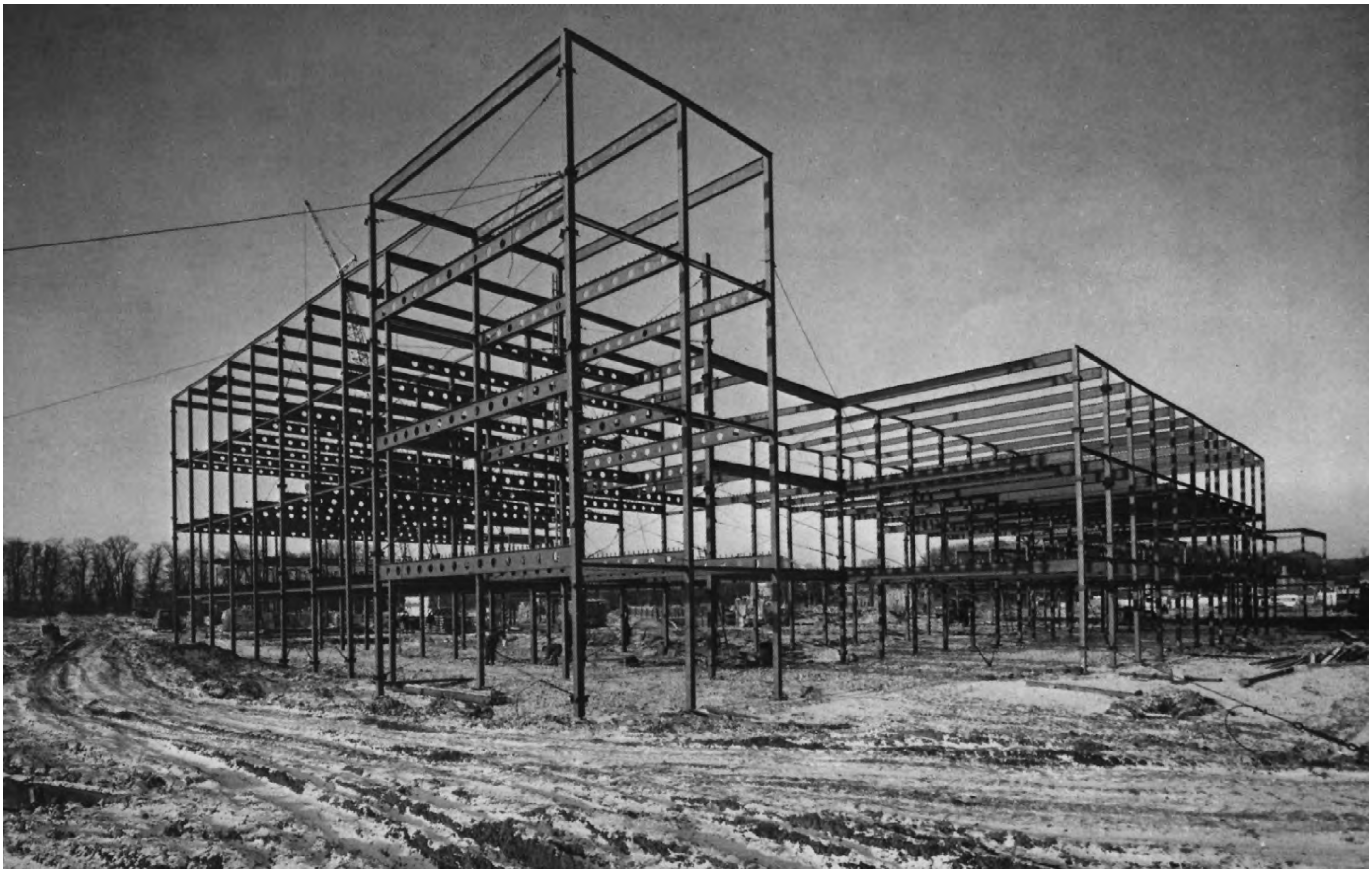
Using the ultimate load design method from BS Code of Practice CP117 Part I, it was found that a 16in beam could generally be adopted for spans of up to 34ft. Stud connectors ¾in diameter by 3in long, averaging 7½in centres, with ⅜in bar transverse reinforcement ensured adequate shear connection between steel and concrete.

