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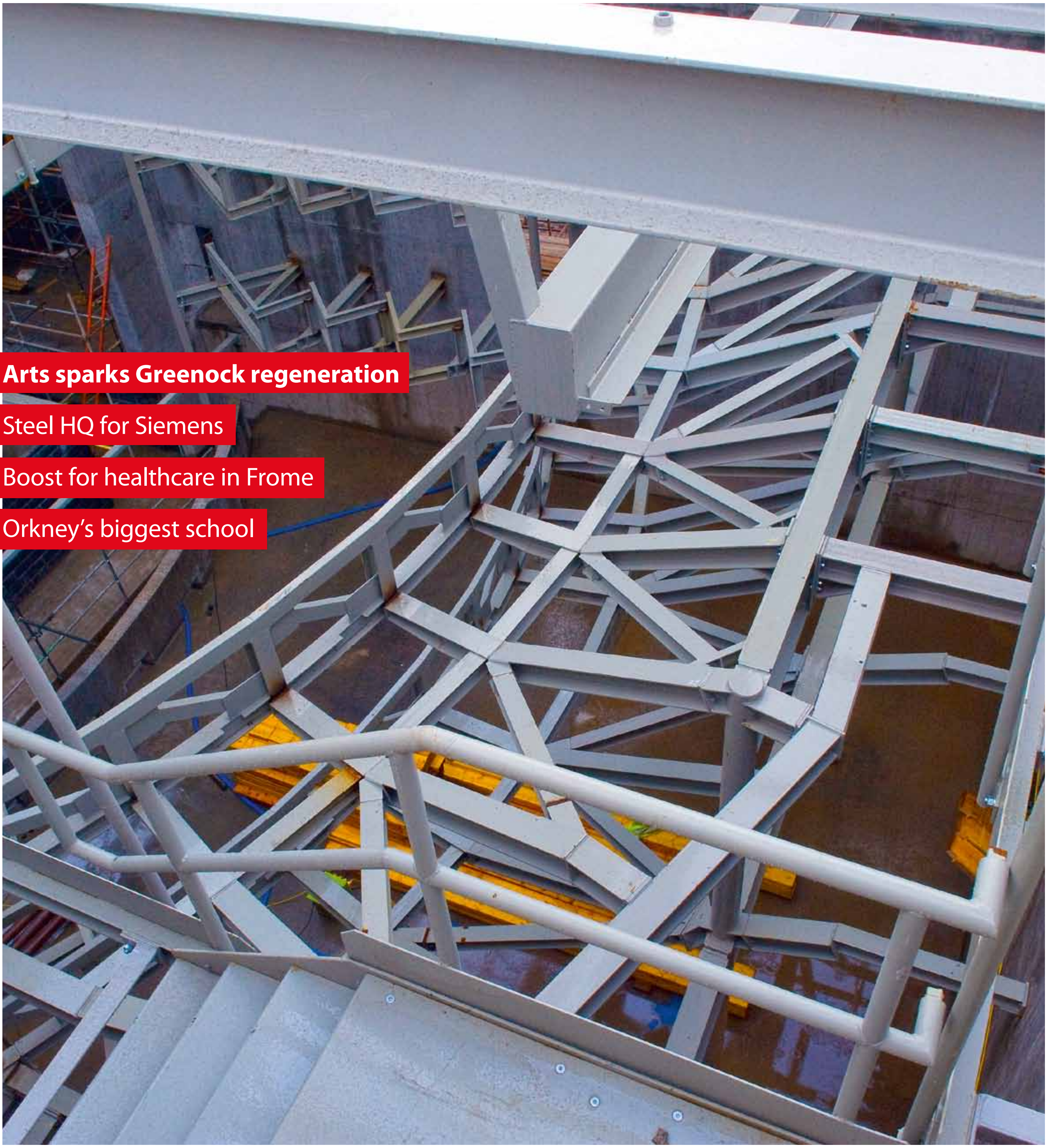
NSC

Mixed use at Regent's Place

Vol 20 No. 4 April 2012



Arts sparks Greenock regeneration

Steel HQ for Siemens

Boost for healthcare in Frome

Orkney's biggest school

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New Steel Construction keeps designers and contractors abreast of all major steel construction related developments and provides detailed technical information on key issues such as the introduction of the Eurocodes. NSC will be the first place most people hear about advances made by the extensive research and development efforts of the steel construction partners – Tata Steel, the British Constructional Steelwork Association, and the Steel Construction Institute, as well as other researchers.

Each issue of NSC is a blend of project reports and more in depth technical material. Taking up our free subscription offer is a guarantee that you will be alerted to significant developments in a sector that retains a commitment to continuous development in knowledge and techniques for timely delivery of cost effective, quality projects across all sectors of construction.

Each issue of NSC is typically 44 pages and contains five pages of news, developments related to Eurocodes, cutting edge project reports from site, and the latest technical updates from the Steel Construction Institute in its Advisory Desk Note series. Popular features are 50 Years Ago and 20 Years Ago, looking at key projects of the past by revisiting the pages of 'Building With Steel' and 'Steel Construction'.

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Cover Image
The Beacon Arts Centre, Greenock, Renfrewshire
Main Client: Greenock Arts Guild
Architect: LDN Architects
Steelwork contractor: Walter Watson
Steel tonnage: 745t

BCSA

TATA STEEL

SCI Steel Knowledge

NSC

April 2012 Vol 20 No 4

These and other steelwork articles can be downloaded from the New Steel Construction Website at *www.new-steel-construction.com*

Strength and diversity

Nick Barrett - Editor

Two items in particular will grab attention in this month's news section; the amazingly strong and diverse field of entries for the Structural Steel Design Awards and the continuing strength of steel in the key multi storey building frames market. Neither should come as any surprise as quality, economy and sustainability will always dominate regardless of market conditions, which of course remain challenging.

