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NSC

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Science housed at Harwell

Cambridge offices don steel

City tower inclines to steel

Steel serves for Wimbledon roof

Sports outlet a Glasgow first

Cover Image
50/60 Station Road, Cambridge
Main client: Brookgate
Architect: Grimshaw Architects
Main contractor: Galliford Try
Structural engineer: Mott MacDonald
Steelwork contractor: Billington Structures
Steel tonnage: 2,000t

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

The Tipo G31 - heralds the dawn of a new era in the processing of heavy plate

This is the new technologically advanced, gantry CNC Machining Centre for drilling, milling, marking, scribing, tapping, chamfering and cutting of heavy steel plates up to 100mm thick x 3100mm in width

The Tipo G31 system is one of the most productive and versatile lines currently available for manufacturers of heavy structural steelwork, agricultural, earth moving and mining equipment who are looking to maximise productivity, minimise production costs and increase accuracy when processing large, heavy plate.

It can be equipped with dual spindles with independent sub axis which increase the productivity over single spindle lines by approximately 40%.

The dual spindles can drill, mill and scribe simultaneously even if the holes are not in line - and up to 24 tools can be available for each spindle.

The integrated hold down facility keeps the plate secure during processing, avoiding vibrations that could otherwise compromise the part quality, accuracy and tool life.

In addition to the drilling heads, the Tipo G can also be equipped with a maximum of two plasma torches (straight or bevel) and a maximum of three oxycutting torches.

For more details on how this innovative, small footprint machine can help you to maximise productivity and profitability call - **01924 223530**, e-mail **info@ficep.co.uk** or visit our website at **www.ficep.co.uk**

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New chapters in steel's success story

Nick Barrett - Editor

Recent surveys show that the construction market has paused for breath after a strong run lasting several years (see News). Brexit and the business cycle together may have conspired to slow things down, but only for a while.

Steel's success in serving the construction sector is a story that has been running for some 40 years now. Clues to the likely plot of the next chapters are easily found in the pages of NSC and in today's market.

Opportunities are growing in infrastructure for example, growth markets that steel is uniquely positioned to provide innovative solutions for. HS2 will need steel for stations, bridges and other structures, as well as the world-class railway track produced by UK steelmakers.

The sector has always been forward looking and has been an early adopter of what are still regarded elsewhere as new techniques. Offsite production, for example, has been getting a lot of attention recently as something that the construction industry as a whole needs to adopt. The steel sector has always had the ability to produce offsite in factory conditions, bringing sections to site only when needed and in sizes that are only restricted by lorry load and site constraints. In this issue of NSC we have a 40-storey commercial development that involved over 6,500 individual pieces of steel fabricated offsite and brought to the City for assembly only when needed.

Steel's offsite advantages – always delivered as part and parcel of the normal service from steelwork contractors – will increasingly come into their own. Any large scale expansion of Heathrow airport, for example, will take advantage of steel's offsite production potential, with the project to be serviced from logistics hubs as far away from the airport as perhaps British Steel's Scunthorpe site, as we also mention in News.

Design guidance continues to flow from Steel for Life, the SCI and the BCSA. Recent publications have included the *Brittle fracture* guide and a guide for *The design of cast-in plates* for connecting structural steel beams to concrete core walls. This month we report on the publication of the third in a series of model answers for engineers preparing for the IStructE chartered membership examination. They present steel solutions for selected questions posed in previous examinations.

In this month's issue we also find the All England Lawn Tennis Club so pleased with their innovative retractable steel roof installed over Wimbledon's Centre Court a few years ago that they have commissioned a similarly designed one for No.1 Court. Stories about repeat orders from satisfied clients could fill steel construction history books of their own.

Looking ahead to the rest of the year we obviously hope that the construction sector will soon start to expand again. When it does, steel construction will be as fully prepared as it has always been to meet the rapidly changing demands of its customers, and to support construction professionals involved in designing in steel.

London office construction slows down

Office construction in central London has dropped to a three year low according to the latest London Office Crane Survey by Deloitte Real Estate.

The current level of commercial office construction – a sector dominated by steel construction – across central London totals just over one million square metres, which represents a 9% drop over the past six months.

Figures from the Survey show 25 projects were started between April and September this year, which is half the number recorded at the beginning of 2016.

Most of this slowdown has been witnessed in the City of London, while the West End has actually bucked the trend and reported a slight increase.

In other areas of the capital, one new start was reported in Midtown and another on the Southbank, while in the remaining central London submarkets of Paddington, Docklands and King's Cross there were no new starts.

Despite uncertainty over Brexit, the Survey also reported that demand for new space will remain resilient, but the continued rise of co-working space is set to impact the market.

Cast-in plates design guide published

Commissioned and funded by the BCSA and Steel for Life, a new SCI guide P416 is now available which provides guidance for the design of cast-in steel plates for connecting structural steel beams to concrete core walls.

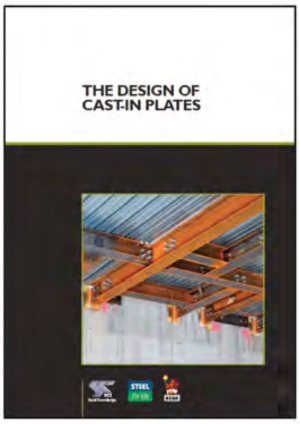
This publication provides a model for the design of simple connections that transfer shear force due to permanent and variable loads and a non-coincident axial tie force resulting from an accidental load case.

It also points out additional issues which must be considered where coincident shear forces and axial forces are to be dealt with.

A sample design of a simple connection for a 610 serial size UB is presented, and the design of punching shear reinforcement for the wall is included.

"The publication provides a code-based model for the design of cast-in plates for making simple connections of steel beams to concrete walls. It suggests the division of responsibilities between building structural engineer and steelwork contractor," said SCI Manager – Advisory Desk, Dr Richard Henderson.

SCI-P416 The design of cast-in plates is available on *www.steelconstruction.info*, the free encyclopedia for UK steel construction information.



Caunton holds steel bricks dissemination day

Steelwork contractor Caunton Engineering has held a dissemination day for the Innovate UK funded research and development project developing steel bricks.

Caunton Engineering is pioneering this new steel walling system that could radically alter the way numerous projects are built, including nuclear power stations.

The Government is backing the project with nearly £1M in funding from Innovate UK, the Technology Strategy Board.

The basic design concept was developed by a Glasgow-based modular walling system company, which then worked with the Steel Construction Institute and Caunton Engineering to refine the product in advance of building the first major sections.

Caunton is now one of a handful of construction companies that have won R&D funding to develop nuclear technologies.

Use of these factory-made steel bricks could pave the way for large sections of nuclear power stations to be built offsite.

This would speed up construction, improve build quality and reduce project risk.

SCI event highlights steel construction opportunities

Entitled 'Steel Construction 2030 – Opportunities and Needs' the Steel Construction Institute's [SCI] annual event, held at the Royal College of Physicians in London, highlighted the sector's increasing relevance in the coming years.

Speakers from both the SCI and member companies looked at some of the opportunities and developments that could be of relevance to the UK steel construction sector.

Arup's Chris Barker, who is also Vice Chairman of the Steel Piling Group, spoke of the benefits the use of steel provides to both building and infrastructure projects.

SCI's Mark Wilkinson took to the stand and discussed the importance of certification and the many ways it can help designers choose steel, thereby aiding the material to increase market share.

According to the SCI, there are a number of environmental and sustainability challenges that the construction industry must face. The steel sector is well positioned and highlighting this fact the SCI Associate Director Michael Sansom spoke of the re-use of steel.

"Our prototype portal for re-used steel will show that even though there are a number of significant hurdles to overcome, if we want to be able to re-use steel that is currently out there in our building stock, developing a database for future use of steel that is going into current projects would actually be very easy," he said.

Wrapping up proceedings, SCI CEO Graham Couchman outlined the SCI's new on-line code of practice for UK steel design. It will show designers what design rules they can use, and will guide them on how to use these rules correctly. It will also facilitate migration to the next generation of Eurocodes.

Steel frames take shape for Essex school

Steelwork is quickly taking shape on Kier's £34M school project set in the large residential Beaulieu development in Chelmsford.

Approximately 700t of structural steelwork will be erected by A C Bacon Engineering for the project that incorporates both secondary and primary schools.

It will also feature enhanced community sports facilities, funded by Chelmsford City Council.

The project consists of four steel-framed buildings: a single storey nursery building, a single and part two-storey primary school building, a three-storey U-shaped secondary school and a large sports hall.

Councillor Tony Ball, Essex County Council's Deputy Cabinet Member for Education, said: "It's a wonderful facility, but not just the school but the community facilities as well.

"It has been excellent working with the Chelmsford Learning Partnership and we're very much looking forward to the first 'through school' in Essex. It's something I'm very pleased to see."

The school will eventually accommodate 1,200 secondary students and 420 primary pupils in two adjoining premises. The primary school is expected to open in September 2018, with the secondary school opening a year later.

Voortmann launches new improved plate processing machine

Netherlands-based Voortman Steel Machinery has launched the V325 heavy plate processing machine.

This latest addition to the Dutch company's product line is said to offer a faster processing speed and improved production capabilities, including precision 3D plasma bevel cutting.

Voortman says a larger drill can be used with the machine to enhance a variety of manufacturing strategies. Consequently, the company says this means steel fabricators can competitively price products by eliminating secondary operations, reducing costs per part, and maximising plate utilisation.

The company also claims that the V325 is equipped with some of the industry's most advanced innovations in intelligent CNC automation and nesting software.

Voortman machines are available in the UK via its official agent Cutmaster Machines.

NEWS IN BRIEF

British Steel's Scunthorpe site has been named on a long list of potential locations for logistics hubs to help Heathrow Airport deliver its expansion plan. The final four selected locations will pre-assemble components for the expanded airport before transporting them in consolidated loads to Heathrow.

Plans to regenerate Croydon town centre and build a new **Westfield** shopping centre have been approved. Approximately £1.4 billion will be set aside for the project, which will commence in 2019, bringing the number of Westfields in the capital to three. Planners envisage the project will create 7,000 new jobs and 1,000 new homes.

Revenues and profits have increased at **Severfield** as it continues to work on some of the UK's most prestigious projects. The company said it is on track to deliver its strategic goal of doubling pre-tax profits to £26.4M by 2020. Reported revenue for the six months to 30 September 2017 increased by 16% to £137.1M, up from £118.2M in the same period in 2016. Profit before tax also increased from £7.4M to £11.5M, an increase of 55%.

Suffolk County Council has opened prequalification for a £60M design and build bridge project in Lowestoft. Known as the **Lake Lothing Third Crossing** it will involve building three distinct parts: a lifting bridge, a new rail bridge on the north side of the waterway to cross the existing East Suffolk Line and a new road underpass on the south side.

The Government has announced a £800,000 investment in **Swansea University**'s SPECIFIC Innovation and Knowledge Centre. The funding, delivered by Innovate UK, will be used to construct the UK's first energy positive Active Office, capable of generating more energy than it uses.

PRESIDENT'S COLUMN

While the standards forms of construction contract – NEC and JCT – aren't perfect, in my opinion they provide a pretty good balance for both main contractors and sub-contractors. And until the adversarial contracting model changes to something much more collaborative, they allow both parties to share project risk.

These contracts are also what's been agreed by the construction sector as a whole. Together, representatives from all parts of the supply chain decide what stays, what goes and what needs to be added.

So it's always galling to see clauses that have absolutely nothing to do with the project specification or risks specific to that job added to a sub-contract. These additions aren't minor either. They can run on to hundreds of additional clauses, scattered throughout the contract, and can have significant consequences for a sub-contractor.

While all sub-contractors are affected, this is particularly unfair on small sub-contractors who don't always have access to on-tap legal advice and who might miss a small yet important detail.

Those sub-contractors that belong to a trade association like BCSA are in a better position, being able to access targeted commercial and contracts training and dedicated legal help lines. But when tender negotiations have come down the wire and the main contractor wants work to start asap, the time available for due diligence evaporates for everyone.

Some of my personal bugbears are blatant attempts at risk shifting.

For example, when a contract says a sub-contractor can't rely on any information about site conditions supplied by the main contractor and must verify all the information themselves. Of course this is an impossible task and it goes way beyond any realistic expectation of taking reasonable care.

Or the explosion in the number of indemnities and in how wide they are – indemnities are always onerous and this just adds to the burden on the sub-contractor.

So why can't we just use the standard forms of contract, with additions limited to those necessary for the specific job? This would certainly save time and money for contractors and sub-contractors, and might even take us one step closer to a more collaborative way of working.

Tim Outteridge
BCSA President & Sales Director Cleveland Bridge

Conservation work on world's first iron bridge under way

Shropshire's historic and iconic Iron Bridge has been shrouded in scaffolding to allow a much-needed conservation project to get under way.

The project, the largest of its kind by English Heritage, will see contractor Taziker Industrial, repair, install new steelwork and repaint the structure in order to stop cracking in the centre of the bridge.

It is believed that most of the cracking has been caused by ground movements that have taken place during the last couple of centuries.

The world's first iron bridge was completed in 1779 and opened to traffic in 1801. It became a Unesco World Heritage Site in 1986 and remains an important feature of Britain's industrial past.

The Iron Bridge was the first single-span arch bridge in the world to be made of cast iron and was a turning point in engineering.

The bridge has been in the care of English Heritage since 1975 and the charity has undertaken regular conservation and monitoring during that time.

BCSA offers IStructE exam help

The British Constructional Steelwork Association (BCSA) and Steel for Life have commissioned the Steel Construction Institute (SCI) to help engineers taking the Institution of Structural Engineers (IStructE) exam by delivering a series of model answers that present steel solutions for selected questions from previous membership examinations.

Each model answer is contained within a stand-alone publication that includes: a summary of the question; the development of the required solutions; the design calculations for the principal structural elements, along with a commentary and drawings, such as general arrangement plans, sections and elevations.

Other required documentation such as method statements, construction programmes and client letters are also included in the model answers.

SCI Associate Director David Brown said: "The Institution's examination can appear very demanding, requiring the preliminary design of all the major elements in a structure including foundations.

"Drawings, a method statement, a construction programme and a letter to the client must also be completed in a very limited period, making the whole event very challenging. Usually, there will be some requirement which adds complexity to the schemes.

"These model answers should be a real help in showing how a steel solution can be prepared."

Candidates for the IStructE exam must demonstrate the validity of the training and experience they have acquired. Examiners must be satisfied that the candidate has conveyed an understanding of structural engineering principles, an ability to initiate and communicate structural design and provide an effective solution to a structural design problem.

The second model answer is to Question 1 from July 2016, which was for a five-storey office building with an underground car park, and is now available at: http://www.steelconstruction.info/Continuing_Professional_Development#Model_answers_to_IStructE_exam

Majestic steel sculpture unveiled in Essex

A new piece of steel artwork by artist Matthew Lane Sanderson and galvanized by Joseph Ash Galvanizing has been unveiled in Chelmsford, Essex.

Mr Sanderson has created a spherical sculpture, with an intricate design, that depicts a regal reflection of a stag under a tree, set on a reflected crown base.

The statue is made from 6t of steel and zinc and is 10m-high.

Sanderson said of the sculpture: "This work of art shall forever mark the status of this place both past, present and future. It is a symbol that not only conveys the beauty of natural form, but the hope we all share for balance in all things."