A cost saving was achieved by using more composite construction compared with a more orthodox stanchion and beam construction with bearers. A further bonus is the much stiffer floor support resulting, as the moment of inertia on the combined Tee beam is nearly three times that of the plain steel member.

Stanchions were composed of 6in × 6in or 7in × 7in box sections built up from 6in × 3in and 7in × 3½in channels welded toe to toe. The welded faces were dressed flush in the transverse plane of the building giving a very satisfactory visual result.

Where steelwork remains exposed internally it was important that the connections should be clean and neat, free of bolt heads and nuts. A simple vertical plate connection welded to the column face was used and the webs of the floor beams were site welded to the plate.

A suspended ceiling was necessary in the science blocks to accommodate the considerable quantity of services in the steel beam depth. Beams were planned to be of castellated type to ensure sufficient points for access through them. In the event it proved cheaper to use solid universal beams with 8in diameter holes at 22in centres burnt out of the webs. This had the advantage of leaving a solid web where dictated by the stress conditions



Steel frame showing the 8in diameter holes in the universal beams and the temporary wire bracing ropes

without expensive welded infilling of castellation being necessary.

Sufficient brickwork panels were included in the design to ensure lateral stability for each building. The concrete floors serving as horizontal diaphragms to bring wind forces to the stiff panels.

In the erection stage of the steel frame, temporary restraint was provided in the form of ½in diameter steel ropes connected with bulldog clips to steel yokes clamped to the beam or column members. These remained in position whilst floor units were erected and were finally removed as the wall panels were built.

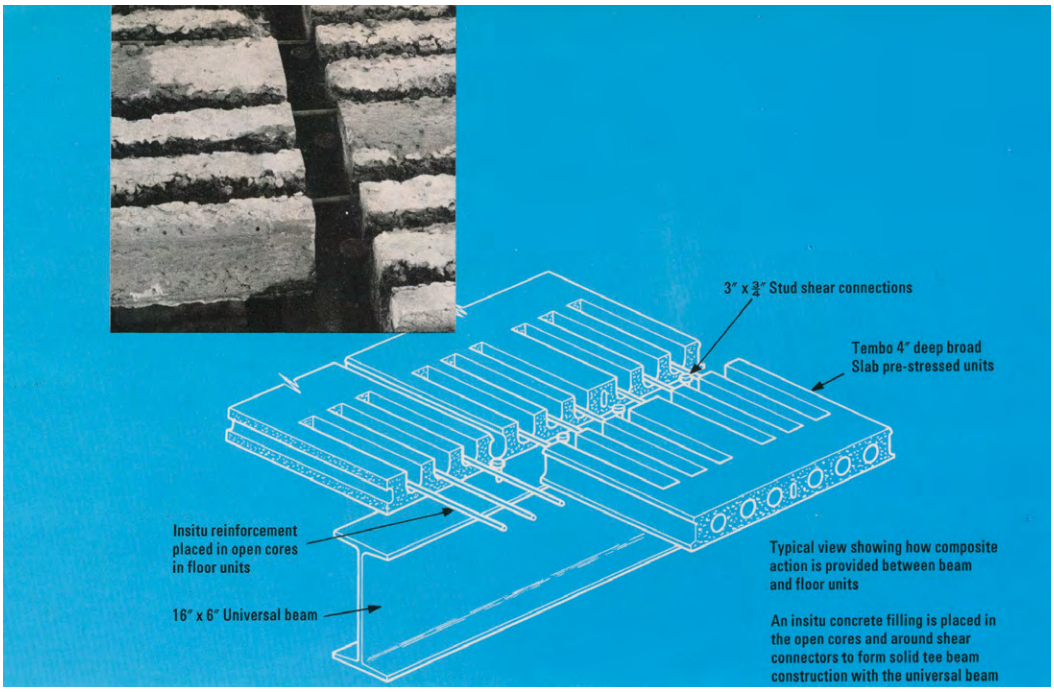
The steel framed sports block, with the gymnasia at first floor level and with the changing accommodation under, has the 100ft × 60ft sports hall spanned by portal frames at 20ft centres. Latticed roof trusses to the swimming pool and gymnasia are in RHS and CHS members shop welded complete.