No fewer than 29 projects from the long list of those eligible have made it past strict scrutiny by the independent SSDA judges. Under the rules of the Awards there is no obligation on the judges to find any project worthy of going forward for an award – in theory all entries could be found wanting and there would be no awards given out. In practice that is highly unlikely ever to happen, but this underscores the independence of the judges who are drawn from the client side as well as from the industry serving them, and includes engineers and architects.

Anyone familiar with any of these projects, most - but by no means all - of which have featured in NSC, will know enough about them to appreciate why they have been shortlisted. But attending the Awards ceremony in July where all the shortlisted projects will be on display will be an even more than usually rewarding exercise even for those familiar with many of the projects.

The shortlist impresses with the diversity of project types and sizes and their geographical spread. Olympic Park projects are becoming eligible for entry and the first of these to be completed, the Velodrome, is up for a possible Award. Growth industries like waste to energy are represented, as is motor manufacture. Buildings serving the media and the arts, education, healthcare, commercial offices, sports, leisure and transport are on the shortlist as well as a wide range of rail, road and footbridges.

London is well represented on the shortlist, and not just with Olympic structures, but shortlist projects come from all over the UK; for example, from the Channel Islands, Belfast, Weston-super-Mare, Cardiff, Norwich, Manchester and Glasgow.

Together they go some way to explaining the continuing dominance of steel in the annual Market Shares survey. The 2011 survey shows steel is still overwhelmingly the preferred choice in the building frames market. The ability of steel to deliver such a wide range of projects, to be as adaptable to different and changing uses as it is, and to make such a contribution to successful project delivery on time and to budget ensures that this trend is only likely to develop as the economy continues to come out of recession, and the hard pressed construction industry starts its recovery.

While we wait for that, the SSDA ceremony should help revive any flagging spirits and remind the wider world of what construction at its best can deliver.

NSC

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SSDA shortlist highlights industry's quality of work

The shortlist for the 44th Structural Steel Design Awards (SSDA) has been announced by the BCSA and Tata Steel.

Contrary to the tough market conditions the construction industry is experiencing, the number of entries for this year's awards has increased, resulting in a shortlist of 29 projects.

The shortlist, as usual, reflects the geographical spread of steel's appeal for a variety of projects ranging from heavyweight industrial plants to houses and sculptures, across the UK and the Channel Islands.

David Lazenby CBE, Chairman of the SSDA Judging Panel, said: "As in recent years, we have a good crop of ingenious and elegant footbridges, as well as heavy duty rail bridges and motorway structures. The buildings include welcome improvements to the transport infrastructure, commercial offices, facilities for the arts and sciences and health, and the continuing activities in energy-from-waste and power generation.

"Structures for the 2012 Olympics have now come through to fruition. I am always pleased that we have "little gems", which are certainly not too small to impress!

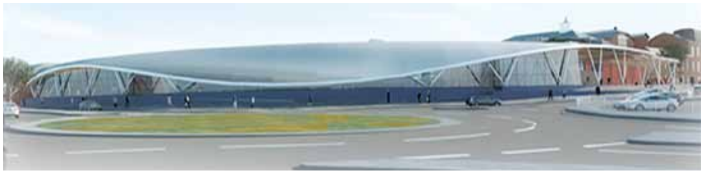
"Altogether this is an outstanding representation of the skills and imagination of the industry, and a great response to the tough environment in which it operates. Congratulations are deserved by all the project teams, because without exception the work is praiseworthy. I am sure that we will have a wonderful array of winners in due course."

The winners of the 2012 SSDAs will be announced at an evening reception in London during July.

SSDA shortlist 2012

McLaren Production Centre, Woking
Maggies Cancer Caring Centre, Nottingham City Hospital
The Balancing Barn, Thorington, Suffolk
The Royal Welsh College of Music & Drama, Cardiff
Ticket Hall and Roof Lights, Farringdon Station, London
Slough Bus Station
West Burton Power Station
Royal Shakespeare Theatre, Stratford-upon-Avon
Media City, Salford Quays
The Walbrook Building, Cannon Street, London
Deptford Lounge, Giffin Street, London
Energy from Waste Facility, La Collette, Jersey
London 2012 Velodrome, Olympic Park, London
NEO Bankside, Holland Street, London
National Indoor Sports Arena, Glasgow
St Georges Grove, London SW17
Peter's Bridge, St Helen's Wharf, Norwich
Porth Teigr Bridge Outer Lock Crossing, Cardiff Bay
IQ Winnersh Footbridge, Winnersh Triangle
M53 Bidston Moss Viaduct Strengthening
The Third Way Bridge, Taunton
Media City Footbridge, Salford Quays
Peace Bridge, Derry/Londonderry
Borough High Street Bridge, London
Arnside Viaduct, Morecombe Bay
RISE Sculpture, Broadway Roundabout, Belfast
The Grand Pier, Weston-super-Mare
Garsington Opera Pavilion, Stokenchurch
2012 Olympic Stadium

Bus terminal to become city landmark



Steelwork erection is due to start this month on Stoke-on-Trent's new multi-million pound bus station, a project which forms part of a large scale redevelopment known as City Sentral.

Built on the site of a former car park, the state-of-the-art facility has been designed by architects Grimshaw and will provide a semicircular enclosed passenger concourse around two sides with buses arriving and departing from one end of the structure.

Once the new bus station is up and running later this year, the old bus station will be demolished, making room for a new shopping centre and further kick starting the city's redevelopment.

Chris Hamer, Managing Director, Vinci Construction UK Building Division - North said: "We are helping to initiate the redevelopment of Stoke city centre with the first phase of the City Sentral, the new bus station. We are replacing a tired 1960s building with a new visually captivating facility."

Steelwork is being carried out by Henry Smith (Constructional Engineers) and is due to be completed in May.