Mick Jackson of Joesph Ash Galvanizing said: "It is always an honour for Joseph Ash Galvanizing to be asked to treat huge works of steel art by amazing artists such as Matthew Lane Sanderson.

"Hours and hours of work go into the design and creation of these sculptures and it is imperative that our galvanizing plants do justice for the artists by providing the best quality galvanized finish."

Barnshaws introduces channel section service

Building on its range of metal bending and fabrication services, Barnshaw Section Benders says it is now offering a new economical approach for creating channel sections to its customers in the UK and Irish steel construction sector.

The method allows customers to recycle existing hollow stock to originate a channel section, instead of purchasing new materials outright.

Barnshaws say this new service has been introduced due to the frequent requirement for channel sections for construction projects and the need for a solution to support this application at a reduced cost.

To begin the process, square hollow sections (SHS) or rectangular hollow sections (RHS) are accurately cut lengthways, after which the cut sections are straightened on roller machines to create the finished product.

Barnshaws Commercial Director Greg North commented: "The introduction of this new service was prompted by our customers, who we noticed would typically hold a number of hollow sections in stock.

"We decided to provide an option to these customers to easily create channel sections from this excess stock, so that the industry has a cost-effective route towards creating these fabrications.

"Coupling this with our section bending expertise to a wide range of radii, we can offer a full turnkey solution for creating these sections."

Steel-framed car terminal opens ahead of schedule

A new vehicle export terminal, which is part of a £50M investment by Associated British Ports (ABP) in The Port of Southampton, has been officially opened following the completion of a major expansion project.

The Pacific Terminal is the sixth multi-deck facility at the Port, and is one of two new car storage facilities recently completed by Morgan Sindall.

The project was handed over three weeks ahead of schedule, while a seventh multi-deck storage facility, as yet un-named, was completed four weeks early with just seven weeks between each completion date. The projects were executed simultaneously and have a combined value of £24.5M.

James Killelea was the steelwork contractor for both of the car storage facilities and erected a total of 2,800t of steel.

The facilities have created almost 10,000 additional spaces, ensuring that The Port of Southampton is the UK hub for automotive shipping by enabling leading British car manufacturers like Jaguar Land Rover to reach global marketplaces.

ABP is a major employer within Southampton docks, already the busiest port in the UK with almost one million vehicles passing through the port in 2017, an increase of almost 10% from 2016.

Morgan Sindall's Managing Director for the South, Andy Duff, said: "The Port of Southampton is a key UK asset and we're proud to have formed such a successful relationship with ABP to deliver this strategic new terminal, building on its capability as a world-leading import and export hub.

"Working collaboratively with ABP and major car transporters at the dock, our team delivered on budget and ahead of schedule. This was a fitting way to end these key projects, the fourth and fifth schemes we have successfully delivered for ABP."

Green light for huge Gatwick hangar

Aircraft manufacturer Boeing's proposed plan with Gatwick Airport to build a new 180m-span aircraft hangar has been granted permission to go ahead by Crawley Borough Council, with full works scheduled to commence later this year.

The steel-framed facility will be fully operational in early 2019 and will add on-site engineering and maintenance capability for operators of Boeing aircraft at Gatwick, including short haul 737 aircraft and Gatwick's growing long haul fleet of 747, 777, and 787 Dreamliner aircraft.

Gatwick Airport said its route network is growing fast, and the airport is in the Premier League of European Airports that serve more than 60 long-haul destinations.

With new services on Boeing aircraft to Denver, Seattle, Austin, Chicago and Singapore recently commenced or announced, this new hangar will play an important role in supporting Gatwick's long-haul network as it continues to grow.

The new hangar facility will support the Gatwick airline community's immediate operational needs which, in turn, will help the airport to continue its record growth in both short and long-haul services.

The new multi-million pound hangar facility, which will be located in the north west zone of the airport, is expected to support more than 200 jobs at Boeing and its suppliers in the region surrounding the airport.

Diary

For SCI events contact Jane Burrell, tel: 01344 636500 email: *education@steel-sci.com*
For Institution of Structural Engineers events email*: training@istructe.org* or telephone 0207 201 9118

Tuesday 16 & Wednesday 17 January 2018
Robustness
This 1 hour webinar will provide inforamtion on design of steel-framed buildings for robustness.

Wednesday 24 & Thursday 25 January 2018
Essential Steelwork Design
This 2-day course introduces the concepts and principles of steel building design to EC3.
London.

Thursday 8 February 2018
Essential Steelwork Design
This 1 day course provides guidance on braced frames, continuous frames and portal frames
Bristol.

Thursday 8 February 2018
Design of Portal Frame Elements (Part 1) This 1 hour webinar establishes principles and veritifcation of portal frame columns
Webinar

The UK construction market relies on steel sections

Phoenix drives confidence in steel

UK steel manufacturing has been lifted by the success of the renamed and reinvigorated British Steel. A new era of customer focused service has been ushered in, as Construction Director, Richard Farnsworth tells Nick Barrett.


Richard Farnsworth says British Steel's apprenticeship programme is an investment for the future

At one point, some feared the manufacturing of the steel sections the construction industry relies on might end in the UK, as Tata Steel looked at the future of its steelworks and mills. That threat has passed however and one of the notable phoenixes to soar from the crisis is the renamed British Steel, which last year announced a return to profit.

The old British Steel and its successors Corus and Tata Steel had helped to build a construction business from small beginnings over some 30 years. The UK construction industry has seen a shift in steel market share from 30% share of the multi-storey buildings market to the current consistent level of 65% share.

The British Steel brand has been readopted by what was formerly Tata Steel Europe's Long Products Division. It manufactures structural sections, rail track, wire rod and special profiles. After being bought by Greybull Capital in June 2016, a turnaround strategy was put in place and is showing clear signs of working.

The 5,000 strong workforce, including management, agreed a 3% pay cut at the time of the acquisition – a strong show of support for what is a leading employer in the traditional steelmaking areas of Scunthorpe and Teesside. That pay cut has been reinstated with employees given shares equivalent to a 5% stake in the company.

British Steel's Construction Director, Richard Farnsworth explains: "Accepting the pay cut was a great vote of support for the company and we should thank the workforce, as that was a selfless contribution to keep a great British tradition of steelmaking alive.

"More than 500 new people have joined British Steel since our launch and we're taking on apprentices across the business, including at our Teesside Beam Mill. It's a significant investment in ensuring skills for the future."

Yorkshire born Richard has been in the steel sector since graduating in Natural Sciences, majoring in Materials Science at Cambridge University in 1989. He joined British Steel as a Technical / Production Graduate Trainee and has had experience across many of the company's technical and commercial operations, including Plant Manager at the Scunthorpe Plate Mill and as Product Director for Rods. In October

2016, he oversaw bringing distribution and the company's sections business together to form the new construction business.

British Steel has a global customer base and produces around three million tonnes of steel a year. The construction business Richard heads is a highly significant part of that. The company is a world-leader in producing long steel products, which are the products used most by the steel construction sector.

Manufacturing in the UK is centered on the integrated steelworks at Scunthorpe, which supplies feedstock to rolling mills both at Scunthorpe and Teesside (see map), as well as at Skinningrove, Hayange in north east France.

For construction products, mills at Scunthorpe and Teesside process steel into their final shape for use in buildings of all types and sizes, as well as bridges and other structures, with the larger sections coming from the Teesside Beam Mill, which celebrates its 60th anniversary in 2018.

As the only UK manufacturer of structural sections, British Steel branded products are known for their high quality worldwide, providing the customer with confidence and reassurance. "British Steel manufactures a comprehensive size range – well within the tightest dimensional tolerances," says Richard.

The new company is more streamlined than before, it has adopted more efficient processes and has an emphasis on being more responsive to customers. Manufacturing and distribution used to be kept as distinct and separate enterprises, but are now integrated. Construction used to be serviced by a range of other divisions, but there is now an integrated construction team across manufacturing, sales, delivery and customer service.

Customer service is behind the development of British Steel's network of service centres across the UK and Ireland. The Teesside Service Centre, adjacent to the Teesside Beam Mill, is a national hub for processing and distributing structural steel for construction. Other centres and sales offices are located from Newport and Dartford to Newcastle and Dundee, as well as in both Northern Ireland and the Republic of Ireland.

The aim is to provide a responsive service to steelwork contractors and steel stockholders, allowing a wide range of products to be sourced from a single site and delivered in mixed loads as required by the company's own transport fleet.

Improved product availability and shorter lead times are key customer benefits from a 'prairie' stockyard of 40 acres of steel and 15,000m^2 of warehousing, holding light sections including square and circular hollow sections.

Sections held include grades S355J2 and S355J0. All of British Steel's sections range is produced in accordance with BS EN10025-2 and complies with the Construction Products Regulations. All British Steel products are also fully traceable.

"We have made significant investments in the service centres to provide a comprehensive stock range and the best possible facilities for a range of processing services. The Ireland Service Centre at Lisburn for example offers sawing, shotblasting and priming. It means that customers can access state-of-the-art processing and a wide range of stock all in the one place," says Richard.

British Steel recognises the importance of the large and often iconic projects that it provides steel for, but Richard stresses that the smaller projects and customers also receive the same commitment to quality service. "We have established a regional network of metal centres where speed and convenience are the by-words, allowing customers to access a wide range of products in smaller quantities, including sections."


All British Steel products are fully traceable

Next day delivery is a part of the service, but customers can also collect their own material from the centres. Direct supply of steel to end users is also available if required. "There are a variety of ways of doing business," says Richard. "We are more fleet of foot and versatile than before and can consider a solution to suit an individual project. We will respond to what the market demands."

Richard says the company is conscious that a new steel manufacturing industry is being shaped, with new and revitalised relationships. "Becoming a headline sponsor of Steel for Life is a sign of that. We think supporting market development of steel construction is very important to us and our customers," he says.

"There is a real opportunity for us to be more open and outward looking, working closely with the supply chain in line with industry trends towards collaborative ways of working.

"We aim to make a large contribution to creating value in the world-leading UK steel construction supply chain. We have proven capability and look forward to using it with supply chain partners to build a better Britain of the future together."

British Steel is a headline sponsor of *Steel for Life*

An introduction to section bending

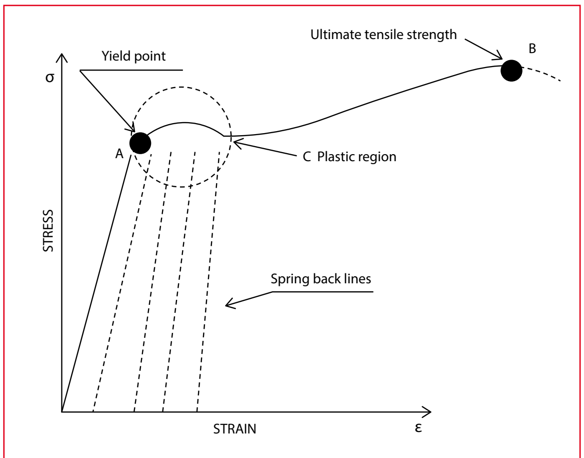
Section bending was used extensively on Slough's iconic Curve

Bending steel sections to help create stunning architectural designs not only allows steelwork to show its flexibility in construction, the process is also very economical.

Section bending is a cost-effective way of changing the shape of a structure, as it is relatively inexpensive when compared to manufacturing a multi-faceted member. In this article NSC will focus on section bending; the process, metallurgy of curving steel and minimum radii and tolerances.

The metallurgy of curving steel

The process of cold bending takes the material past its yield point and this strain will harden the steel to some degree. Some of the yield plateau has to be used, so in general plastic design is not recommended.



Schematic stress-strain diagram illustrating the effect of roller bending

The toughness of the steel can also change particularly at small radii, but for most radii found in structural applications the changes are modest.

For structural steel, the strain induced during the bending process produces no real problems, as afterwards the material exhibits the same elastic characteristics in the elastic range.

As mentioned, during the rolling bending process the material must be subjected to a stress greater than its yield strength or elastic limit, shown as point 'A' on the figure below. This is the maximum stress that the material can withstand and still spring back, or return to its original shape.

A stress less than the yield strength will not permanently bend the material. The amount of stress to apply to the material being bent is in area 'C', which is the plastic region. The spring back lines show how, when the stress is removed, the material will spring back to a curvature somewhat smaller than when the stress was being applied.

The steel sections become work hardened when using the cold bending process. The amount of work hardening is dependent on the radius required and the geometry of the section. This results in a 'flattened-out' stress-strain curve. A tensile test on a sample of steel that has been cold-roller bent will show a small loss in ductility, but a higher ultimate tensile strength. Even though there is a loss of some ductility, for normal structural applications the effect is minimal and can be ignored.

Minimum radii and tolerances

The minimum radius to which a section can be bent without any meaningful local distortion depends on the section properties and bending methods being used. These minimum radii have been reduced as new techniques have been developed, so the minimum has continued to get smaller.

Normal bending tolerances for single radius bends are in line with those specified in the National Structural Steelwork Specification. For tolerances for multi-radius bends or other complex curves it is best these are discussed with a specialist steel bender.

It is not easy to provide a definitive and comprehensive list of the radii to which every section can be curved. There are large numbers of standard sections (each with different bending characteristics), there are different methods of bending (hot and cold), and the end uses vary widely. Also, with continuing technical developments minimum radii also change.

In general, sections, tubes and hollow sections can be curved to single radius curves, to multi-radius curves, to parabolic or elliptical curves, or even to co-ordinates. They can also be curved in two planes or to form spirals. There are, however, a number of physical constraints which limits the degree to which three-dimensional curvature is possible in practical terms.

STEEL for life

Sponsors Steel Bending

Bronze: Barnshaw Section Benders Limited

Thanks to Barnshaw Section Benders Limited for contributing to this article.

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Five trusses that support the retractable roof trusses surround the court

Anyone for tennis?

A retractable roof, which will allow uninterrupted play irrespective of the weather, is being installed over Wimbledon's No.1 Court. Martin Cooper reports from the home of lawn tennis.

FACT FILE
Wimbledon No.1 Court Retractable Roof
Main client: All England Lawn Tennis Club (AELTC)
Concept architect: Grimshaw
Main contractor: Sir Robert McAlpine
Structural engineer: Thornton Thomasetti
Steelwork contractor: Severfield
Steel tonnage: 6,000t

Each year there are two weeks during the summer when most people in the UK become tennis fans. Whether they go and attend the event or watch it on television, seemingly nobody is immune and able to avoid getting sucked into the excitement and drama that unfolds during The Wimbledon Championships.

In order to maintain The Championships as the world's premier tennis tournament played on grass, The All England Lawn Tennis Club (AELTC) has developed the Wimbledon Master Plan. Central to this are the improvements currently being undertaken on No.1 Court. This work includes two additional tiers with 900 seats, new hospitality facilities and improved public catering areas, and most importantly a new fixed and retractable roof.

Similar in design to the one spanning Centre Court [See NSC July/August 2009], the roof will guarantee uninterrupted tennis on Wimbledon's second largest court, regardless of what the notoriously fickle British summer weather ushers forth.

The retractable roof is based on a concertina design with two main sections that meet in the middle. It will be made of transparent Gore Tenara (a type of Gore-Tex fabric), which is stretched between steel trusses.