The present development, with allowance for foundation abnormals, has been carried out within the current Department of Education and Science cost limits. This client has benefited from building areas greater than the minimum laid down and from the special provisions within the sports block. This may be due in no small measure to the economic and efficient contribution of the steel-concrete design.

The first school was occupied 22 months after commencement, the second school 24 months, with overall completion, other than planting and playing fields in 27 months.

Acknowledgements
Mr J V Wall, FRIBA, Borough Architect, County Borough of Teeside.

The sports hall showing the steel portal frames



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- **H** Large span trusswork (over 20m)
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- **L** Architectural steelwork for staircases, balconies, canopies etc
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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, ● = Member)

Notes

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

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

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
A C Bacon Engineering Ltd	01953 850611			●	●	●	●				●			●			2			Up to £3,000,000
Adey Steel Ltd	01509 556677	●		●	●	●	●	●	●	●	●			●	●	✔	3		Silver	Up to £4,000,000
Adstone Construction Ltd	01905 794561			●	●	●	●									✔	2	✔	Gold	Up to £3,000,000
Advanced Fabrications Poyle Ltd	01753 653617				●	●	●	●		●	●			●	●	✔	2			Up to £800,000
AJ Engineering & Construction Services Ltd	01309 671919			●	●		●		●	●	●			●	●	✔	4		Silver	Up to £3,000,000
Angle Ring Company Ltd	0121 557 7241												●			✔	4			Up to £1,400,000*
Arminhall Engineering Ltd	01799 524510	●			●	●		●		●	●			●	●	✔	2			Up to £800,000
Arromax Structures Ltd	01623 747466	●		●	●	●	●	●	●	●	●	●		●	●		2			Up to £800,000
ASME Engineering Ltd	020 8966 7150			●	●	●		●		●	●			●	●	✔	4		Gold	Up to £4,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●	●	●			●	●			●	●	✔	2			Up to £1,400,000
B D Structures Ltd	01942 817770			●	●	●	●				●	●		●	●	✔	2	✔	Silver	Up to £1,400,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●			●	✔	4			Up to £1,400,000
Barnshaw Section Benders Ltd	0121 557 8261												●			✔	4			Up to £1,400,000
BHC Ltd	01555 840006	●	●	●	●	●	●	●			●	●		●	●	✔	4	✔	Silver	Above £6,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	Gold	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●		4			Up to £3,000,000
Bourne Group Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●		●	●	●	✔	4			Up to £6,000,000
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●				●	●	✔	4		Silver	Up to £4,000,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●		●	●	●		●	●	✔	4	✔	Gold	Above £6,000,000