Multi-million pound distribution centre open for business

Tata Steel has invested £3.1M in a new steel distribution centre which has opened on Teesside.

The opening of the centre has led to the creation of 30 new jobs, which have been filled by Tata Steel employees redeployed from the company's Teesside Beam Mill and Steelpark distribution centre in Wednesfield, West Midlands.

The centre will be responsible for managing and distributing around 100,000t of the company's construction steel stock from the Teesside Beam Mill, the sections mill in Scunthorpe and the tubes mills in Corby.

Director of the new facility, Rob Ridge, said: "The steel was previously transported to our Steelpark distribution centre in Wednesfield, and other service centres, before being transferred to the customer. The Wednesfield site will still process a large number of the steel sections, but it is anticipated the vast majority will now be delivered to the customer straight from the Teesside service centre.

"This is a much more efficient way of handling our steel sections that will bring cost saving benefits to Tata Steel, while also speeding up delivery for our customers."

Steel construction posts 25% reduction in accidents

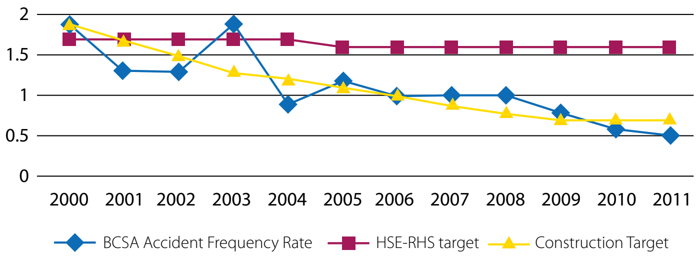
Statistics for BCSA members in 2011 reveal that the number of reportable accidents recorded under Reportable Injuries Diseases and Dangerous Occurrences Regulations (RIDDOR) has been reduced by 25%.

"This is good news for the steel construction industry as this statistic follows on from last year's (2010) 25% reduction in accidents," said Pete Walker, BCSA Health, Safety and Training Manager.

"The 25% reduction demonstrates the industry is committed to improving working practices and procedures, some of which are developed with the BCSA health and safety committee to address the current issues and best practice that is based on their shared experiences and intended to help to reduce accidents and injuries."

Records for 2011 also show there were no fatal injuries, while major injuries were reduced from 18 in 2010 to 15.

Over three day injuries (those that involved a person being absent from work for more than three days) were reduced from 100 reported in 2010 to 75 for 2011. Handling, lifting and carrying as well as slips, trips and falls were the two main categories to report a reduced accident rate.



Specialist steel success

BCSA member Bourne Construction Engineering won the 2012 *Construction News* Specialist Award for steelwork.

Pictured is Steve Govier, Bourne Group CEO holding the award. He is flanked by (left) Nick Hayes, Divisional Director of Bourne Off-Site Solutions and (right) Nick Hatton, Bourne Steel Managing Director.

The event was held at the London Hilton and was attended by nearly 600 leading specialist contractors. The evening was hosted by comedian Simon Evans (pictured furthest right), while Bourne's award was presented by Alasdair Thompson, Business Development Director, Mott MacDonald (furthest left).

Major city-centre office development takes shape

Due for completion early next year, a new prestigious 17-storey commercial block is now towering above Birmingham's Snowhill due to advantages of steel construction.

Known as Number Two Snowhill, the development is 65m tall includes four basement levels for car parking, scenic lifts and a stunning steel-framed glazed atrium.

The steelwork contract for the job was let on a design and build basis to Caunton Engineering, and the company has designed, fabricated and supplied over 2,000t of structural steelwork together with metal decking and shear studs to the project.

The building footprint covers an area 54m long by 45m wide and is made up of a 9m by 9m structural grid. The main entrance façade tapers out from ground level up to level 13 where the building then steps back, creating balconies.

Double height spaces at level 15 and 16 contain plant. Above ground level, floors are of composite construction with steel beams and columns framing into the three main stability giving cores.

NEWS IN BRIEF

As part of a £1.6M investment programme **BW Industries** has completed the installation of a new heavy duty roll forming line for the production of steel sections. It will increase existing capacity and also adds new section sizes to the company's range. The installation will produce 2mm to 6mm thick lipped C and plain U channel sections, web range of 100mm to 500mm, and flange range of 50mm to 150mm, with a maximum length of 18m.

Tata Steel has launched a new free-of-charge roof decking software package that enables structural engineers and designers to carry out full deck analysis to achieve optimum design and cost efficiencies. The software has been created in partnership with structural software developer, CSC, and uses CSC's widely-adopted structural calculation software, Tedds, as the platform for the deck analysis. RoofDek Analysis Software can be obtained from *www.tatasteelconstruction.com/roofieksterity*. For more information on Tedds visit *www.cscworld.com*

Tekla has upgraded its BIM software offering with the launch of Tekla Structures 18. "Faster and smoother modeling gives our customers competitive advantage. Added to the assets of BIM, like saving time and money during the bidding process and more manageable construction projects, our new software release will help our customers to raise their project profit margins," said Risto Räty, Executive Vice President of Tekla Corporation.

Steadmans has supplied materials including roof and wall cladding for a key redevelopment project at Glenavon Football Club's stadium in Lurgan, Co Armagh. The company supplied 186 linear metres of ocean blue 0.7 plastisol-coated AS34 single-skin cladding for the roof of the redeveloped Crescent End stand of the IFA Carling Premiership club's Mourneview Park ground. It also provided matching roof lights, plus ridge and eaves fillers. In addition, Steadmans supplied 183 linear metres of ocean blue 0.5 plastisol-coated AS34 cladding for the side walls of the enclosure.

AROUND THE PRESS

Construction News
8 March 2012
Mixed scheme sets logistical puzzles
With typical spans of 15m through the office space, the Severfield-Rowen team that took the steel subcontract has installed 1,440 tonnes of steelwork since it started its work at the beginning of August, using more than 2,000 lifts from the three luffing cranes that have been inched onto the site.