According to SCX, the company responsible for the design and supply of all the mechanical and electrical equipment, around 220 electro-mechanical devices (including motors), will be needed along with a control system capable of working to accuracies of a fraction of a millimetre, to ensure the roof operates smoothly and quietly.

Covering an area of about 5,500m^2, the new roof can be deployed or retracted in around 8 minutes.

There are 11 steel trusses in total, each spanning 75m across the top of the court, and each having an overall height of 6.5m.

Ten of the trusses are identical prismatic sections, but one, the most southerly, is rectangular in shape and slightly heavier at 65t instead of 60t.

"Ordinarily five trusses are parked at the north end and six at the south, and when deployed they all move inwards to cover the court," explains Thornton Thomasetti Associate Director Michael Roberts. "However, to maximise the amount of sunlight on the grass, all of the trusses can be moved to the north end with the eleventh rectangular truss being the last in line.

"Having no fixed restraining arms attached to the surrounding fixed roof, this truss needed to be a different shape."

Allowing the roof to move, the ends of each truss are supported on a wheeled bogie that moves along rails that are fixed to the new superstructure of No.1 Court. This superstructure includes five more trusses that surround the arena, with two of them, east and west, primarily supporting the retractable roof.

The east and west trusses are both 80m-long and weigh 490t and 555t respectively.

"All sections for these trusses were installed by the site's four tower cranes. They were constructed on temporary works and the booms were incrementally welded together to form the full truss and then laced together via a bracing structure," explains Severfield Project Manager Darren Brockhouse.

Truss boom sections varied in size, from 8t up to 22t, and consisted of CHS sections ranging in length from 8m to 15m. Stability and support for the trusses is provided by eight existing concrete cores and three jumbo 1,083mm-diameter CHS columns. These were threaded through the stands and founded on the concrete sub-structure.

Two of these large columns are positioned either end of the east truss, with the third supporting one end of the west truss. A fourth jumbo column could not be installed as there are ground level water tanks in the area where this section would have been founded. Instead a 40m-long x 11.5m-deep north-west truss was installed, acting as a bridge over the obstructions and helping to support one end of the west truss.

Any construction work undertaken at Wimbledon has to be done around the tennis schedule. Nothing can get in the way and obstruct The Championships taking place during its allotted two weeks.

Consequently, the Wimbledon No.1 Court project is being done over three phases, with two breaks in the schedule to allow The Championships in 2017 and 2018 to take place.

The sequencing involves a large logistical exercise, whereby all construction equipment and materials are decamped for the duration and then brought back a fortnight later. All areas where construction work has taken place must also be made safe to allow spectators to fully use the prestigious tennis venue.

Having successfully completed the similar roof over Wimbledon's Centre Court, Severfield has used this experience to organise its three-phased steelwork package.

Installing the east, west and north-west trusses, along with all of their supporting steelwork, formed the majority of Severfield's first year works. However, the company also installed some cantilevering steelwork that will form new hospitality and access walkways around the upper external levels.

Fixed inner roof elements that adjoin the east and west trusses were also installed. This steelwork consists of a plated box section tension ring with a combination of tapered plate girders and lattice trusses tying back to the main trusses on each face of the structure.

"The tension ring installation was a combination of pre-welded assembly units and site welding to form a complete ring. This inner roof structure is then braced using a mixture of tubular and I-sections. The inner gutter then hangs off the tension ring which forms the gutter and bullnose surface for the inner roof," says Mr Brockhouse.

An array of air conditioning units will be hung from the fixed roof, needed to keep the court and its all-important grass condensation free when the retractable roof is deployed.

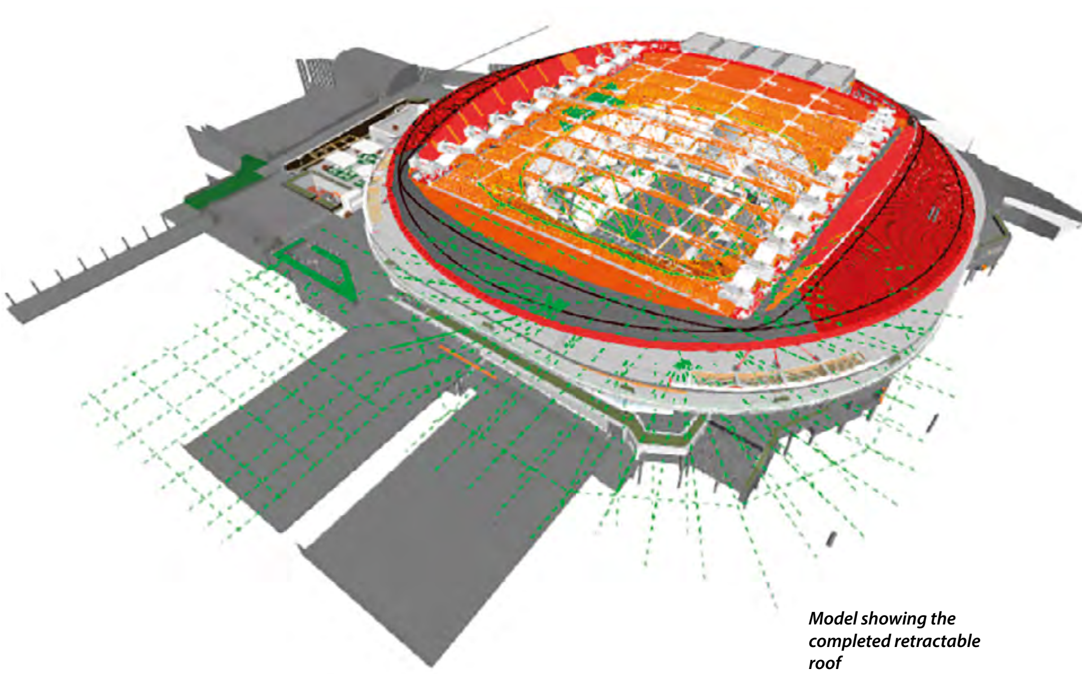
Since late summer, Severfield has been carrying out its year two works, which include the installation of two further trusses, north and south, and their adjoining inner fixed roof sections. The north truss is 76m-long x 9m deep, weighing 195t, while the south truss is 68m-long × 5.7m-deep and weighs 168t. These two trusses complete and form the rooftop of the arena, while the north truss also supports a large amount of plant equipment.

Currently, Severfield is also assembling the 11 retractable roof trusses on land adjacent to No.1 Court, which was formerly occupied by two grass practice courts and two other hard courts.

All the trusses will be stored on this site until after The Championships 2018. They will then be constructed as part of the company's year three works programme. Using a 600t crawler crane, each truss will be lifted over the court into position, topping off the main element of Wimbledon's Master Plan.

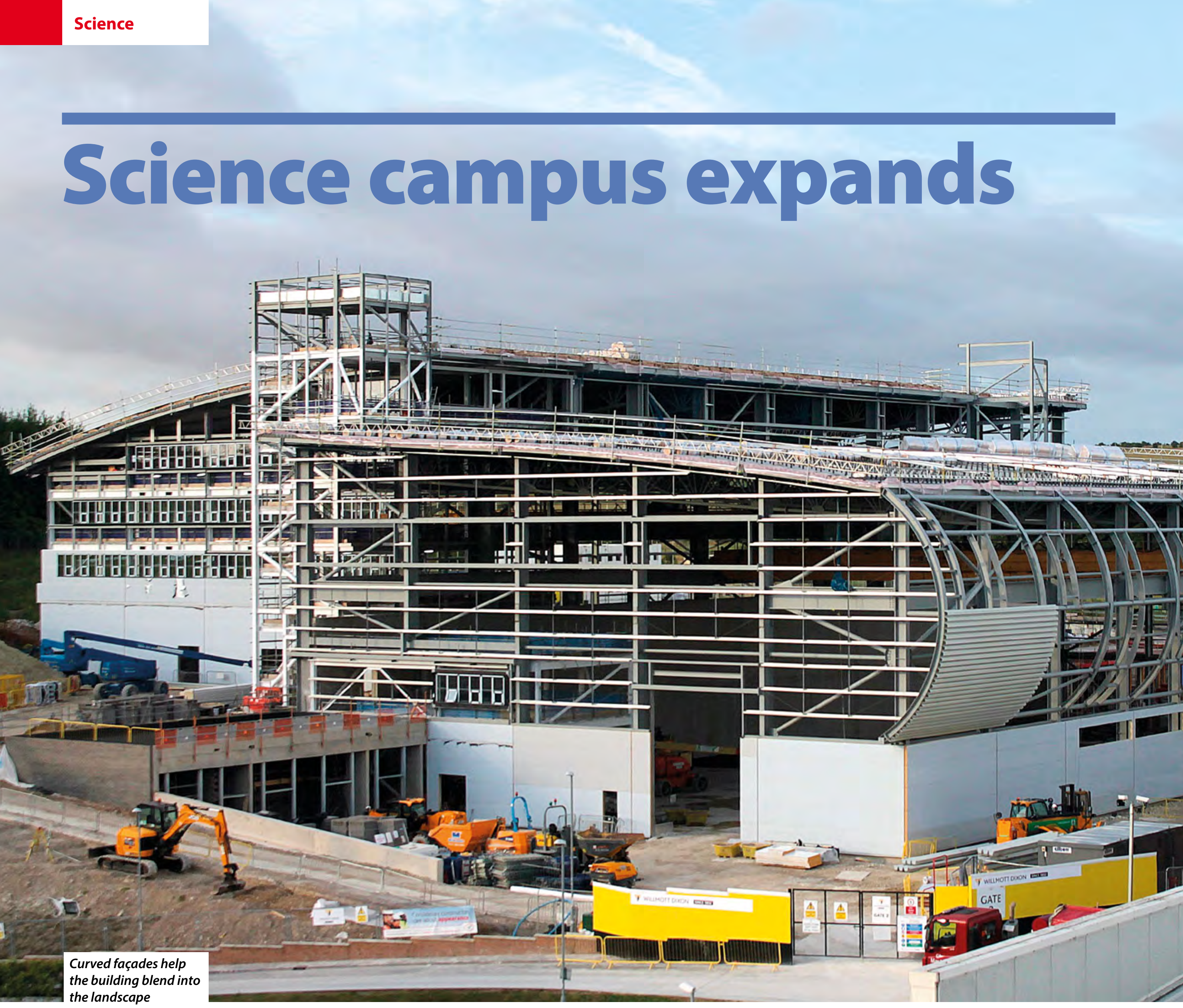
Work progresses on the year two works

A roof truss connection



Model showing the completed retractable roof

Science campus expands



Curved façades help the building blend into the landscape

A steel-framed facilities building at the Harwell Science Campus has been designed to provide column-free testing and storage space, as well as to fit unobtrusively into the rural landscape.

FACT FILE
Rutherford Appleton Laboratory, Facilities Support Building, Harwell Science Campus, Oxfordshire
Main client: Science & Technology Facilities Council
Architect: Oxford Architects
Main contractor: Willmott Dixon
Structural engineer: Clarke Nicholls Marcel
Steelwork contractor: Hambleton Steel
Steel tonnage: 900t

Home to more than 200 organisations, Harwell is a vast world-renowned science and innovation campus covering 710 acres in the Oxfordshire countryside a few miles south of Didcot.

It has been claimed that every major industry sector in which the UK economy is actively involved either resides at Harwell in some form or visits the campus to conduct research and product development.

One of the main tenants is Rutherford Appleton Laboratory (RAL), operated by the Science & Technology Facilities Council which provides research into a diverse range of areas such as particle physics, space science, materials, astronomy, and computational and e-science.

RAL is currently constructing a new £23.7M Facilities Support Building that will provide specialist support areas allowing researchers to test and commission new scientific equipment.

Being built by Willmott Dixon, the facility consists of two large open plan halls; the handling hall and the test hall. Each hall is a single storey, steel braced frame measuring 70m-long × 35m-wide.

The two halls sit side-by-side, share a central row of columns and are part of one large steel frame. However, due to the sloping site, there is a 5m difference of floor level from the testing hall at the top of the site to the lower handling hall.

"Steel was the obvious choice for this project because of the building's size and the required spans," says Clarke Nicholls Marcel Structural Engineer Steven Coates.

"We did initially look at a portal frame design, but as both halls' steelwork supports large overhead cranes there would have been too much lateral loading, and so we have vertical bracing providing the structural stability."

Each hall has an overhead gantry crane, serving the full length of the building. The crane in the handling hall has a maximum lifting capacity of 50t, while the crane in the test hall's has a maximum capacity of 35t.

Creating each hall's open column-free space is a series of 2m-deep 35m-long triangular roof trusses, which slope downwards from the central row of columns. This means that the interior height of each hall slopes down from 19m to 14m at the perimeter elevation.

Tubular members were chosen for the trusses as they are less likely to collect dust, something which is highly important in a sterile scientific and research environment.

According to Willmott Dixon Site Manager Noel Cafferty, the sloping roofs have been designed to add architectural interest to the structure as well as helping

Roof trusses were fabricated from CHS members as they are less likely to collect dust

the halls to blend into the surrounding countryside.

The facility is set into a dip in the landscape, dug-out by Willmott Dixon early in its construction programme. The building is also set on the very edge of the Campus and so the upper parts of both halls can be seen from afar and importantly from a popular walking trail. The sloping roofs help the structures become less obtrusive, while the Kalzip roof and wall cladding has a striped design and colour that is said to blend into the horizon.

Steelwork contractor Hambleton Steel brought the tubular trusses to site in three sections. Two mobile cranes were used to erect the trusses, one lifting two bolted-up sections, while the second crane lifted the third piece. Once both pieces were bolted to the supporting columns, the final connection between each piece was made while the steelwork was being held in place by the cranes.

Hambleton's steel erection programme started with the structurally independent four-storey braced steel frame that forms an office building, which is connected to one end of the test hall.

The offices are constructed using cellular beams supporting 150mm-thick concrete slabs on profiled metal decking. The curved roof of the office matches the profile of the curved roof of the adjacent test hall.

After erecting the offices, Hambleton progressively erected the two halls with two gangs working simultaneously. Once the main frame and roofs were up Hambleton then installed a number of interior features, along with an architectural bullnose element that runs along the main elevation of the handling hall. The bullnose feature was created by attaching a series of secondary curved members to the main frame.