Cementation Fabrications	0300 105 0135	●			●		●	●			●		●	●	●	✔	3		Gold	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●		●	●	●			✔	4		Gold	Above £6,000,000
CMF Ltd	020 8844 0940				●		●	●		●	●				●	✔	4			Up to £6,000,000
Cook Fabrications Ltd	01303 893011			●	●		●			●	●			●	●		2			Up to £1,400,000
Coventry Construction Ltd	024 7646 4484			●	●	●	●	●	●	●	●	●		●	●	✔	4			Up to £1,400,000
D H Structures Ltd	01785 246269			●	●		●				●						2			Up to £40,000
D Hughes Welding & Fabrication Ltd	01248 421104				●	●	●	●	●	●	●		●	●	●	✔	4			Up to £800,000
Duggan Steel	00 353 29 70072	●	●	●	●	●	●	●	●		●				●	✔	4			Up to £6,000,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●	●	●	●	●			●	●	✔	3		Gold	Up to £3,000,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●	●	●	●	●	●		●	●	✔	4	✔	Gold	Up to £6,000,000
EvadX Ltd	01745 336413			●	●	●	●	●	●	●	●	●			●	✔	3		Gold	Up to £3,000,000
Four Bay Structures Ltd	01603 758141			●	●	●	●	●	●	●	●			●	●		2			Up to £1,400,000
Four-Tees Engineers Ltd	01489 885899	●			●		●	●	●	●	●		●	●	●	✔	3		Member	Up to £2,000,000
Fox Bros Engineering Ltd	00 353 53 942 1677			●	●	●	●	●		●	●				●		2			Up to £2,000,000
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●				●	●	✔	2			Up to £1,400,000
G.R. Carr (Essex) Ltd	01286 535501	●		●	●			●			●			●	●	✔	4			Up to £800,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
H Young Structures Ltd	01953 601881			●	●	●	●	●						●	●	✔	2		● green	Up to £2,000,000
Had Fab Ltd	01875 611711				●				●	●	●				●	✔	4			Up to £3,000,000
Hambleton Steel Ltd	01748 810598		●	●	●	●	●	●			●	●		●		✔	4		● grey	Up to £6,000,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●	✔	2			Up to £3,000,000
Intersteels Ltd	01322 337766	●			●	●	●	●		●				●	●	✔	3			Up to £2,000,000
J & A Plant Ltd	01942 713511				●	●									●		4			Up to £40,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●				●	●		●			4			Up to £6,000,000*
Kiernan Structural Steel Ltd	00 353 43 334 1445	●		●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	● orange	Above £6,000,000
Kloeckner Metals UK Westok	0113 205 5270												●			✔	4			Up to £6,000,000
LA Metalworks	01707 256290				●	●				●	●			●	●	✔	2			Up to £2,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●					✔	2		● grey	Up to £6,000,000
Legge Steel (Fabrications) Ltd	01592 205320			●	●		●		●	●	●			●	●		3			Up to £800,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●				●	✔	4		● green	Up to £2,000,000
M J Patch Structures Ltd	01275 333431				●					●	●				●	✔	3			Up to £1,400,000
M&S Engineering Ltd	01461 40111				●				●	●	●			●	●		3			Up to £2,000,000
Mackay Steelwork & Cladding Ltd	01862 843910			●	●		●			●	●			●	●	✔	4			Up to £1,400,000
Maldon Marine Ltd	01621 859000				●	●		●	●	●	●			●	●	✔	3			Up to £1,400,000