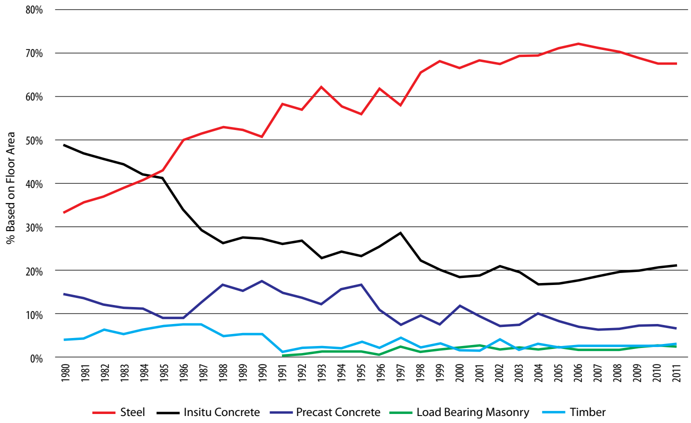
Construction News
15 March 2012
Refurb challenge for Victorian icon
Over the years the continual use of the Royal Albert Bridge has seen some parts of the structure require significant strengthening work. In all, some 2,305 areas have required predesigned steelwork repairs. These include the cross girder end plate connections, which were showing signs of cracking, and diagonal struts, which were beginning to elongate and slacken.

RIBA Journal
March 2012
Steely resolve
[Wills Imperial Tobacco HQ, Bristol] "With its exposed CorTen structure, it was one of the earliest examples of a modern movement office building in the UK," says AFM director David Caird. "Because the design set the weathering frame structure away from the building's glazed skin, it helped us in the refurbishment. Not only that, but the integrity of the primary structure meant the firm could cut out two structural bays for an atrium."

Building Magazine
2 March 2012
Just what the doctor ordered
[The Royal London Hospital] With 148,500m^2 of new build accommodation and 15,600m^2 of refurbished space it is now the largest hospital in London. The frame comprises 1, 750 of structural steelwork.

New Civil Engineer
23 February 2012
Low loader
[Troja Bridge, Prague] At its apex, the welded steel box section arch is 6.2m wide and a wafer thin 800mm deep. At approximately quarter span the arch dramatically splits giving it four legs, each measuring 4.5m deep by 1.1m wide

Market share stays strong



Steel continues to be overwhelmingly the structural framing material of choice for multi storey non-residential buildings, according to the latest survey from independent market research consultants Construction Markets.

The 2011 survey, commissioned by BCSA and Tata Steel, is the latest in a series going back to 1980 and is thought to be the biggest of its type in the UK, involving over 450 interviews with construction specifiers.

The survey shows that steel frames continue to dominate the multi storey market with a 67.7% market share, despite the difficult construction market conditions. The survey also shows that the market contracted by a further 6.3% in 2011, with overall floor area constructed in all multi storey buildings reducing to 10,850,000m^2, which was only 71% of the size of the market at its peak of 2008, when it was 15,266,000m^2.

Steel now has a 69.4% share of the multi storey offices market. In the 'other multi storey buildings' sector, which includes retail, education, leisure and health, steel has a 67.3% share.

In situ concrete had a market share of only 20.7%. Load bearing masonry had a 6.6% share, while precast concrete accounted for 2.8% and timber 2.3%.

Alan Todd, General Manager of Construction Services & Development in Tata Steel Europe said: 'Even in the difficult market that we find ourselves, these figures clearly show that the key multi storey construction markets continue to value steel above any other framing material. It is good to see that steel is the natural choice of framing material for the construction industry where factors like speed, cost, and sustainability are important.'

Pedestrian footbridge spans river and canal

A new steel composite pedestrian and cycle bridge over the River Nene and Grand Union Canal, Northampton Arm, has been lifted into place on behalf of Northampton Borough Council.

The bridge, fabricated and erected by Nusteel Structures on behalf of Balfour Beatty Regional Civil Engineering, spans both the canal and river with piled foundations in place on a small strip of land between the waterways.

With a total weight of 79t, a 500t capacity mobile crane was used to lift the 86m long three span steel bridge into place.

The bridge installation took many sustainability factors into consideration prior to works commencing on site. Measures were put in place to ensure the installation would not interfere with a family of otters that use the river as a home and the majority of the temporary works were constructed out of recycled capping materials.

Steel sculpture goes for Olympic run

A large sculpture featuring three 10t letters, spelling out the word 'RUN', has been installed in the London 2012 Olympic Park.

Created by renowned artist Monica Bonvicini, it is the largest standalone artwork in the Park and has been erected adjacent to the Copper Box, the new name for the Handball Arena.

Inspired by song titles such as The Velvet Underground's Run Run Run and Bruce Springsteen's Born to Run, the artwork has been constructed from steelwork and reflective glass, producing a mirrored effect during the day and light glow at night via installed LED lights.

Dennis Hone, Olympic Delivery Authority Chief Executive, said: "The RUN sculpture will not only become an attraction for the Olympic Park during the Games but also for years to come as a focal point for the many thousands of visitors that will come when the Park is transformed after the Games."

Transport museum inspires art exhibition

Glasgow's steel-framed Riverside Transport Museum is the focus of prize-winning artist Patricia Cain's 'construction art' exhibition, being held at a London gallery throughout April.

Ms Cain is well known for her art and painting of industrial regeneration. For her study of the Transport Museum she sat and worked among the construction workers as the structure evolved.

Her endurance resulted in more than 100 highly detailed paintings, drawings and sculptures, all recreating the iconic museum's complex steel structure and uniquely contoured wave-shaped roof.

"As a relative outsider I was given a real insight into the experience of what it's like to be on site during the construction of a seminal public building," said Ms Cain. "I came to appreciate how construction is all about management, being able to work with others and creating something through skill."