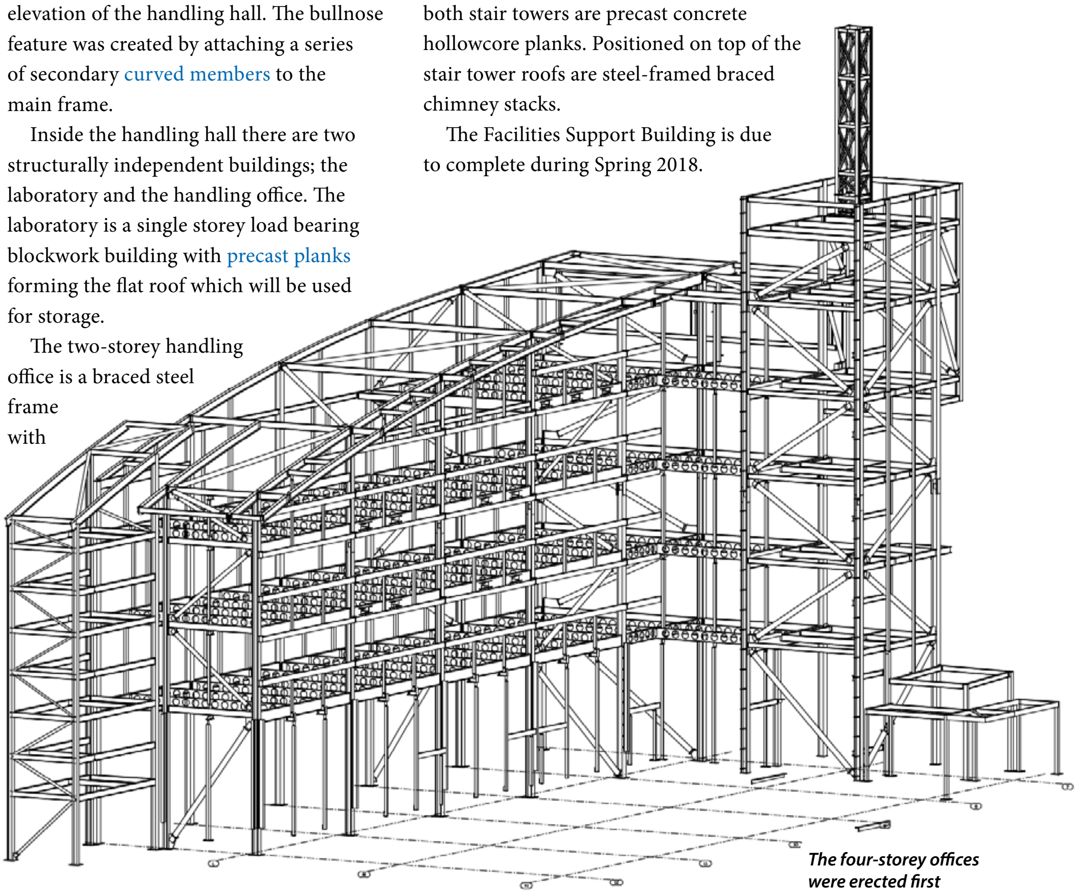
Inside the handling hall there are two structurally independent buildings; the laboratory and the handling office. The laboratory is a single storey load bearing blockwork building with precast planks forming the flat roof which will be used for storage.

The two-storey handling office is a braced steel frame with composite beams supporting a 130mm-thick concrete slab on profiled metal decking. The roof beams are cellular to allow distribution of services within the structural depth.

Two steel-framed stair towers are located at either end of the building and were both installed by Hambleton during a return visit sometime after the main frame had been completed.

Both stairs provide access to the roof and are approximately 27m high. The stair flights are precast concrete units spanning the width of the stair well. The roofs of both stair towers are precast concrete hollowcore planks. Positioned on top of the stair tower roofs are steel-framed braced chimney stacks.

The Facilities Support Building is due to complete during Spring 2018.

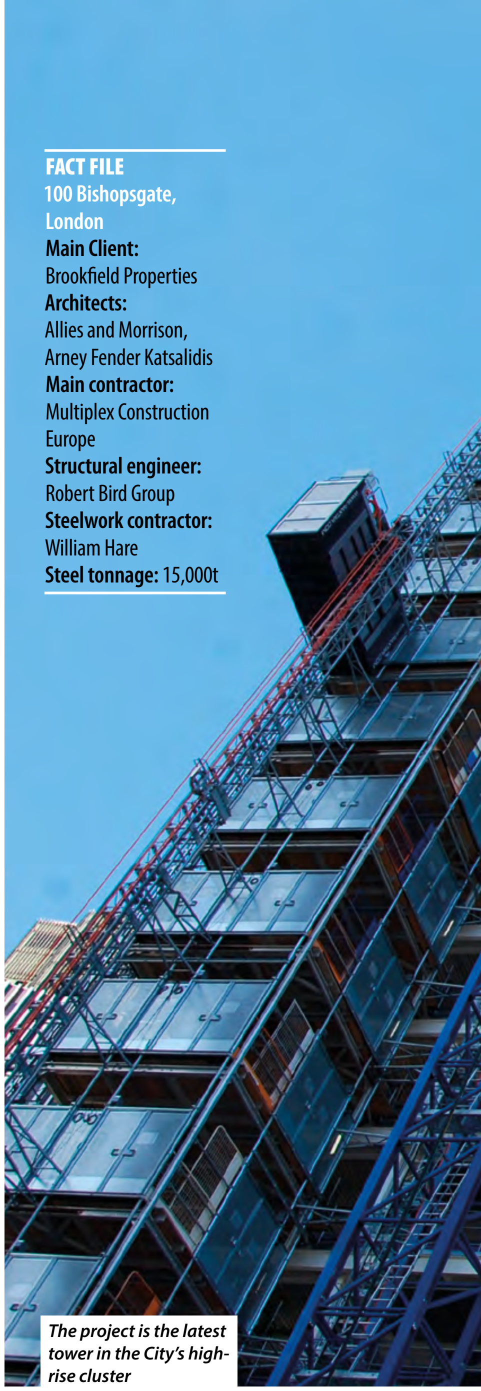


The four-storey offices were erected first

The tower changes shape entirely from level 24

Shape shifter

Transforming from a parallelogram at its base to a rectangle at the top, the 40-storey 100 Bishopsgate project is the City of London's latest stand-out commercial development. Martin Cooper reports.



FACT FILE
100 Bishopsgate, London
Main Client:
Brookfield Properties
Architects:
Allies and Morrison, Arney Fender Katsalidis
Main contractor:
Multiplex Construction Europe
Structural engineer:
Robert Bird Group
Steelwork contractor:
William Hare
Steel tonnage: 15,000t

The project is the latest tower in the City's high-rise cluster

The steelwork for 100 Bishopsgate has recently been completed, topping out the frame for the City of London's latest addition to its ever-changing high-rise cityscape.

This 40-storey mixed-use commercial development, situated a stone's throw from Liverpool Street Station, will provide just over 83,900m² of net lettable space within its main tower and a contiguous six-storey podium.

The 60m-long podium, adjoining the main tower along its eastern elevation, accommodates large column-free floors in excess of 4,080m². The podium will be topped by a landscaped roof terrace, offering tenants on that floor a large outdoor breakout or entertaining space.

Perimeter steelwork for the scheme starts at ground floor and the frame is sat atop a three-level concrete basement. In addition, there are steel plunge columns temporarily supporting the core extending down within the permanent piles. Forming this basement

Blast resistant design

Once the scheme began construction in 2015, a design change relating to the structure's blast resistance was undertaken.

"Initially the main tower was to feature a truss that wrapped around the structure at level six," says Multiplex Construction Director Cliff Wynn. "This would have helped to support the building in the event of a blast."

However, a more cost-effective cutting edge engineering solution was devised, taking away the need for extensive welding at level six.

During the construction programme for the ground floor, a two-stage procedure was employed with the main steel columns being installed first. CHS shrouds were then slipped over the columns and grouted into place. These 9m-high columns weigh up to 30t with their shrouds and base plates.

was the first part of the construction programme to be undertaken when work kicked off in 2015.

The upper level of the basement was excavated and the ground floor cast. The use of plunge columns then allowed the basement to be constructed top-down simultaneously with the concrete core construction and steel frame erection starting above.

Alongside the development, a new half-acre public realm boasting restaurant and retail amenities will provide pedestrian access between Bishopsgate, St Mary Axe and Camomile Street to the north. Forming another part of the overall scheme, 15-16 St Helen's Place is separated from the main structure by this realm.

The six-storey steel-framed St Helen's Place structure incorporates a retained façade and shares a basement with 100 Bishopsgate.

The main 40-storey tower provides the main stand-out element of the project. With floorplates ranging from 1,800m² to 2,300m², the space is said to be suitable for a range of City tenants and, unsurprisingly, large parts of the building have already been let. In fact, the scheme is 68% let to various tenants including Royal Bank of Canada, Jefferies, Freshfields and Equinox.

According to architect Allies and Morrison, the form of the tower responds to the geometries of the site and context by transitioning from a parallelogram at its base to a rectangle at its top.

In combination with contrasting façade textures and articulated junctions repeated rotationally around the building, this transition in form lends the tower a distinctive twisting dynamic.

To form this eye-catching shape, two façades, north and south, feature a series of inclined columns. They are installed in a staggered configuration from ground level up to level 24, where the entire building straightens into a rectangle.

The sloping elevations have a fold that stretches upwards from east to west on the north side, with the geometry then reversed on the south façade.

The folds end a bay in from the building's perimeter at one end, meaning the eastern end of the north elevation slopes and the western end has straight columns. Again, this twisting geometry is reversed on the south side.

In the areas where the folds straighten, raking columns change position, and consequently large axial loads are encountered.

"Large tension and compression forces are transferred to the core in these areas, and in order to help distribute these loads we

▶20

▶19 have two storeys with extra bracing in the floors," explains Robert Bird Group Director Russell Whitehead.

Based around a centrally-positioned core, steelwork radiates outwards to supporting perimeter columns spaced at 9m centres. Accommodating the building's services within the structural ceiling void, 700mm-deep Fabsec cellular beams have been used throughout the scheme.

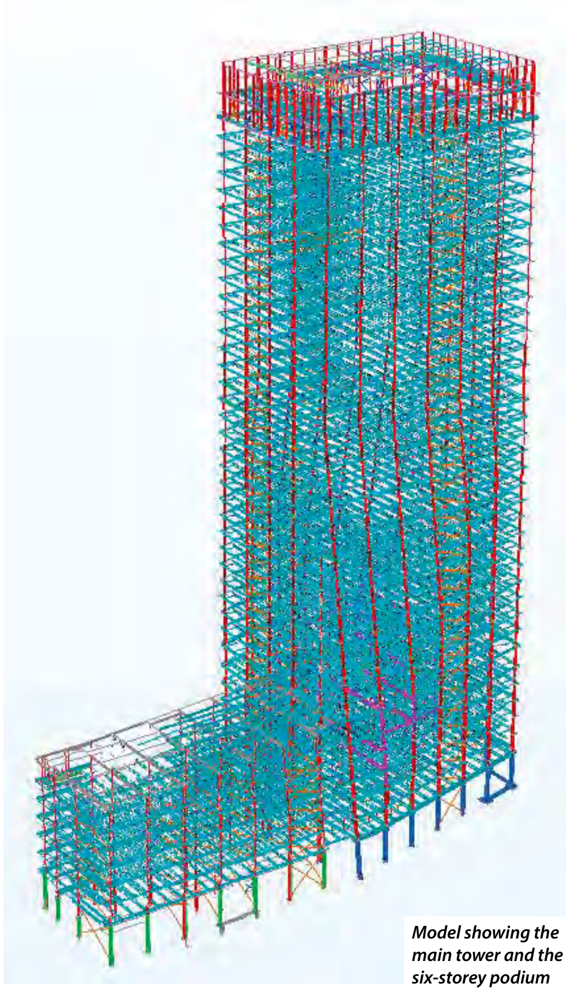
Because of the tower's changing sloping shape the internal spans along the north and south elevations vary from a maximum of 23m-long to 11m-long on level 24. As the building turns into a rectangle, the levels from floor 24 upwards all have 11m internal spans.

Except for the declining length of the internal beams, the steel frame is fairly repetitive until the uppermost plant level at floors 38 and 39. Here three 4.5m-deep trusses, each 22m-long, have been installed to support plant equipment.

Steelwork contractor William Hare's package consists of a grand total of 15,000t of steel, which includes more than 6,500 individual pieces. The company, alongside Prodeck-Fixing Ltd, is also installing 90,000m² of ComFlor metal decking for the project's composite floor construction.

In recognition of its good working practice Multiplex won a Silver Considerate Constructors Scheme 2016 National Site Award. In addition the Project was awarded the City of London Corporation's Chairman's Cup for most Considerate Contractor in the City of London. The 100 Bishopsgate job was said to have shown the highest levels of consideration towards the public, its workforce and the environment through adhering to the Scheme's five-point Code of Considerate Practice.

100 Bishopsgate is due to complete in early 2019.



Model showing the main tower and the six-storey podium

Inclined columns

Richard Henderson of the SCI discusses some of the structural consequences of inclined columns

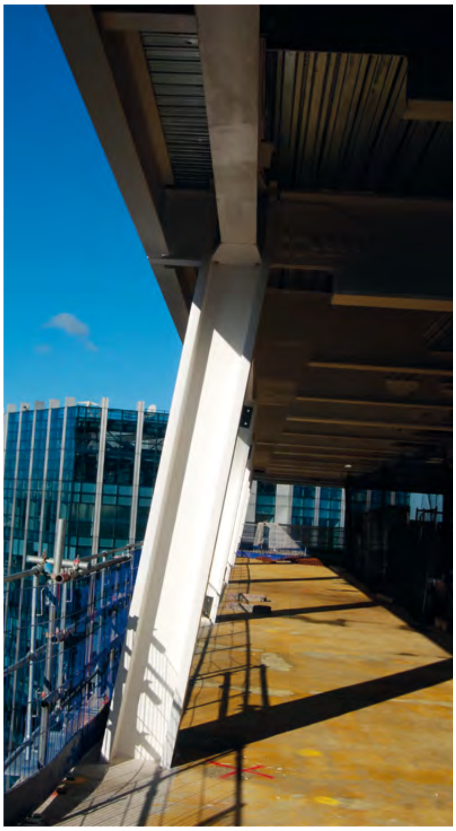
The crispy folded surfaces of the sculpted façade of 100 Bishopsgate indicate the changes in slope of the column centrelines behind. The columns are vertical through the upper storeys and become inclined outward below the horizontal fold lines. At the change in direction of a column, the horizontal component of the outward-sloping lower portion is resisted by a compression in the floor structure. At various heights lower down the building, the inclined columns become vertical again with the horizontal component this time resisted by a tension in the floor structure.

The horizontal components at the changes in direction are large: for example where a column which carries about 50 m² at each of 17 storeys changes from vertical to a slope of 1 in 8, it is likely to have a horizontal component of the order of 1 MN. Where a floor beam is carried by an outwardly inclined column and the slope continues past the floor, a smaller horizontal compression is developed in the floor structure. If all the horizontal components (both tension and compression), are resisted by the core the net horizontal load is zero.

The folds are present in the north and south elevations so where the horizontal thrusts are equal on both sides, they can be passed through the core without resulting in a shear force in the vertical walls. Where the geometry is such that the thrusts from the two sides are different, the core walls are subjected to shear and bending due to the net horizontal components of the vertical loads. These actions are present in the core walls until the balancing tension cancels them out.

The building's core layout shows the perimeter columns are in line with vertical walls which are therefore available to resist these forces, except for the middle column on the longer facades. At this position, any out of balance in the horizontal components of the column loads in the floor structure needs to transfer sideways to the vertical structure.

The steel floor structure is connected to the concrete core using cast-in plates. The floor plans suggest the floors are present right up to the core walls and if so, the horizontal components of the column forces can be transferred to the cores through the concrete floor slabs. This would allow the connections to the floor beams to be designed as simple connections (carrying vertical load only) in accordance with the SCI "Green Book".