Mifflin Construction Ltd	01568 613311			●	●	●	●				●						3			Up to £3,000,000
Murphy International Ltd	00 353 45 431384	●			●		●	●	●		●				●	✔	4			Up to £1,400,000
Newbridge Engineering Ltd	01429 866722	●	●	●	●	●	●	●			●	●				✔	4		● grey	Up to £2,000,000
North Lincs Structures	01724 855512			●	●					●	●				●		2			Up to £400,000
Nusteel Structures Ltd	01303 268112						●	●	●	●				●		✔	4		● orange	Up to £3,000,000
Painter Brothers Ltd	01432 374400	●			●				●	●	●				●	✔	3			Up to £6,000,000*
Peter Marshall (Steel Stairs) Ltd	0113 307 6730									●					●	✔	2			Up to £1,400,000*
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●		3			Up to £1,400,000
Robinson Structures Ltd	01332 574711			●	●	●	●				●				●	✔	3			Up to £2,000,000
S H Structures Ltd	01977 681931	●		●	●	●	●	●	●	●	●	●			●	✔	4	✔	● orange	Up to £2,000,000
SAH Engineering Ltd	01582 584220			●	●	●				●	●			●	●		2			Up to £800,000
SDM Fabrication Ltd	01354 660895	●	●	●	●	●	●				●			●	●	✔	4			Up to £2,000,000
Severfield plc	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	● orange	Above £6,000,000
SGC Steel Fabrication	01704 531286				●					●				●	●	✔	2			Up to £200,000
Shaun Hodgson Engineering Ltd	01553 766499	●		●	●		●			●	●			●	●	✔	3			Up to £1,400,000
Shipley Structures Ltd	01400 251480			●	●	●	●		●	●	●			●	●		2			Up to £3,000,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●	●	●	●			●				●		2	✔		Up to £2,000,000
South Durham Structures Ltd	01388 777350			●	●	●				●					●		2			Up to £1,400,000
Southern Fabrications (Sussex) Ltd	01243 649000				●	●				●	●			●	●	✔	2			Up to £1,400,000
Steel & Roofing Systems	00 353 56 444 1855	●		●	●	●	●				●	●		●	●	✔	4			Up to £3,000,000
Structural Fabrications Ltd	01332 747400	●			●	●	●	●	●	●	●			●	●	✔	3		● grey	Up to £1,400,000
Taunton Fabrications Ltd	01823 324266				●	●				●	●			●	●	✔	2		● grey	Up to £2,000,000
Taziker Industrial Ltd	01204 468080	●		●	●		●			●	●		●	●	●	✔	3			Above £6,000,000
Temple Mill Fabrications Ltd	01623 741720			●	●	●	●			●	●			●	●	✔	2			Up to £400,000
Traditional Structures Ltd	01922 414172			●	●	●	●	●	●		●			●	●	✔	3	✔	● grey	Up to £2,000,000
TSI Structures Ltd	01603 720031			●	●	●	●	●			●			●			2	✔		Up to £2,000,000
Underhill Engineering Ltd	01752 752483				●		●	●	●	●	●			●	●	✔	4	✔		Up to £3,000,000
W I G Engineering Ltd	01869 320515				●					●					●	✔	2			Up to £400,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✔	4			Above £6,000,000
Westbury Park Engineering Ltd	01373 825500	●		●	●	●	●	●	●	●	●				●	✔	4		● green	Up to £800,000
William Haley Engineering Ltd	01278 760591				●	●	●									✔	4		● orange	Up to £6,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	● orange	Above £6,000,000
WT Fabrications (NE) Ltd	01642 691191			●	●	●	●				●			●	●	✔	4			Up to £40,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)