Paul Jaffray, BAM's Project Manager for the £70M project, said: "BAM allowed Patricia unprecedented access to the site throughout the build process, which was vital to allow her to capture the structure in its raw state."

The Patricia Cain exhibition is being held at the Eleven Spitalfields Gallery, east London, until 29 April.

Steel makes a stand at Edgbaston

Metsec lightweight steel framing products have been used on the new stand at Edgbaston Cricket Ground to create accommodation for catering facilities and provide support for aesthetic fin walls.

Part of the £30M redevelopment of Warwickshire County Cricket Club, the new stand will provide seating for some 8,250 spectators as well as providing hospitality and media facilities.

Needing to provide a bar and catering concession on one of the new stand's curved upper terraces, contractors Galliford Try opted for Metsec's SFS lightweight steel framing system.

The system provides the necessary column-free openings of up to 8m in an area which will be subject to large volumes of spectators during peak periods.

At street level, the main entrance is protected by the overhanging structure of the stand itself, supported by four structural columns housed behind fin-shaped, cladded box sections, the unusual shape adding to the stand's aesthetic appeal. In this area, Metsec SFS was chosen as it has the strength required to withstand crowd pressures as spectators enter and exit the ground.

Diary

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

19 April 2012
Members in Bending
1 hour webinar

26 April 2012
Steel Building Design to EC3
Leeds

17 May 2012
Selection of steel Sub-Grade
1 hour webinar

22 May 2012
Steel Connection Design
Manchester

Frames for feature façade

A large mixed use scheme currently being developed near Regent's Park in London is relying on steel construction's inherent qualities for its commercial and retail elements. Martin Cooper reports.

Located along central London's Euston Road, Regent's Place is a 13 acre, fully managed estate which is currently home to some 10,000 workers and residents. Comprised of 450,000m² of office and residential space, within seven buildings, the estate is set to expand significantly with the delivery of a new mixed use development known as the North East Quadrant (NEQ).

When complete in 2013, this key component to the overall masterplan, will provide a further 152,000m² of new development to the site, including office space, retail levels and 100 apartments within a separate 26 storey concrete tower.

The commercial and retail portions of the NEQ will be housed in a large and architecturally impressive steel framed structure, overlooking the development's main plaza. This building consists of three interconnected fingers, featuring floor to ceiling glazed external cladding, and linked by two atria.

The central finger is the tallest portion of the commercial zone reaching a height of 15 storeys and flanked by 10 storey and eight storey finger structures. Visually the front elevation of the 15 storey portion offers the most impressive element of the NEQ. It has a leaning façade, which is skewed to the rest of the building, further accentuating the four degree lean.

This façade played a significant role in the overall steel design. Stability for the steel frame is provided by three cores, one in each finger, however the central finger's core is located towards the back of the structure, far from the leaning façade. Consequently the steel frame would have had a tendency to pull itself towards this southern elevation and so to negate this, moment frames have been positioned on the upper levels of the leaning façade, mitigating any potential structural sway.

The reasoning behind the location of the central finger's core is all to do with efficiency.

"The initial steel design had the main core positioned centrally, a location which wouldn't have required us to design moment frames," says Keith Davidson, Halcrow Yolles Project Engineer. "However, by moving the core back we gained more high value floor space."

The moment frames begin at level nine and extend to the uppermost 16th roof level. Heavier plate girder sections have been erected, to form the moment frames, instead of the regular columns used elsewhere. These stiffen this elevation by providing additional lateral stability and limiting inter storey drift. Some of the project's heaviest individual steel members are located in the upper frames, with some girders weighing in excess of 9t.

Each of the three fingers is topped by a pitched and skewed steel framed roof. Structurally independent from the steelwork below them, the roofs are formed from a myriad of pieces, more than 150 for the two outer roofs.

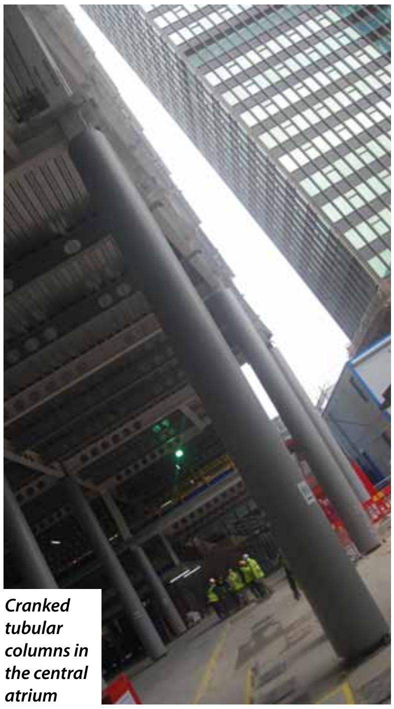
The roofs also act as moment frames, together with the frames below. Some

FACT FILE
North East Quadrant, Regent's Place, London
Client: British Land
Architect: Wilkinson Eyre
Construction Manager: Lend Lease
Structural engineer: Halcrow Yolles
Steelwork contractor: William Hare
Steel tonnage: 4,700t

NEQ's front elevation which overlooks the development's plaza

The central finger structure has a skewed and leaning façade

The northern or rear elevation features a curved portion overlooking a fourth floor roof garden



Cranked tubular columns in the central atrium

substantial beams have been used on these roofs as they also have to accommodate the loads from Building Maintenance Units (BMU), which clean the external elevations and travel across the roofs via a track. Larger section sizes also had to achieve the stringent perimeter deflection criteria associated with the glazed curtain wall finish of the structure.

"Because of the core's position and the fact that all elevations feature open glazed areas bracing was out of the question, which was another reason we had to include moment frames," explains Mr Davidson.