The new frame sits adjacent to the existing building

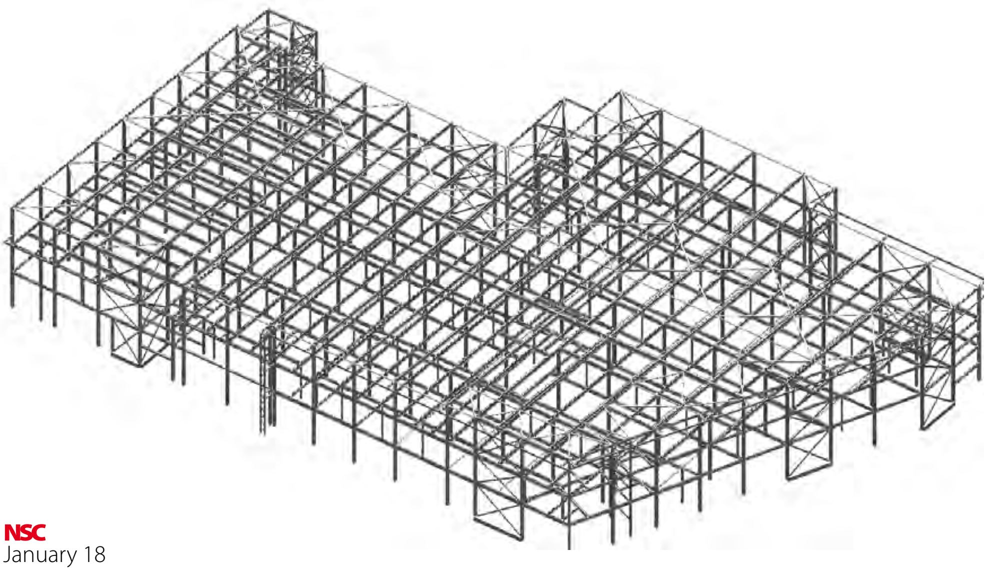
Sport and fitness in the frame

A steel-framed solution is the answer for a leading retailer's first new build outlet in Scotland.

Sports goods retailer Sports Direct is building its first new build outlet in Scotland.

Designed specifically to house the company's leading retail fascias under one roof, including Sports Direct, Flannels, USC and an Everlast Fitness Club, the new development is located close to the popular Glasgow Fort shopping centre, adjacent to the M8 motorway.

The scheme comprises the refurbishment and reconfiguration of a steel-framed former retail unit adjacent to an existing Morrisons store on Auchinlea Way, along with the construction of a three-storey steel frame extension, totalling over 16,700m² of retail space.



The project is said to be aligned with a new direction for Sports Direct in how it manages its current portfolio of stores, which includes a focus on securing freehold assets, where its portfolio of fascias can potentially be brought together in a single location.

Main contractor ISG will form distinct retail space for each of the retail fascias at the new Glasgow outlet, with the luxury men and women's designer store Flannels, extending across the ground and first floors.

Sports Direct's latest concept store design will be showcased in Glasgow, as will be Scotland's very first Everlast Fitness Club, occupying the entire second floor of the extension and featuring an open plan gym area, café, dance and spinning studios.

The renovated existing steel-framed building will be subdivided and let to other retailers, as will a separate unit within the new build element.

The striking design for the new unit includes a gullwing roof structure, extensive glazing and cladding panels, including distinctive coloured mosaic feature panels to the façade.

"The existing building will be over-clad with the same material as the new build, so even though they are separate structures sitting end-to-end, they will appear to be one new building," explains ISG Senior Project Manager Stephen Maclaren.

Prior to steelwork contractor Walter Watson completing its eight-week erection programme, which also included installing metal decking, cold rolled joists, precast concrete lift shafts and a travellator pit, ISG had completed the groundworks on this brownfield site.

The ground has been vibro-improved and the new steel frame sits on pad foundations, similar in design to the adjacent existing structure.

There is a 600mm gap between the new frame and the existing frame and this close proximity meant that one row of column's foundations were obstructed by old foundations.

"There was very little information available regarding the old structure and its foundation," explains Adept Structural Engineer Andrew Spencer. "As the old foundations protruded into the zone of the new works we designed a cantilevering ground beam to avoid the obstructions and carry the columns closest to the existing building."

The new steel frame is based around 6m-wide bays, with some slightly larger where needs, such as escalators, dictate. It is a braced frame, with cross bracings located along the perimeter walls.

"We completed our works by handing over the building in three phases, allowing other trades to follow on as each phase was finished," says Walter Watson Project Manager Trevor Irvine.

Two different solutions have been used for the flooring, with a composite steelwork supporting metal decking and a concrete topping for the second floor, and cold-rolled steel joists supporting timber flooring for the first level.

The first floor is essentially a mezzanine level, covering roughly 85% of the frame's footprint. Supported on slim box section columns, that are positioned at regular intervals between the main columns, they can be removed if required, adding flexibility into the scheme.

Likewise, a timber flooring system supported on cold rolled steel was chosen as it can be easily removed along with its supporting steel members.

The steel design has also taken into account that the upper second floor needs to be as column-free as possible, due to it being a large open-plan gym.

"There are only seven internal spine columns on this floor, giving the area the required open feel," says Mr Maclaren. "Either side of the central columns two rows of 20m-long rafters form the building's roof."

The roof was initially designed as a portalised frame, however, after some value engineering by ISG, it was altered to a more cost-effective and eye-catching gullwing design.

Vibration could be issue for the gym's floor especially in areas where weights may get dropped on to the deck. In these areas, the 150mm-thick slab is supported by deeper beams, 610 UBs instead of 457 UBs used elsewhere on the project, to negate any issues.

ISG completed the construction of the new outlet towards the end of last year, with the store fit-out due to commence in early 2018.

Summing up, ISG's Retail Framework Director Richard Oldfield says: "Sports Direct represents one of the UK's most successful retail roll outs and the company's focus on creating a house of brands for its new store designs is a key development for the business.

"The new Glasgow outlet brings a new gym concept – Everlast Fitness Clubs to Scotland, as well as the country's second ever Flannels store. This is a key win for our business as we add Sports Direct to our client portfolio of the most influential global retail brands."

Mobile cranes help to erect the new build

FACT FILE

Sports Direct outlet, Easterhouse, Glasgow

Main client: Sports Direct
Architect: Halliday Fraser Munro
Main contractor: ISG
Structural engineer: Adept Consulting Engineers
Steelwork contractor: Walter Watson
Steel tonnage: 470t

Visualisation of the completed project

Cellular beams have been used throughout for service integration

Peak development

Cambridge's tallest office block will form the centrepiece of the city's ambitious CB1 master plan.

FACT FILE
50/60 Station Road, Cambridge
Main client: Brookgate
Architect: Grimshaw Architects
Main contractor: Galliford Try
Structural engineer: Mott MacDonald
Steelwork contractor: Billington Structures
Steel tonnage: 2,000t

Cambridge is currently a hive of construction activity, so much so that in some quarters it has even been dubbed 'Cranebridge'.

The famous university city is expanding as new residential, commercial, as well as educational and science establishments are springing up, predominantly around the outskirts.

One of the largest schemes however, is being undertaken right in the city centre, next to the main railway station. Known as CB1 and covering an area of 23 acres, the development will eventually provide a new city quarter on land that had mostly been occupied by railway sidings and a mill.

As well as a new station square and transport interchange, CB1 will provide Grade A office blocks, residential and student accommodation, retail units and hotels.

CB1 is currently delivering what is said to be the city's tallest office block, which is designed to accommodate a European or UK regional headquarters and will attain a BREEAM 'Outstanding' rating.

The steel-framed 50/60 Station Road will provide 15,100m² of office space and ground floor retail units, within an eight and nine storey block, both positioned above an underground car park.

Originally designed as two separate buildings, the plans developed over time and finally the two structures were joined with an eight-storey link structure to form one large frame. This is said to have increased construction efficiency while delivering a far greater floorplate.

Located opposite the station, this project is in terms of height CB1's peak building and a centrepiece, as future developments will progressively step down in size the further they are from the station.

50/60 Station Road's steel frame comprises cellular beams used in conjunction with composite metal deck flooring; this has helped to create the desired spans of up to 12m.

The lateral stability of the structure is provided through concrete core structures, into which the steel frame connects. There are two cores, the largest one [east] positioned within the nine-storey block contains all of the lifts, while a small stairwell core is located in the eight-storey part.

Below ground the structure is supported on piled foundations with steel sheet piles creating the perimeter of the basement.

Explaining why this project is being constructed with a steel framing solution, Galliford Try Senior Projects Manager Fergus Anscombe says: "We have spans of up to 12m and creating these long column free spaces is easier with steelwork as the floor-to-ceiling heights are restricted by local planning."

"We've also made use of cellular beams throughout the building, they accommodate services, thereby helping to keep the structure within its specified height restriction."

Mott MacDonald Senior Structural Engineer Roger Faires adds: "The project also benefited from the involvement of Billington Structures who worked to refine the cellular beams using plain beams and its in-house plasma cutter to bring about more commonality in the structure."

Work on the project began last year

with Galliford Try demolishing a row of Victorian terraced houses, that occupied part of the site. In readiness for excavating the basement car park. a series of 10m-deep sheet piles were then installed to help form the basement perimeter wall.

The steel frame and basement slab are supported on 3m deep pile caps which, in turn, are supported by 190 x 750mm diameter CFA piles extending 23m down to suitable strata. The 9m x 12m steel column grid pattern, used pretty much right through the scheme, was deemed suitable for the car park, offices and retail units.

The project's two stability-giving concrete cores were next to be constructed.

"As the west core is smaller and was quicker to construct, we started the steel erection programme at this end of the scheme," says Mr Anscombe. "This worked well for our on-site logistics and allowed the earliest availability to erect 50% of the structural steel. The steel erectors had one part of the site to themselves, while the east core was still being built at the other end."

Galliford Try says working in this sequence enabled steelwork contractor Billington Structures to complete the first half of the project faster than originally expected, which had the positive knock-on effect of allowing the follow-on trades to start early.

The entire steel frame will be completed during January 2018 with all the steelwork being lifted into place via the site's two tower cranes.

According to Billington Structures the heaviest steel member was 8t, but this had to be reduced due to the capacity of the tower cranes.

The only time the company needed to use other cranes was when it hired a 220t mobile to lift its MEWPs into the basement from where they helped erect the entire frame.

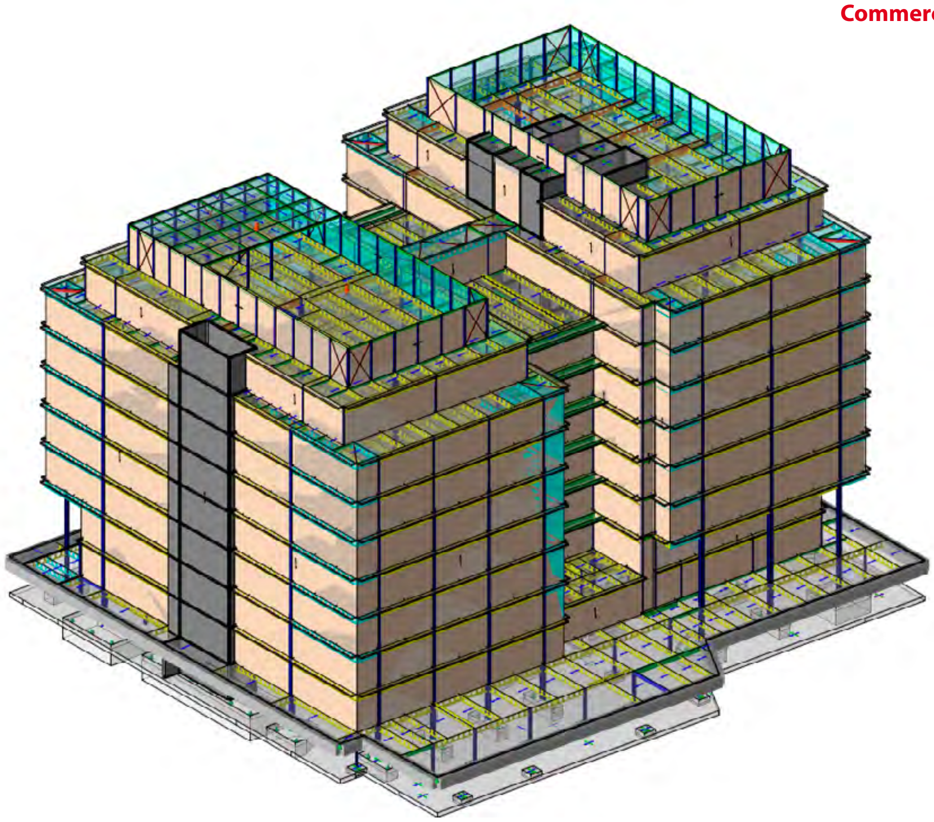
Having competed its initial steelwork, Billington Structures is scheduled to return to site later this year to complete some final elements. This includes some basement infill work and a car park ramp, as well as a cantilevering pod attached to the building's link structure.

The pod has to be retrofitted as its main support, as well as bracing, comes from the building's completed floors in the adjacent link structure.

The one-storey pod cantilevers by up to 6m from the first floor and overhangs a colonnade that runs along the front of the building.

Measuring up to 8m-wide, the fully-glazed pod is formed with a series of curved and straight beams, creating a highly visual structure that will seem to float above the ground floor.

50/60 Station Road is due to complete by April 2019.



BIM aids cost-effective cellular beam design

Building Information Modelling (BIM) using Tekla Structural Designer (TSD) helped with the project's rationalisation of its cellular beams.

"The top two floors of each block include transfer beams for inset floors. The original design was for double beams to support the inset columns. Using TSD we replaced a number of double beams with Westok plate beams, which could be designed within the model. The model also allowed us to react quickly to the early design changes including removing the original second basement" explains Mott MacDonald Senior Structural Engineer Roger Faires.

Using the drawing function, information could be sent to the mechanical engineer to confirm web penetration requirements with their service route requirements. The section was then exported to Revit and the information could be used to ensure web penetrations were displayed accurately on drawings.

Using this process savings were made on steel weight and the number of connections, while allowing a more integrated design.

The first floor is set back to create a double-height space in the entrance foyer

Stainless steel in construction

Stainless steels may appear to be more suitable for teaspoons and kitchen sinks than for structural elements, but they can be used for support and other structures in aggressive environments, says Nancy Baddoo of SCI.

The main property that distinguishes stainless steel from carbon steel is that it possesses inherent corrosion resistance, due to the tightly adherent protective layer of chromium oxide which spontaneously forms on its surface in the presence of oxygen. This means that stainless steel components can be exposed to a wide range of environments without the need for protective coatings.

Stainless steels are highly versatile materials, possessing a unique selection of useful properties which can be exploited in load-bearing applications where cost is not a primary consideration. Figures 1 and 2 show stress-strain characteristics at low and high strains, compared against carbon steel. Austenitic stainless steels are generally used for structural applications, though the use of duplex stainless steel is increasing, where the higher strength is beneficial. The distinctive mechanical properties - considerable strain-hardening and ductility - make austenitic and duplex stainless steel particulary well suited for structures required to withstand accidental loading.