RQSC
The Register of Qualified Steelwork Contractors Scheme

Steelwork contractors for bridgeworks

BCSA

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

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

- **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, ● = Member)

Notes

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

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

BCSA steelwork contractor member	Tel	FB	CF	SG	PG	TW	BA	CM	MB	SRF	FRF	AS	QM	FPC	BIM	NHSS 19A	NHSS 20	SCM	Guide Contract Value [1]
AJ Engineering & Construction Services Ltd	01309 671919	●			●	●	●	●	●			●	✓	4				Silver	Up to £3,000,000
Billington Structures Ltd	01226 340666	●		●	●	●	●					●	✓	4	✓	✓	✓	Gold	Above £6,000,000
Bourne Group Ltd	01202 746666	●			●	●				●		●	✓	4	✓		✓	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	●	●	●	✓	4			✓		Up to £6,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●	●	●	●		●	●	●	✓	4			✓	Silver	Up to £4,000,000
Cementation Fabrications	0300 105 0135	●		●	●	●	●					●	✓	3			✓	Gold	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Above £6,000,000
D Hughes Welding & Fabrication Ltd	01248 421104	●		●		●			●	●	●	●	✓	4			✓		Up to £800,000
Donyal Engineering Ltd	01207 270909	●		●						●	●	●	✓	3			✓	Silver	Up to £1,400,000
ECS Engineering Services Ltd	01773 860001	●			●	●	●		●			●	✓	3				Gold	Up to £3,000,000
Four-Tees Engineers Ltd	01489 885899	●			●	●	●		●	●	●	●	✓	3			✓	Member	Up to £2,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●				●				●		●	✓	4	✓		✓	Gold	Up to £6,000,000
M Hasson & Sons Ltd	028 2957 1281	●	●	●	●	●	●	●	●	●		●	✓	4			✓	Member	Up to £2,000,000
Millar Callaghan Engineering Services Ltd	01294 217711	●	●	●	●	●	●	●	●	●	●	●	✓	4			✓		Up to £1,400,000
Murphy International Ltd	00 353 45 431384	●	●	●	●	●	●					●	✓	4			✓		Up to £1,400,000
Nusteel Structures Ltd	01303 268112	●	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Up to £4,000,000
S H Structures Ltd	01977 681931	●	●	●	●	●	●	●	●	●	●	●	✓	4	✓		✓	Gold	Up to £2,000,000
Severfield (UK) Ltd	01204 699999	●	●	●	●	●	●	●	●	●	●	●	✓	4	✓	✓	✓	Gold	Above £6,000,000
Structural Fabrications Ltd	01332 747400	●		●	●	●	●			●	●	●	✓	3				Silver	Up to £1,400,000
Taziker Industrial Ltd	01204 468080	●		●	●	●	●	●	●	●	●	●	✓	3		✓	✓		Above £6,000,000
Underhill Engineering Ltd	01752 752483	●	●	●	●	●				●	●	●	✓	4	✓		✓		Up to £3,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●		●	✓	4	✓	✓	✓	Gold	Above £6,000,000
Non-BCSA member																			
Centregreat Engineering Ltd	029 2046 5683	●		●	●	●	●	●	●	●	●	●	✓	4					Up to £2,000,000
Cimolai SpA	01223 836299	●	●	●	●	●	●	●	●	●	●	●	✓	4		✓	✓		Above £6,000,000
CTS Bridges Ltd	01484 606416	●	●	●	●	●	●	●	●	●		●	✓	4			✓	Member	Up to £1,400,000
Ekspan Ltd	0114 261 1126	●				●			●	●	●	●	✓	2					Up to £400,000
Francis & Lewis International Ltd	01452 722200											●	✓	4			✓	Gold	Up to £2,000,000
Harrisons Engineering (Lancashire) Ltd	01254 823993	●		●	●	●	●	●	●	●		●	✓	3		✓			Up to £1,400,000
Hollandia Infra BV	00 31 180 540 540	●	●	●	●	●	●	●	●		●	●	✓	4					Above £6,000,000*
HS Carlsteel Engineering Ltd	020 8312 1879									●	●	●	✓	3			✓		Up to £200,000
IHC Engineering (UK) Ltd	01773 861734											●	✓	3			✓		Up to £400,000
In-Spec Manufacturing Ltd	01642 210716									●	●	●	✓	4			✓		Up to £400,000
Kelly's Welders & Blacksmiths Ltd	01383 512 517											●	✓	2			✓		Up to £200,000
Lanarkshire Welding Company Ltd	01698 264271	●		●	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Up to £2,000,000
Total Steelwork & Fabrication Ltd	01925 234320	●		●		●						●	✓	3			✓		Up to £3,000,000
Victor Buyck Steel Construction	00 32 9 376 2211	●	●	●	●	●	●	●	●	●		●	✓	4		✓	✓	Silver	Above £6,000,000

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
Gene Mathers	0115 974 7831
Griffiths & Armour	0151 236 5656
Highways England Company Ltd	08457 504030
Inspire Insurance Services	02476 998924
Sandberg LLP	020 7565 7000
Structural & Weld Testing Services Ltd	01795 420264
SUM Ltd	0113 242 7390