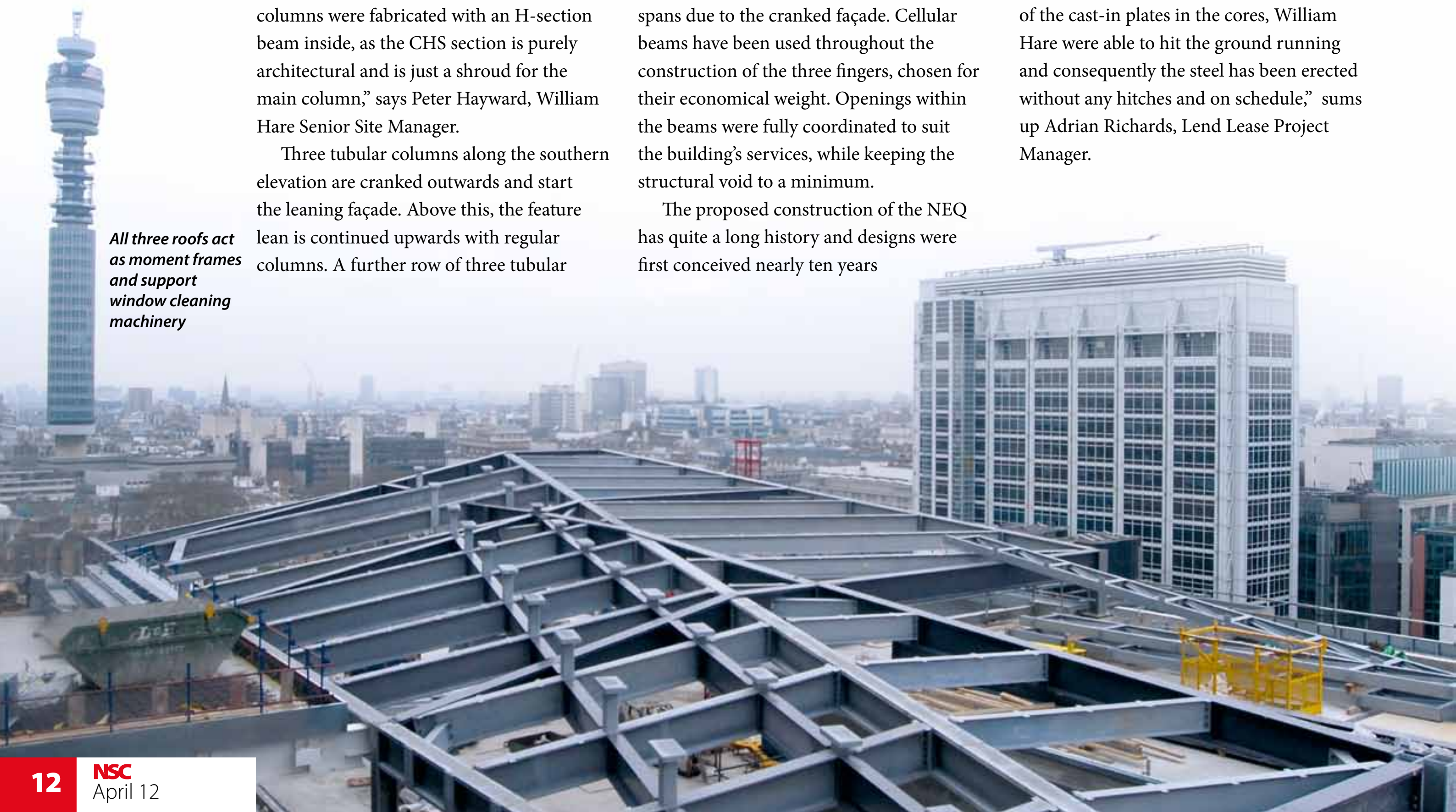
Meanwhile, large diameter 13m-high tubular columns dominate the ground floor area of the central finger. "These columns were fabricated with an H-section beam inside, as the CHS section is purely architectural and is just a shroud for the main column," says Peter Hayward, William Hare Senior Site Manager.

Three tubular columns along the southern elevation are cranked outwards and start the leaning façade. Above this, the feature lean is continued upwards with regular columns. A further row of three tubular columns, positioned in a line adjacent to the perimeter members, are cranked in the opposite direction, balancing those at the front and forming one side of a large void which extends up to level 10, within the central finger. As the columns are cranked (leaning) in opposite directions the floor plates gradually get larger from first floor to 10th floor, while conversely the atrium void gets narrower.

Overall the steelwork has predominantly been erected around a standard 12m x 9m grid pattern, giving the office levels the desired long clear spans. This pattern does slightly vary towards the top of the central finger where there are some 15m spans due to the cranked façade. Cellular beams have been used throughout the construction of the three fingers, chosen for their economical weight. Openings within the beams were fully coordinated to suit the building's services, while keeping the structural void to a minimum.

The proposed construction of the NEQ has quite a long history and designs were first conceived nearly ten years ago. The recession saw plans put on the back burner for some time, until work finally kicked off in earnest during 2009. Construction manager Lend Lease began working on site in December 2010, taking over a cleared site which had been piled and had its concrete basement levels already formed. The company oversaw the laying of the ground floor slab and the construction of three concrete cores, in readiness for the steel erection.