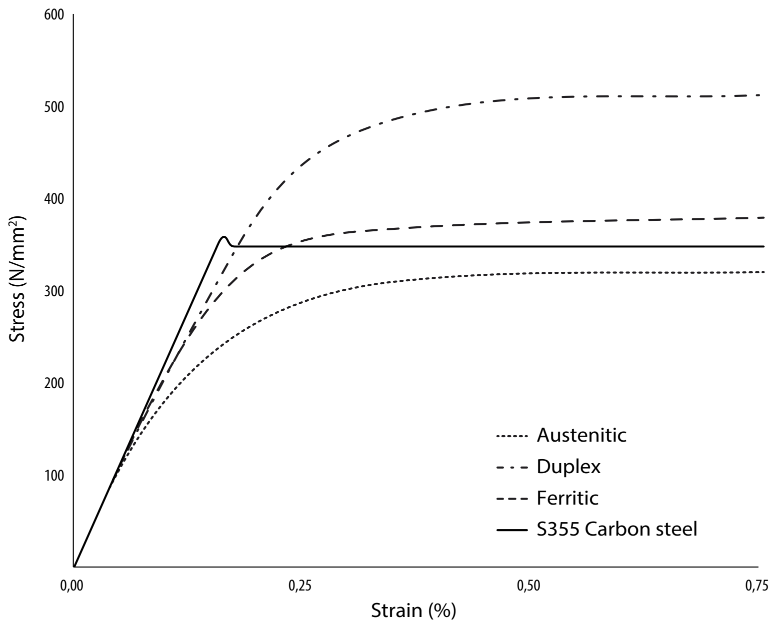


Figure 1 Stress-strain curves for stainless steel and carbon steel from 0 to 0.75 % strain

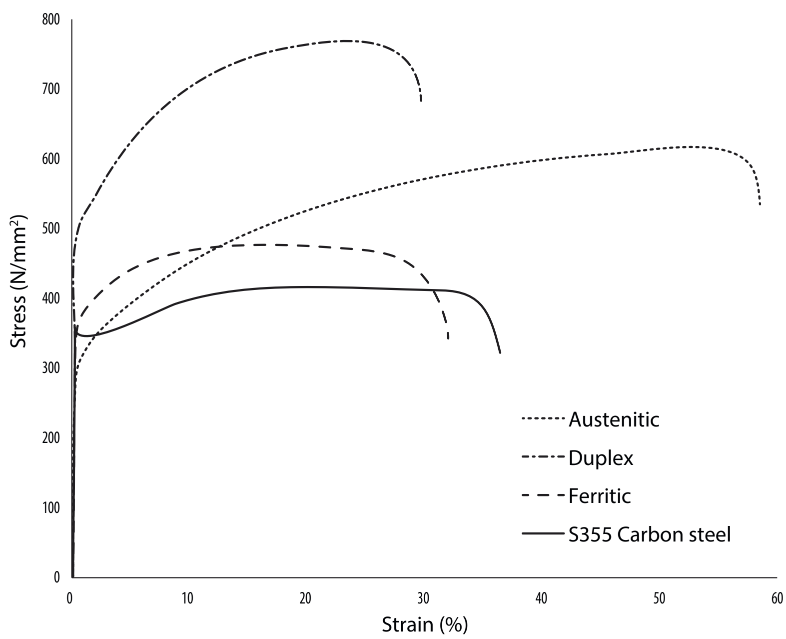


Figure 2 Full range stress-strain curves for stainless steel and carbon steel

Typical load-bearing applications include:

- Platforms and supports in processing plant for the water treatment, pulp and paper, nuclear, biomass, chemical, pharmaceutical, and food and beverage industries where the aggressive environment requires it.
- Pins, barriers, railings, cable sheathing and expansion joints in bridges
- Seawalls, piers and other coastal structures
- Reinforcing bar in concrete structures
- Curtain walling, roofing, canopies, tunnel lining
- Support systems for curtain walling, masonry, tunnel lining etc
- Security barriers, hand railing, street furniture
- Fasteners and anchoring systems in wood, stone, masonry or rock
- Structural members and fasteners in swimming pool buildings (special precautions should be taken for structural components in swimming pool atmospheres due to the risk of stress corrosion cracking in areas where condensates may form).
- Explosion- and impact- resistant structures such as security walls, gates and bollards
- Fire and explosion resistant walls, cable ladders and walkways on offshore platforms

In 2017, a new 160 m footbridge was constructed adjacent to the Grade 2 listed Countess Wear Bridge (figures 3 & 4 over page) in order to create a 3 m wide pedestrian and cycle route. The new footbridge comprises nine spans using conventional carbon steel and is supported in part by five hidden cantilevers embedded into the piers of the stone bridge, made from 1.4462 (2205) duplex stainless steel box sections.

The use of cantilevers avoided the need for work to be carried out in the river and complemented the appearance of the historic bridge rather than obscuring it. For these structurally critical components stainless steel was chosen for strength (grade 1.4462 stainless steel has a design strength of 450 MPa), to meet the 120 year design life target and because they were difficult to inspect and maintain.

The cantilevers are supported by piles carrying tension forces through the stone bridge into the bedrock 20 m below by means of stainless steel threaded bars. The parapet posts and handrails along the bridge were also made from duplex stainless steel. The client and designer for the project was Devon County Council and the steelwork was fabricated and installed by Taziker Industrial.

▶28

Figures 3 & 4: Countess Wear Footbridge:
Left: Stainless steel cantilevers being lifted into position during a night closure
Right: Stainless steel parapet posts and handrails

Although sharing many similar mechanical properties with carbon steel, the non-linear stress-strain characteristics mean that different design rules are needed for stainless steel. The non-linearity primarily affects local and global buckling response with some section classification limits being stricter.

Design standards for stainless steel have developed around the world. In Europe, when Eurocode 3: Part 1.4 was published in 2006[1], it was the first design standard for stainless steel in almost all European countries and the only design standard in the world which covered hot rolled, welded and cold formed products, as well as design in the fire situation. EN 1993-1-4 is a brief standard, just giving supplementary rules where the rules for carbon steel given in EN 1993-1-1[2], EN 1993-1-3[3], EN 1993-1-5[4] and EN 1993-1-8[5] are not applicable.

In certain places the rules in the 2006 edition of EN 1993-1-4 were very conservative with limited scope due to a shortage of test data. However, over the last 10 years or so there has been a very significant increase in research into the structural performance of stainless steel in Europe and worldwide and much useful information has been generated. The international database of structural tests is now three times larger than what was used to derive the original stainless steel Eurocode rules. As a result of the availability of these new research data, it was possible to develop improvements to the rules in the 2006 edition of EN 1993-1-4 and an amendment to the rules was published in 2015. The new rules permit less conservative design and extend the range of grades to which the rules apply (the grades listed in the standard did not reflect current usage). Efficient design methods are essential for stainless steel because of its high cost relative to carbon steel.

The most significant revision to the structural design rules in the 2015 amendment concern section classification: the limiting width to thickness ratios have been increased to align with those for carbon steel, except for internal compression elements. Additionally, less conservative shear buckling guidance has been included and clearer guidance on how to design cold worked stainless steel.

A key difference between stainless steel and carbon steel is that there are a wide range of stainless steel grades, each with slightly different compositions and hence corrosion resistance. Another significant revision in the 2015 amendment of EN 1993-1-4 was the inclusion of a step-by-step procedure for grade selection. The procedure involves the following steps:

- Determination of the **Corrosion Resistance Factor (CRF)** for the environment
- Determination of the **Corrosion Resistance Class (CRC)** from the CRF

The CRF depends on the severity of the environment and is calculated as follows:

$$CRF = F_1 + F_2 + F_3$$

where

F_1 = Risk of exposure to chlorides from salt water or de-icing salts;

F_2 = Risk of exposure to sulphur dioxide;

F_3 = Cleaning regime or exposure to washing by rain.

The CRF considers all corrosion risks including pitting, crevice corrosion and stress corrosion cracking of stainless steels that may affect integrity of load bearing parts. The assumption in the selection procedure is that no corrosion of stainless steel will occur that would impact the structural integrity of a load-bearing component. However, in some instances cosmetic corrosion (staining or minor pitting) could occur. These effects may be unsightly and unacceptable where appearance is important but are not detrimental to integrity.

Grades of stainless steel are classified in one of five CRCs, with CRC V being the most durable (e.g. containing grades suitable for the highly corrosive atmospheres above indoor swimming pools). The final choice of a specific grade within a CRC will depend on other factors in addition to corrosion resistance, such as strength and availability in the required product form. It is sufficient for the designer to specify the material by CRC and design strength, e.g. CRC II and $f_y = 450$ N/mm^2.

The publication of the amendment rendered all existing resources for designers relating to the stainless Eurocode obsolete. A new collection of supporting design resources is being prepared in order to help designers to use the new rules in the European dissemination project PUREST (Promotion of new Eurocode rules for structural stainless steel), part funded by the EU's Research Fund for Coal and Steel. The 18 month project started in 2016 and finishes in December 2017 and involves partners from Germany, Belgium, Spain, Portugal, Czech Republic, Finland, Sweden, Poland and Italy. SCI co-ordinates the work with support from Imperial College London and Arup.

Activities are mostly targeted at design practitioners and include:

- Updating and extending the *Design Manual for Structural Stainless Steel*,
- Translating the *Design Manual* from English into 9 languages,
- Developing online design software and design apps,
- National seminars and recording webinars for distance learning.

SCI published the Fourth Edition of the *Design Manual for Structural Stainless Steel* in 2017[6] (Figure 5). It consists of three parts:

- **Recommendations**, which give the design guidance and essential information needed by designers concerning grade selection, durability, material properties, design rules and fabrication
- **Commentary**, which explains how the design expressions in the Recommendations were derived and gives background information and references
- **Design Examples**, which demonstrate the use of the Recommendations

As well as updating the design rules to align with the 2015 amendment to EN 1993-1-4, the *Design Manual* also includes information on ferritic stainless steels. These grades are generally used in gauges of 4 mm and below, and offer a corrosion resistant alternative to many light gauge galvanized steel applications.

Additionally two new design methods are included. The first gives rules on how to take advantage of the work hardening associated with cold forming operations during fabrication (a strength enhancement of about 50 % is typical in the cold formed corners of cross sections, and the strength of the material in the flat faces also increases). The second gives a method for calculating the enhanced cross-section design resistances due to the beneficial influence of work hardening in service using the Continuous Strength Method.

All the design resources developed in the PUREST project will be accessible at www.steel-stainless.org/designmanual from the start of 2018.

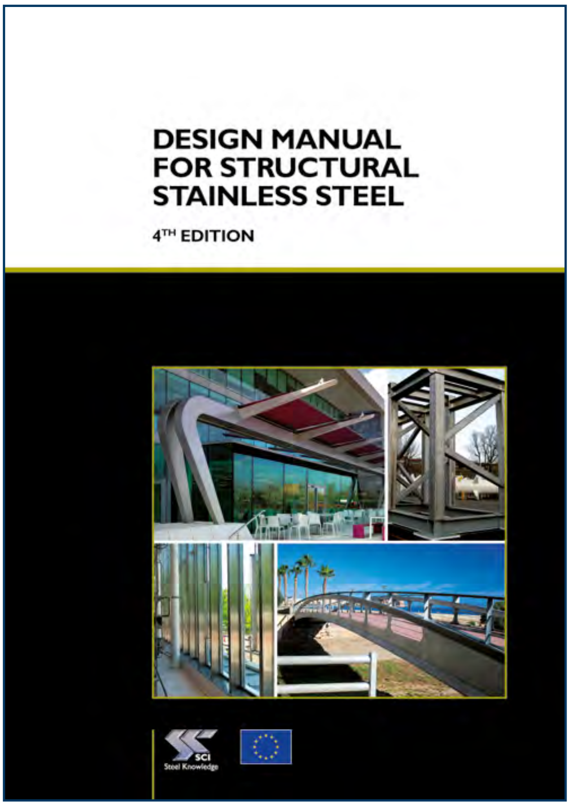


Figure 5: Design Manual for Structural Stainless Steel, Fourth Edition, 2017

For more information, please contact Nancy Baddoo at SCI (n.baddoo@steel-sci.com).

References:

1 EN 1993-1-4:2006+A1:2015 Eurocode 3. Design of steel structures. General rules. Supplementary rules for stainless steels
2 EN 1993-1-1:2005+A1:2014 Eurocode 3. Design of steel structures. General rules and rules for buildings
3 EN 1993-1-3:2006 Eurocode 3. Design of steel structures. General rules. Supplementary rules for cold-formed members and sheeting
4 EN 1993-1-5:2006 Eurocode 3. Design of steel structures. Plated structural elements
5 EN 1993-1-8:2005 Eurocode 3. Design of steel structures. Design of joints
6 Design Manual for Structural Stainless Steel, SCI Publication P413, 2017

AD 413: Shear resistances of M12 bolts

Designers using paper or online versions of the Eurocode Blue Book may have noted that the shear resistance of an M12 bolt has different values quoted, depending on the resource selected.

According to BE EN 1090, the clearance hole for an M12 bolt is 13 mm. If this diameter hole is used, then the shear resistance may be calculated in the normal way, without any additional factors. This value of shear resistance appears in the online Steel for Life version of the Blue book.

Clause 3.6.1(5) of BS EN 1993-1-8 allows M12 bolts to be used in 14 mm holes (i.e. slightly oversize), but applying a factor of 0.85 to the quoted resistance. This factor was applied in the paper versions of the Blue Book (P363) and the ArcelorMittal Orange Book resource. It is clearly conservative to apply the 0.85 factor, though the reduction is unnecessary if M12 bolts are used in 13 mm holes.

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

AD 414: Slip-resistant connections to BS EN 1993-1-8

Clause 3.4.1 of BS EN 1993-1-8 describes two types of slip-resistance connections:

- Category B: Slip-resistant at SLS.
- Category C: Slip-resistant at ULS.

Designers often ask when the different categories are appropriate.

Category B is appropriate if slip after SLS but before ULS only produces some unsightly deflections (which may be very unwelcome), but crucially, does not reduce the ultimate resistance of the element or structure. An example might be a splice connection in a roof truss. According to Table 3.2 of the Eurocode, in addition to verifying slip resistance at serviceability the shear and bearing resistance of the bolts must be verified in Category B connections, so that the ultimate resistance of the joint is not reduced even if slippage occurs after SLS.

Category C is appropriate when slip below ULS might reduce the ultimate resistance of the element or structure. An example of this might be a plan bracing restraint system to a compression member – for example in a heavily loaded transfer truss. Slippage within the restraint system might reduce the buckling resistance, so this must be prevented.