Industry Members

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

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

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

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

SfL Steel for Life Sponsor

Structural components

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
Albion Sections Ltd	0121 553 1877	✓	M	4			
BW Industries Ltd	01262 400088	✓	M	3			
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			
Fabsec Ltd	01937 840641		N/A				
Farrat Isolevel	0161 924 1600	✓	N/A				
FLI Structures	01452 722200	✓	M	4	20		
Hadley Industries Plc	0121 555 1342	✓	M	4		● (Silver)	
Hi-Span Ltd	01953 603081	✓	M	4		● (Member)	
Jamestown Manufacturing Ltd	**00 353 45 434288**	✓	**M**	**4**	**20**		**Headline**
Kingspan Structural Products	01944 712000	✓	M	4		● (Gold)	
Lionweld Group	01642 233238	✓	M	4			
MSW UK Ltd	0115 946 2316		D/I				
Prodeck-Fixing Ltd	01278 780586	✓	D/I				
Structural Metal Decks Ltd	01202 718898	✓	M	2			
Stud-Deck Services Ltd	01335 390069		D/I				
Tata Steel – ComFlor	**01244 892199**		**M**				**Silver**
voestalpine Metsec plc	**0121 601 6000**	✓	**M**	**4**		● (Gold)	**Gold**

Computer software

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
SDS/2 Ltd	07734 293573		N/A				
StruMIS Ltd	01332 545800		N/A				
Trimble Solutions (UK) Ltd	**0113 887 9790**		**N/A**				**Silver**

Steel producers

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
British Steel Ltd	01724 404040	✓	M				
Tata Steel – Tubes	**01536 402121**	✓	**M**				**Silver**

Manufacturing equipment

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
Behringer Ltd	01296 668259		N/A				
Cutmaster Machines (UK) Ltd	**07799 740191**		**N/A**				**Bronze**
Ficep (UK) Ltd	**01924 223530**		**N/A**				**Gold**
Kaltenbach Ltd	**01234 213201**		**N/A**				**Silver**
Lincoln Electric (UK) Ltd	0114 287 2401	✓	N/A				
Peddinghaus Corporation UK Ltd	**01952 200377**		**N/A**				**Gold**
Wightman Stewart (WJ) Ltd	01422 823801		N/A				

Protective systems

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
Forward Protective Coatings Ltd	01623 748323	✓	N/A				
Hempel UK Ltd	**01633 874024**	✓	**N/A**				**Bronze**
Highland Metals Ltd	01343 548855	✓	N/A				
International Paint Ltd	0191 469 6111	✓	N/A				
Jack Tighe Ltd	**01302 880360**	✓	**N/A**		**19A**		**Silver**
Joseph Ash Galvanizing	**01246 854650**	✓	**N/A**				**Bronze**
Jotun Paints (Europe) Ltd	**01724 400000**		**N/A**				**Bronze**
PPG Architectural Coatings UK & Ireland	01924 354233	✓	N/A				
Sherwin-Williams Protective & Marine Coatings	**01204 521771**	✓	**N/A**			● (Silver)	**Bronze**
Vale Protective Coatings Ltd	01949 869784		N/A				
Wedge Group Galvanizing Ltd	**01909 486384**	✓	**N/A**				**Gold**

Safety systems

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
easi-edge Ltd	01777 870901	✓	N/A			● (Gold)	

Steel stockholders

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
AJN Steelstock Ltd	**01638 555500**	✓	**M**	**4**			**Bronze**
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			
Cleveland Steel & Tubes Ltd	**01845 577789**	✓	**M**	**3**			**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			
Kloeckner Metals UK	0113 254 0711	✓	D/I	4	3B		
Murray Plate Group Ltd	0161 866 0266	✓	D/I	4	3B		
NationalTube Stockholders Ltd	**01845 577440**	✓	**D/I**		**3B**		**Gold**
Rainham Steel Co Ltd	01708 522311	✓	D/I	4	3B		

Structural fasteners

Company name	Tel	QM	CE	FPC	NHSS	SCM	SfL
BAPP Group Ltd	01226 383824	✓	M		3		
Cooper & Turner Ltd	0114 256 0057	✓	M		3		
Lindapter International	01274 521444	✓	M				
Tension Control Bolts Ltd	**01978 661122**	✓	**M**		**3**		**Bronze**

Welding equipment and consumables

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