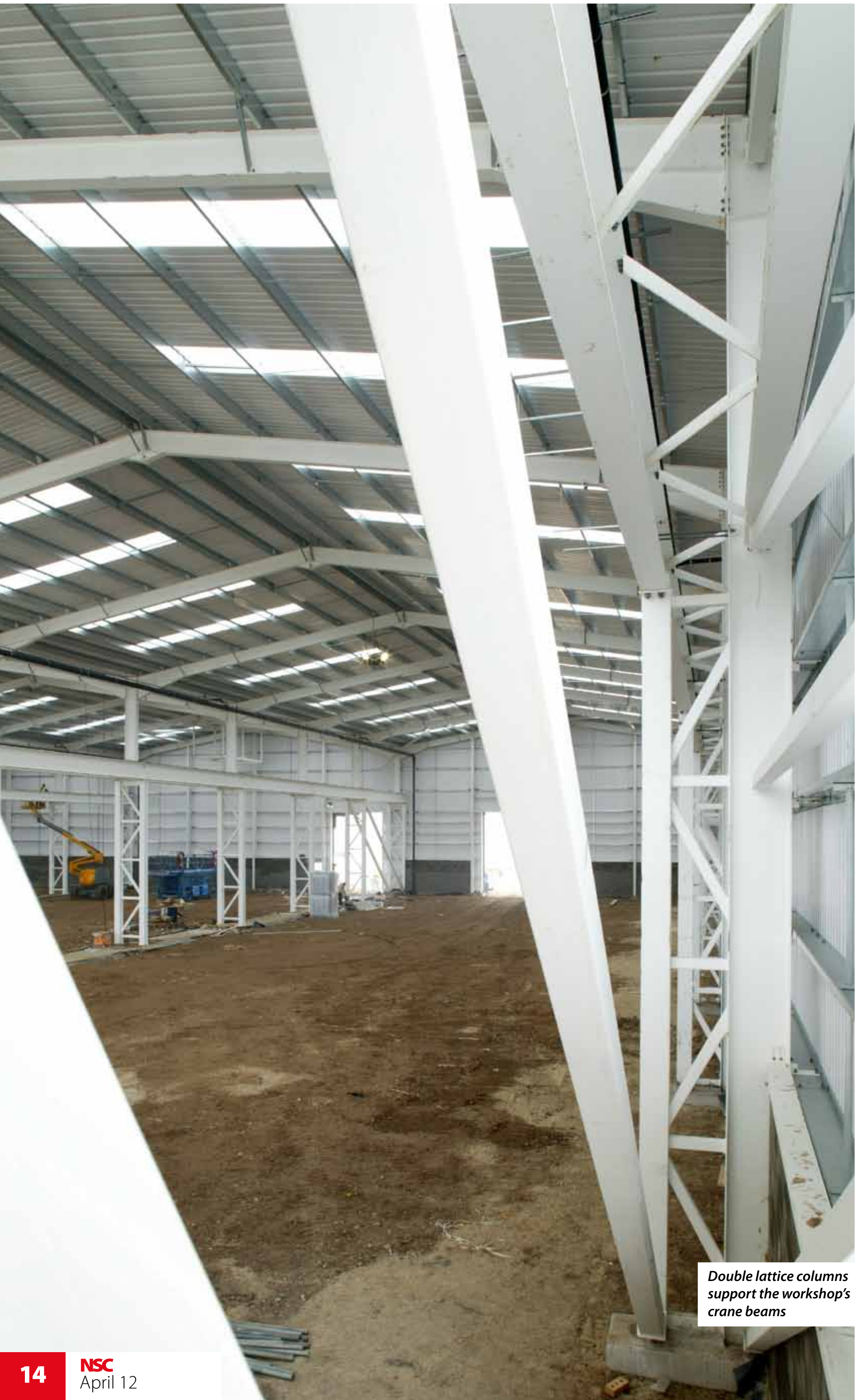
"The steel frame was designed in early 2011 and within four months it was being fabricated and delivered to site. With good planning and coordination between all team members, including the installation of the cast-in plates in the cores, William Hare were able to hit the ground running and consequently the steel has been erected without any hitches and on schedule," sums up Adrian Richards, Lend Lease Project Manager.



All three roofs act as moment frames and support window cleaning machinery

Siemens advances with steel

Steel construction is playing a pivotal role in the development of a large new business park on the outskirts of Lincoln, providing a major boost to the local economy.



Double lattice columns support the workshop's crane beams

A landmark development, known as Teal Park, is rapidly taking shape on the outskirts of Lincoln. With the potential to attract millions of pounds of business and create thousands of new jobs, the park is set to give a major boost to the local economy.

One of the initial phases of the scheme is a new office and workshop facility for Siemens. The engineering company is one of the largest employers in Lincoln and it is relocating its industrial gas turbine business from existing premises in the city centre.

Commenting on the move, Neil Corner, Siemens Director of Service at Lincoln, says it will bring major benefits to the business. "The new facility will allow us to bring together the majority of our service operations in Lincoln on to one site."

Siemens' move is viewed as an endorsement for the business park and may even encourage others to consider moving here. Teal Park is currently undergoing some major infrastructure works, with a new access road being built and the nearby A46 being widened, projects which will greatly improve transportation links to the site.

The new Siemens facility consists of a three level 4,500m^2 office building, adjacent to a 7,300m^2 service workshop. Both are structurally independent steel framed buildings, erected by Hambleton Steel during a nine week programme which completed in March.

Construction work on this previously greenfield plot began last October with main contractor Bowmer & Kirkland initially undertaking some earthworks, and then installing piling mats in readiness for the steelwork erection.

"There will be some heavy loadings exerted in the workshop from the large turbines, so the ground was also stabilised," says Scott Millington, Bowmer & Kirkland Project Manager.

Steelwork erection began with the office block as this structure requires a longer fit-out programme. Once Hambleton had completed the office structure and the metal decking had been installed by SMD, the follow-on trades were able to begin while steel erection moved onto the workshop building.

The three level office building is approximately 100m long by 15m wide, and split into three zones by its two braced cores that are positioned next to the two entrance areas. Steelwork is based around a regimented 7.5m x 6m grid pattern, which will give the offices an open plan feel as there is only one internal column line.

Structural steelwork was chosen for this project for a number of reasons, such as the spans required in the workshop and the economy of construction.

"Steelwork for the office block was completed in just five weeks," adds Mr Millington. "Speed of construction was an important consideration for this job."