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New and revised codes & standards

From BSI Updates November 2017

BRITISH STANDARDS WITHDRAWN

BS 6779-1:1998

Highway parapets for bridges and other structures. Specification for vehicle containment parapets of metal construction

Partially superseded by BS EN 1317-1:1998

DRAFT BRITISH STANDARDS FOR PUBLIC COMMENT – ADOPTIONS

17/30346735 DC

BS EN 10225-3 Weldable structural steels for fixed offshore structures. Technical delivery conditions. Part 3. Hot finished hollow sections

Comments for the above document are required by 7 November 2017

17/30346738 DC

BS EN 10225-2 Weldable structural steels for fixed offshore structures. Technical delivery conditions. Part 2. Sections

Comments for the above document are required by 7 November 2017

17/30347632 DC

BS EN ISO 11126-8 Preparation of steel substrates before application of paints and related products. Specifications for non-metallic blast–cleaning abrasives. Part 8. Olivine

Comments for the above document are required by 28 November 2017

17/30361154 DC

BS EN ISO 11124-3 Preparation of steel substrates before application of paints and related products. Specifications for metallic blast-cleaning abrasives. Part 3. High-carbon cast-steel shot and grit

Comments for the above document are required by 28 November 2017

17/30361157 DC

BS EN ISO 11124-4 Preparation of steel substrates before application of paints and related products. Specifications for metallic blast-cleaning abrasives. Part 4. Low-carbon cast-steel shot

Comments for the above document are required by 28 November 2017

CEN EUROPEAN STANDARDS

EN 1993-4-1:2007/A1:2017

Eurocode 3. Design of steel structures. Silos

EN ISO 2063-1:2017

(ISO 2063-1:2017)

Thermal spraying. Zinc, aluminium, and their alloys. Design considerations and quality requirements for corrosion protection systems

EN ISO 2063-2:2017

(ISO 2063-2:2017) Thermal spraying. Zinc, aluminium and their alloys. Execution of corrosion protection systems

ISO PUBLICATIONS

ISO 2063-2:2017

Thermal spraying. Zinc, aluminium and their alloys. Execution of corrosion protection systems

Will be implemented as an identical British Standard

BUILDINGWITHSTEEL
Reprinted from Volume 4 No. 8
November 1967

Design of two buildings with suspended structures

The structures described in this article are two office tower blocks currently under construction (1967) for the Commercial Union Assurance Co. Ltd. and the P&O Steam Navigation Co., conceived as a comprehensive development on adjoining sites in the City of London.

The CU Building is 387 ft high above ground level and 124 ft. square in plan. The entire tower is supported by a reinforced concrete core 75 ft. by 50 ft. in plan, and contains lifts, staircases and services. There are two plant rooms in the tower, one at mid-height and the other at the top. Each plant room contains steel frames cantilevering from the core to support trusses and girders around the perimeter of the building. The cantilevers reach 37 ft. out from the core on two sides of the building and 25 ft. out on the other two sides. Steel hangers within the external walls are suspended from the trusses and girders around the plant rooms and they support the outer ends of the castellated steel beams at each floor level. The inner ends of these beams are carried by the concrete core. Twelve office floors are supported by the hangers in the upper potion of the tower, and eleven office floors, an open podium and a mezzanine are suspended on the hangers in the lower half of the building.

The construction of the P&O Building is similar to that of the CU Building, but it is smaller in size, having one plant room at the top of the tower and ten office floors suspended from the cantilever steel work accommodated within this plant room. The height of this building is 191 ft.

Both buildings are enclosed in curtain walling with extruded aluminium mullions on a module of 6.31 ft. and the hangers are housed inside alternate mullions. The typical floors are of structural lightweight concrete generally 5 in. thick and span continuously over the castellated floor beams. The heating and ventilation services pass through holes in the castellated beams. At each floor level there is a composite concrete and steel truss around the buildings connecting all the hangers. This, with some overstress, will transfer the load from a failed hanger safely to the adjacent hangers.

The positions of the cantilever frames in the plant rooms are determined by the arrangement of the major walls in the core and, for the CU building, on two opposite sides of the tower there are two cantilever frames, whilst on the other two sides there are four. On the sides with two frames a deep truss, occupying the height of the plant room is used to transfer the hanger loads to the cantilever frames, while on the sides with four frames, a plate girder suffices.

The cantilever frames themselves comprise horizontal struts embedded in the plant room floor and diagonal ties connected to steel anchor blocks resting upon corbels formed in the concrete walls of the core. The horizontal component of the tension in the diagonal ties is transferred to the core by post tensioned prestressing cables that attach the anchor blocks to the core.

The horizontal struts in the cantilever frames are lattice box members connected to the perimeter trusses and girders through steel-to-steel end bearing plates. At the inner end the struts have steel bearing plates that thrust against the core walls. These struts also act as beams supporting the plant-room floors, and the vertical reactions due to this loading are resisted by steel brackets built into the core.

The steel lattice struts acting alone are only designed to resist the forces induced during the erection of the steelwork and the casting of the concrete plant room floor slab. The horizontal forces from subsequent dead and live loading applied to the structure are shared between the lattice strut and the 28 in thick lightweight concrete slab forming the plant room floor.

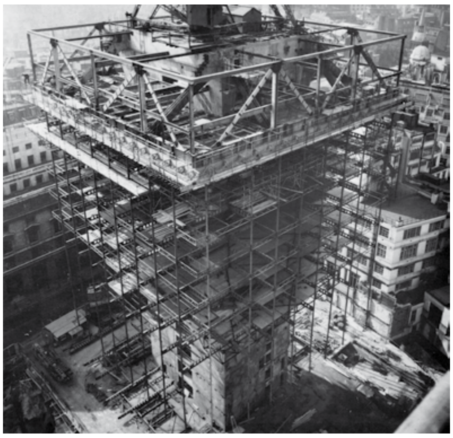
The curtain-walls for both buildings are supported by specially designed frames of extruded aluminium. The infilling panels of the CU Building will be entirely of grey tinted glass, extended from floor to ceiling of each room, with aluminium transom panels covering the depth of the floors and ceiling spaces.

The Structural Steelwork.

There are approximately 2,500 tons of structural steel in the CU Tower, and 900 tons in the P&O Tower, of which a considerable proportion is high yield stress steel to BS 968:1962. The steelwork was generally designed to BS 449 using the elastic method.

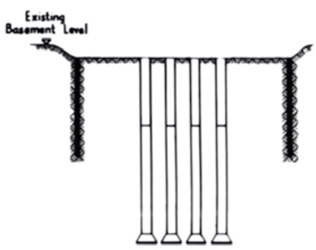
The plate girders and the bottom chords of the trusses around the plant rooms are 4 ft deep and comprise high yield stress plates up to 2½ in. thick, welded together. All the other members in the trusses are of mild steel, plates being used for the diagonals and universal column sections for the top chords and the vertical posts.

The diagonal ties in the cantilever frames and also the blocks that anchor them to the core are fabricated from high yield stress plates up to 2¼ in. thick. The hangers, too, are of high yield stress steel, their section ranging from 9 in. by 2 in. to 9 in. by ¾ in. The individual parts of the hangers are up to 66 ft long, spliced together with friction grip bolts.

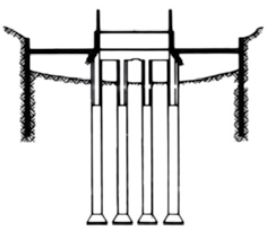


The maximum working stress in the hangers is 13.5 ton/sq in. and there would be no advantage in using steel with a higher working stress because the extension of the hangers under the superimposed load is at the acceptable limit. Indeed, considerable attention was paid to the deflections of the suspended floors due to the superposition of the extension of the hangers themselves, the deflections of plant-floor steelwork and also the vertical creep and drying shrinkage of the core. The drilling of the hangers for the floor beam connections was arranged so that the floors will be level under the permanent load and about half of the superimposed load. The total extension of the hangers under permanent and superimposed loading amounted to 1.5 in. At the top of the hangers the drilling was varied from hanger to hanger to compensate for the deflections of the perimeter trusses and girders. It was simpler to do this than to camber the trusses and girders themselves.

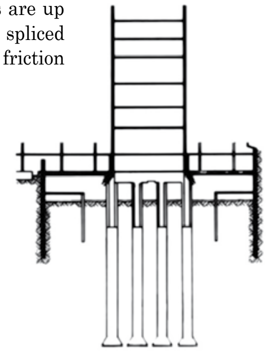
Architects for both buildings were Gollins, Melvin, Ward & Partners. Consulting civil and structural engineers were Scott Wilson Kirkpatrick & Partners.



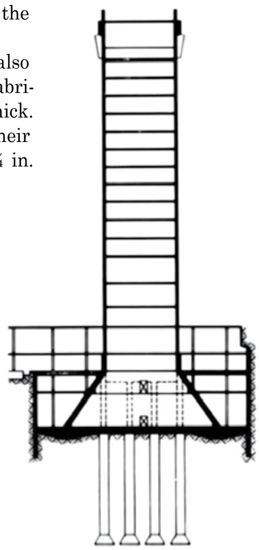
STAGE 1: Commence excavation, sink diaphragm wall and 12 No. cylinder piles. Concrete diaphragm walls and cylinder piles



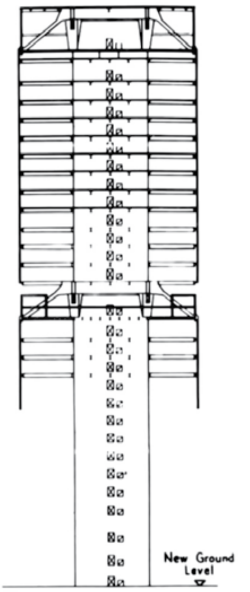
STAGE 2: Cast columns on piles. Excavate within diaphragm wall, construct slab and commence casting core walls.



STAGE 3: Core in progress. cast perimeter section of intermediate basement slab (supported on ring of temporary piles) to strut diaphragm walls.



STAGE 4: Core in progress. Complete excavation and cast remainder of raft and walls.



STAGE 5: Tower foundation complete. Steelwork ereted from the top. Upper floors cast while lower steelwork is being erected.

BCSA

Steelwork contractors for buildings

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

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

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

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

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

Notes

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

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

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)
A & J Stead Ltd	01653 693742			●	●					●	●			●	●		3			Up to £400,000
A C Bacon Engineering Ltd	01953 850611			●	●	●	●				●			●			2			Up to £3,000,000
A&J Fabtech Ltd	01924 439614	●					●		●	●	●		●	●		✔	3			Up to £400,000
Access Design & Engineering	01642 245151					●				●	●			●	●	✔	2			Up to £4,000,000
Adey Steel Ltd	01509 556677	●		●	●	●	●	●	●	●	●			●	●	✔	3	✔	Silver	Up to £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			Up to £3,000,000
Angle Ring Company Ltd	0121 557 7241												●			✔	4			Up to £1,400,000
Apex Steel Structures Ltd	01268 660828					●	●			●	●			●	●		2			Up to £2,000,000
Arc Fabrication Services Ltd	01709 557654			●	●	●	●	●	●	●	●			●	●	✔	3			Up to £200,000
Arminhall Engineering Ltd	01799 524510	●			●	●		●		●	●			●	●	✔	2			Up to £800,000
Arromax Structures Ltd	01623 747466	●		●	●	●	●	●	●	●	●	●		●	●		2			Up to £800,000
ASA Steel Structures Ltd	01782 566366			●	●	●	●			●	●			●	●	✔	4			Up to £800,000
ASME Engineering Ltd	020 8966 7150				●	●				●	●			●	●	✔	4		Gold	Up to £2,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●	●	●				●			●	●	✔	2			Up to £1,400,000
Austin-Divall Fabrications Ltd	01903 721950			●	●		●	●		●	●			●	●	✔	2			Up to £1,400,000
B D Structures Ltd	01942 817770			●	●	●	●				●	●		●		✔	2			Up to £1,400,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✔	4			Up to £1,400,000
Barnshaw Section Benders Ltd	0121 557 8261												●			✔	4			Up to £1,400,000
BHC Ltd	01555 840006	●	●	●	●	●	●	●			●	●		●	●	✔	4		Silver	Above £6,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●	●	●	●	●		●	●	✔	4	✔	Gold	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●		4			Up to £3,000,000
Bourne Construction Engineering Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●			●	●	✔	4			Up to £6,000,000
Builders Beams Ltd	01227 863770			●	●	●	●			●	●			●	●	✔	3	✔		Up to £3,000,000*
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●				●	●	✔	4		Silver	Up to £3,000,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●		●	●	●		●	●	✔	4	✔	Gold	Above £6,000,000
Cementation Fabrications	0300 105 0135	●			●			●			●		●		●	✔	3		Gold	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	●		●		✔	4		Gold	Above £6,000,000
CMF Ltd	020 8844 0940				●		●	●		●	●				●	✔	4			Up to £6,000,000
Cook Fabrications Ltd	01303 893011			●	●		●			●	●			●	●		2			Up to £1,400,000
Coventry Construction Ltd	024 7646 4484			●	●	●	●		●	●	●			●	●	✔	4			Up to £1,400,000
D H Structures Ltd	01785 246269			●	●		●				●						2			Up to £100,000
D Hughes Welding & Fabrication Ltd	01248 421104				●	●	●	●		●	●		●	●	●	✔	4			Up to £800,000
Duggan Steel	00 353 29 70072		●	●	●	●	●	●	●	●	●	●			●	✔	4			Up to £6,000,000
ECS Engineering Services Ltd	01773 860001	●		●	●	●	●	●	●	●	●			●	●	✔	3			Up to £3,000,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●	●	●	●	●	●		●		✔	4	✔	Gold	Up to £6,000,000
ESL (GB) Ltd	01482 787986	●					●	●	●	●	●	●	●	●	●	✔	4			Up to £400,000
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

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)
Fox Bros Engineering Ltd	00 353 53 942 1677			●	●	●	●	●		●	●				●		2			Up to £2,000,000
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●				●	●	✔	2			Up to £1,400,000
Gregg & Patterson (Engineers) Ltd	028 9061 8131			●	●	●	●	●				●		●		✔	3			Up to £3,000,000
H Young Structures Ltd	01953 601881			●	●	●	●	●		●	●			●	●	✔	2		● (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
Harry Marsh (Engineers) Ltd	0191 510 9797			●	●	●	●			●	●				●	✔	2			Up to £1,400,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●	✔	2			Up to £3,000,000
Intersteels Ltd	01322 337766	●			●	●	●	●					●	●		✔	3			Up to £2,000,000
J & A Plant Ltd	01942 713511				●	●									●		4			Up to £40,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●				●	●		●			4			Up to £6,000,000*
John Reid & Sons (Strucsteel) Ltd	01202 483333		●	●	●	●	●	●	●	●	●	●		●	●	✔	4		● (grey)	Up to £6,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445			●	●	●	●	●	●	●	●	●		●	●	✔	4		● (orange)	Up to £6,000,000
Kloeckner Metals UK Westok	0113 205 5270												●			✔	4			Up to £6,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●					✔	2		● (grey)	Up to £6,000,000
Legge Steel (Fabrications) Ltd	01592 205320			●	●		●		●	●	●			●	●		3			Up to £800,000
Luxtrade Ltd	01902 353182									●	●				●	✔	2			Up to £800,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●				●	✔	4			Up to £2,000,000
M J Patch Structures Ltd	01275 333431				●					●	●				●	✔	2			Up to £1,400,000
M&S Engineering Ltd	01461 40111				●				●	●	●			●	●		3			Up to £1,400,000
Mackay Steelwork & Cladding Ltd	01862 843910			●	●		●			●	●			●	●	✔	4			Up to £1,400,000
Maldon Marine Ltd	01621 859000				●	●		●	●	●	●			●	●	✔	3			Up to £1,400,000
Mifflin Construction Ltd	01568 613311			●	●	●	●				●						2			Up to £3,000,000
Murphy International Ltd	00 353 45 431384	●			●		●	●	●		●				●	✔	4			Up to £1,400,000
Newbridge Engineering Ltd	01429 866722	●	●	●	●	●	●	●	●		●	●		●	●	✔	4		● (grey)	Up to £2,000,000
Nusteel Structures Ltd	01303 268112						●	●	●	●				●		✔	4		● (orange)	Up to £4,000,000
Overdale Construction Services Ltd	01656 729229			●	●		●	●			●				●		2			Up to £400,000
Painter Brothers Ltd	01432 374400								●		●			●	●	✔	3			Up to £6,000,000*
Pencro Structural Engineering Ltd	028 9335 2886			●	●	●	●	●	●		●			●	●	✔	2			Up to £2,000,000
Peter Marshall (Steel Stairs) Ltd	0113 307 6730									●					●	✔	2			Up to £800,000*
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●		3			Up to £1,400,000
Rippin Ltd	01383 518610			●	●	●	●	●						●	●		2			Up to £1,400,000
Robinson Structures Ltd	01332 574711			●	●	●	●				●			●	●	✔	2			Up to £3,000,000
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
Sean Brady Construction Engineering Ltd	00 353 49 436 4144			●	●	●	●			●	●			●	●		2			Up to £800,000
Severfield plc	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4		● (orange)	Above £6,000,000
SGC Steel Fabrication	01704 531286				●					●				●	●	✔	2			Up to £800,000
Shaun Hodgson Engineering Ltd	01553 766499	●		●	●		●			●	●			●	●	✔	3			Up to £800,000
Shipley Structures Ltd	01400 251480			●	●	●	●		●	●	●			●	●		2			Up to £3,000,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●	●	●	●			●				●		2	✔		Up to £1,400,000
South Durham Structures Ltd	01388 777350			●	●	●				●	●	●			●		2			Up to £1,400,000
Southern Fabrications (Sussex) Ltd	01243 649000				●	●				●	●			●	●	✔	2			Up to £800,000
Steel & Roofing Systems	00 353 56 444 1855			●	●	●	●					●		●	●	✔	4			Up to £3,000,000
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			Up to £800,000
William Haley Engineering Ltd	01278 760591			●	●	●			●	●	●			●		✔	4		● (orange)	Up to £4,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✔	4	✔	● (orange)	Above £6,000,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	FPC	BIM	SCM	Guide Contract Value (1)

Steelwork contractors for bridgeworks

RQSC The Register of Qualified Steelwork Contractors Scheme

BCSA

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

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

FG Footbridge and sign gantries
PG Bridges made principally from plate girders
TW Bridges made principally from trusswork
BA Bridges with stiffened complex platework (eg in decks, box girders or arch boxes)
CM Cable-supported bridges (eg cable-stayed or suspension) and other major structures (eg 100 metre span)
MB Moving bridges
RF Bridge refurbishment

AS Ancilliary structures in steel associated with bridges, footbridges or sign gantries (eg grillages, purpose-made temporary works)
QM Quality management certification to ISO 9001
FPC Factory Production Control certification to BS EN 1090-1
1 – Execution Class 1 2 – Execution Class 2
3 – Execution Class 3 4 – Execution Class 4
BIM BIM Level 2 compliant
SCM Steel Construction Sustainability Charter (● = Gold, ● = Silver, ● = Member)

Notes
(1) Contracts which are primarily steelwork but which may include associated works. The steelwork contract value for which a company is pre-qualified under the Scheme is intended to give guidance on the size of steelwork contract that can be undertaken; where a project lasts longer than a year, the value is the proportion of the steelwork contract to be undertaken within a 12 month period.
Where an asterisk (*) appears against any company's classification number, this indicates that the assets required for this classification level are those of the parent company.

BCSA steelwork contractor member	Tel	FG	PG	TW	BA	CM	MB	RF	AS	QM	FPC	BIM	NHSS 19A	NHSS 20	SCM	Guide Contract Value [1]
A&J Fabtech Ltd	01924 439614	●	●	●	●				●	✓	3					Up to £400,000
AJ Engineering & Construction Services Ltd	01309 671919	●	●	●	●		●	●	●	✓	4					Up to £3,000,000
Bourne Construction Engineering Ltd	01202 746666	●	●	●				●	●	✓	4	✓		✓	Gold	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	✓	4			✓		Up to £6,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●	●		●	●	✓	4			✓	Silver	Up to £3,000,000
Cementation Fabrications	0300 105 0135	●	●						●	✓	3			✓	Gold	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Above £6,000,000
D Hughes Welding & Fabrication Ltd	01248 421104	●		●			●	●	●	✓	4			✓		Up to £800,000
Donyal Engineering Ltd	01207 270909	●						●	●	✓	3			✓	Member	Up to £1,400,000
ECS Engineering Ltd	01773 860001	●	●	●	●		●		●	✓	3					Up to £3,000,000
ESL (GB) Ltd	01428 787986							●	●	✓	4			✓		Up to £400,000
Four-Tees Engineers Ltd	01489 885899	●	●	●	●		●	●	●	✓	3			✓	Member	Up to £2,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●		●				●	●	✓	4			✓	Gold	Up to £6,000,000
Millar Callaghan Engineering Services Ltd	01294 217711	●				●		●	●	✓	4			✓		Up to £1,400,000
Murphy International Ltd	00 353 45 431384	●	●	●	●				●	✓	4			✓		Up to £1,400,000
Nusteel Structures Ltd	01303 268112	●	●	●	●	●		●	●	✓	4		✓	✓	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
Shaun Hodgson Engineering Ltd	01553 766499							●	●	✓	3			✓		Up to £800,000
Taziker Industrial Ltd	01204 468080	●	●	●	●			●	●	✓	3		✓	✓		Above £6,000,000
Underhill Engineering Ltd	01752 752483	●	●	●	●			●	●	✓	4			✓		Up to £3,000,000
Non-BCSA member																
Allerton Steel Ltd	01609 774471	●	●	●	●	●		●	●	✓	4			✓		Up to £4,000,000
Centregreat Engineering Ltd	029 2046 5683	●	●	●	●	●	●	●	●	✓	4					Up to £1,400,000
Cimolai SpA	01223 836299	●	●	●	●	●	●	●	●	✓	4					Above £6,000,000
CTS Bridges Ltd	01484 606416	●	●	●	●	●	●		●	✓	4			✓	Member	Up to £800,000
Francis & Lewis International Ltd	01452 722200							●	●	✓	4			✓	Gold	Up to £2,000,000
Harland & Wolff Heavy Industries Ltd	028 9045 8456	●	●	●	●	●		●	●	✓	3					Up to £2,000,000
Hollandia Infra BV	00 31 180 540 540	●	●	●	●	●	●	●	●	✓	4					Above £6,000,000*
HS Carlsteel Engineering Ltd	020 8312 1879	●	●					●	●	✓	3			✓		Up to £40,000
IHC Engineering (UK) Ltd	01773 861734	●							●	✓	3			✓		Up to £400,000
Interserve Construction Ltd	020 8311 5500							●		✓	N/A					Above £6,000,000*
Lanarkshire Welding Company Ltd	01698 264271	●	●	●	●	●	●	●	●	✓	4		✓	✓	Gold	Up to £2,000,000
P C Richardson & Co (Middlesbrough) Ltd	01642 714791	●						●	●	✓	N/A					Up to £3,000,000
Total Steelwork & Fabrication Ltd	01925 234320	●		●				●	●	✓	3			✓		Up to £3,000,000
Victor Buyck Steel Construction	00 32 9 376 2211	●	●	●	●	●	●	●	●	✓	4		✓	✓	Silver	Above £6,000,000

Corporate Members

BCSA

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
Kier Construction Ltd	01767 640111
McGee Group (Holdings) Ltd	020 8998 1101
PTS (TQM) Ltd	01785 250706
Sandberg LLP	020 7565 7000
Structural & Weld Testing Services Ltd	01795 420264
SUM Ltd	0113 242 7390

Industry Members

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

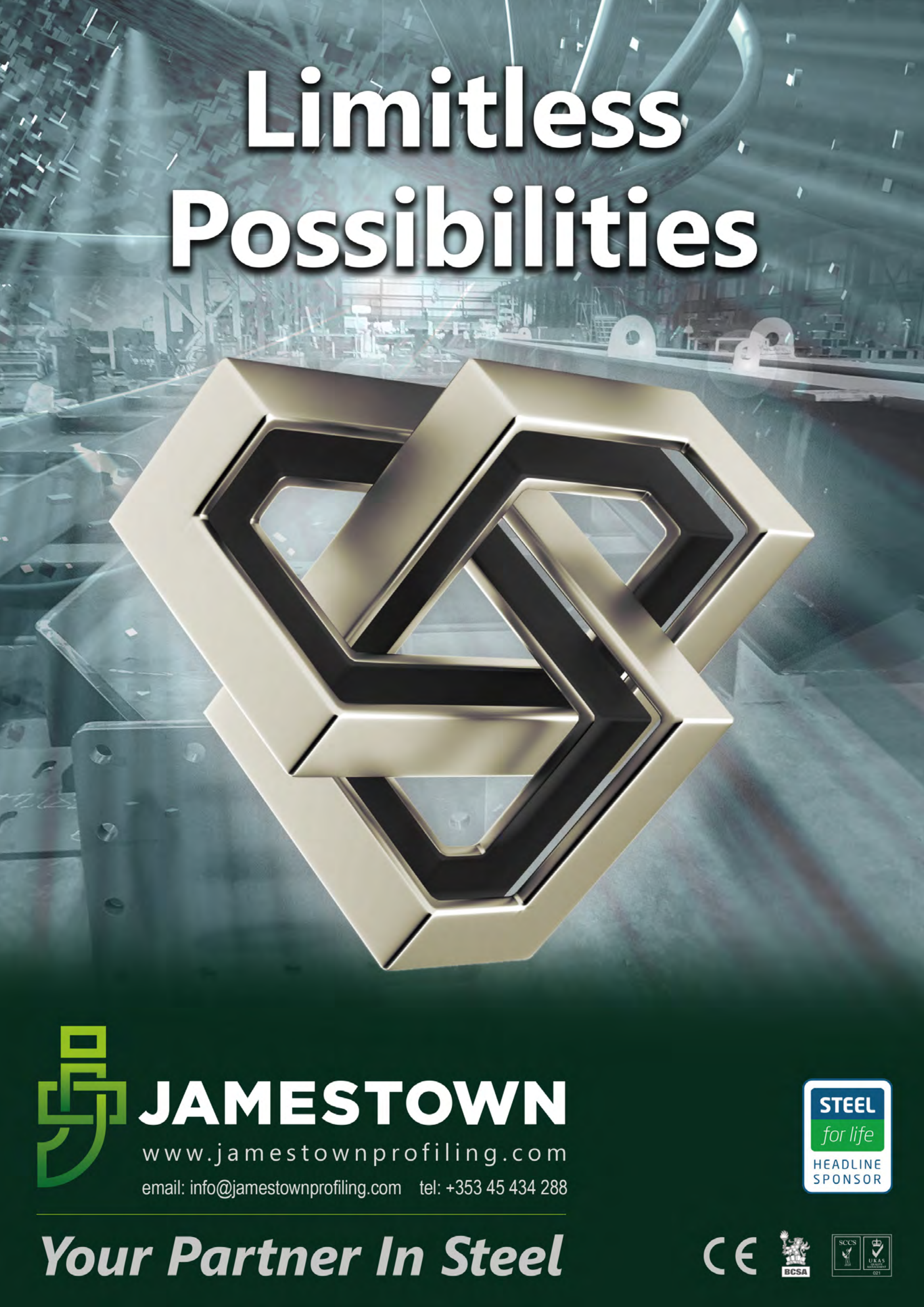
1 Structural components
2 Computer software
3 Design services
4 Steel producers
5 Manufacturing equipment
6 Protective systems
7 Safety systems
8 Steel stockholders
9 Structural fasteners

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

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

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM	BIM
AJN Steelstock Ltd	01638 555500								●		M		
Albion Sections Ltd	0121 553 1877	●									M		
Arcelor Mittal Distribution - Scunthorpe	01724 810810								●		D/I		
AVEVA Solutions Ltd	01223 556655		●								N/A		
Ayrshire Metals Ltd	01327 300990	●									M		✓
BAPP Group Ltd	01226 383824									●	M		
Barrett Steel Services Limited	01274 682281								●		M		
Behringer Ltd	01296 668259					●					N/A		
British Steel Ltd	01724 404040				●						M		
BW Industries Ltd	01262 400088	●									M		
Cellbeam Ltd	01937 840600	●									M		
Cleveland Steel & Tubes Ltd	01845 577789								●		M		
Composite Metal Flooring Ltd	01495 761080	●									M		
Composite Profiles UK Ltd	01202 659237	●									D/I		
Cooper & Turner Ltd	0114 256 0057									●	M		
Cutmaster Machines (UK) Ltd	01226 707865					●					N/A		
Daver Steels Ltd	0114 261 1999	●									M		
Daver Steels (Bar & Cable Systems) Ltd	01709 880550	●									M		
Dent Steel Services (Yorkshire) Ltd	01274 607070								●		M		
Duggan Profiles & Steel Service Centre Ltd	00353 567722485	●							●		M		
easi-edge Ltd	01777 870901							●			N/A	Gold	
Fabsec Ltd	01937 840641	●									N/A		
Ficep (UK) Ltd	01924 223530					●					N/A		
FLI Structures	01452 722200	●									M	Gold	
Forward Protective Coatings Ltd	01623 748323						●				N/A		
Hadley Industries Plc	0121 555 1342	●									M	Silver	
Hempel UK Ltd	01633 874024						●				N/A		
Highland Metals Ltd	01343 548855						●				N/A		
Hi-Span Ltd	01953 603081	●									M	Member	

Company name	Tel	1	2	3	4	5	6	7	8	9	CE	SCM	BIM
International Paint Ltd	0191 469 6111						●				N/A	Gold	
Jack Tighe Ltd	01302 880360						●				N/A		
Jamestown Manufacturing Ltd	00 353 45 434288	●									M		
John Parker & Sons Ltd	01227 783200								●	●	D/I		
Joseph Ash Galvanizing	01246 854650						●				N/A		
Jotun Paints (Europe) Ltd	01724 400000						●				N/A		
Kaltenbach Ltd	01234 213201					●					N/A		
Kingspan Structural Products	01944 712000	●									M	Gold	
Kloeckner Metals UK	0113 254 0711								●		D/I		
Lindapter International	01274 521444									●	M		
MSW UK Ltd	0115 946 2316	●									D/I		
Murray Plate Group Ltd	0161 866 0266								●		D/I		
National Tube Stockholders Ltd	01845 577440								●		D/I		
Peddinghaus Corporation UK Ltd	01952 200377					●					N/A		
Pipe and Piling Supplies Ltd	01592 770312	●									M		
PPG Performance Coatings UK Ltd	01525 375234						●				N/A		
Prodeck-Fixing Ltd	01278 780586	●									D/I		
Rainham Steel Co Ltd	01708 522311								●		D/I		
Sherwin-Williams Protective & Marine Coatings	01204 521771						●				M	Silver	
Structural Metal Decks Ltd	01202 718898	●									M	Gold	
StruMIS Ltd	01332 545800		●								N/A		
Stud-Deck Services Ltd	01335 390069	●									D/I		
Tata Steel – Tubes	01536 402121				●						M		
Tata Steel – ComFlor	01244 892199	●									M		
Tension Control Bolts Ltd	01948 667700						●			●	M		
Trimble Solutions (UK) Ltd	0113 887 9790		●								N/A		
voestalpine Metsec plc	0121 601 6000	●									M	Gold	
Wedge Group Galvanizing Ltd	01909 486384						●				N/A		
Yamazaki Mazak UK Ltd	01905 755755					●					N/A		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