The 30m high workshop is positioned to the rear of the office block and has a footprint of approximately 100m × 100m. Structurally it is a battened portal frame with four 23m wide spans, each of which will accommodate overhead gantry cranes.

Within the workshop building there is also an integrated two-storey office block, overlooking the main service area. Outside and adjacent to the workshop's service yard there is a steel framed refuse hall structure.

However, it is the workshop's main function of servicing turbines that has made the biggest impact on the steelwork design. Overhead cranes are a vital part of the servicing procedure and these units will run on rails attached to the tops of steel beams which are supported by the structure's main columns. The resultant extra loadings the cranes will place on the steelwork frame has meant the installed columns are bigger than they would otherwise be.

Supporting the crane beams are a series of 7.5m high welded double lattice columns, spaced at 9m centres and brought to site as fully assembled members. Above the crane beam the column arrangement reduces to a single member which extends upwards to support the roof. In order to limit deflections each of the lattice column's base plates includes a moment connection.

After the steelwork erection had been completed on the workshop and the cladding and roof installed, Hambleton had to return to site to realign the crane beam supporting columns.

"The cladding may have resulted in some dead loads on the frame which could have caused some minor movement, which in turn would interfere with the crane's operation," explains Mike Dixon, Hambleton Steel Contracts Manager.

A sliding connection plate had been inserted between the double columns and the crane beam, and as some extremely tight tolerances were required before the gantry cranes could be installed, these plates allowed Hambleton to slightly realign each connection where necessary.

The Siemens facility is aiming to achieve a BREAAM 'Excellent' rating and is scheduled to be completed in July.

The workshop has four 23m wide spans

Three level office block is divided by two core areas

FACT FILE
Siemens Facility, Lincoln
Main client: St Modwen
Architect: Stephen George & Partners
Main contractor: Bowmer & Kirkland
Structural engineer: Alan Brough Associates
Steelwork contractor: Hambleton Steel
Steel tonnage: 620t

Steel was chosen as the only viable and economic solution for the workshop

Best practice with steel

Medical facilities in the town of Frome are being centralised with the construction of a new eye catching steel framed healthcare facility.

Work to build a new centrally located healthcare facility in Frome, Somerset is progressing on schedule and relying on steel construction to achieve its aspirations.

More than £7M is being spent on a new building located adjacent to the town's hospital on land formerly occupied by a showground. The structure has been designed with a view of serving 35,000 local patients and the facility is due to open early next year.

The building will rehouse Frome's existing health centre as well as local general practices currently operating from separate premises. It will also accommodate an operating theatre, opticians, a healthy eating cafe and an education centre.

Local doctors are the client for this project and their brief to the architect was for a structure which would encompass all future needs for a medical centre. Consequently, plenty of space has been designed into the new structure, which consists of two floors and an upper plant level, all housed in a long curved main building that has three attached wings protruding from its back elevation.

Measuring approximately 100m in length, the main structure's most prominent feature is its sloping roof, which follows the building's gentle curvature while tilting gently towards the front.

According to the architect Bundred & Goode, the design also takes its inspiration from the previously sloping site. The curved block and its roof are not just pleasing to the eye, they were also designed to fit into the local environment. The shape of the new health centre complements the adjacent hospital as well as the landscaped plot in which it sits.

More than 15,000m^3 of overburden was excavated by main contractor Interserve to create a level footprint for the structure.

FACT FILE
Frome Medical Practice, Somerset
Main client: Frome Medical Practice
Architect: Bundred & Goode
Main contractor: Interserve
Structural engineer: Clarke Bond
Steelwork contractor: William Haley Engineering
Steel tonnage: 275t

The main curved block has two floors and a plant level

Curved members adorn the rear of each finger block

Cutting into the previously sloping site, the company created a level plot with a curved retaining wall towards the rear of the site, whose shape is mirrored by the structure.

"The curved form of the main building decreases the impact of the main entrance elevation. Also the curved geometry splays the rear medical pods. This increases the opportunity for landscaping between these wings and thus softens and reduces the visual impact of the building from the rear," explains Bundred & Goode Project Architect Phil Goode.

As the structure has such an architectural shape steelwork was deemed the most appropriate material to frame the building.

"Creating the curve of the building and roof has been largely achieved with the setting out," explains Jeff Naish, Project Manager of William Haley Engineering. "All of the beams are straight and so each column is off-set by 1mm, with each connection positioned 90 degrees to the rafters."

The faceted roof, like the entire steel frame, was modelled in Revit and according to Neil Marks, Project Engineer for Clarke Bond, the shape would have been very tricky to design without a 3D model. The modelling of the project also had a collaborative element, with all team members transfering and sharing information.

"We took a BIM (Building Information Management) approach for the design of this project and this saved us a lot of time as everyone from the architect to the M&E contractor and the steelwork contractor all shared the same model and information," he adds.

The majority of the steelwork - all fabricated and erected by William Haley - is based around a fairly regular grid pattern, incorporating the main building's curvature, which in turn means all column lines within this sector of the project follow the same off-set pattern. The longest spans are 9m, and these are located in waiting room areas in both the main block and the wings.

Cross bracing, located in lift shafts and in some elevations, provides the structure with its stability. "The structure was always going to be a steel frame, but originally it included concrete lift shafts. These were later omitted for a complete steel frame as this was considered to be more economical," says Mr Marks.

Working closely with Interserve, all of the steelwork was completed in a six week programme, which also included William Haley landing (positioning) the precast stairs and metal decking.

Prior to steel erection starting on site all of the setting out bases had been positioned and aligned to form the main building's curve. Once this was complete, the steelwork contractor had most of the structure's footprint to itself, which allowed work to progress unhindered and quickly.

All of the steel was erected using a combination of cherrypickers and mobile crane. During the early stages of the steel programme, two mobile cranes were utilised, but as the frame neared completion, only one unit was necessary.

When the Frome Medical Practice opens next year the town is guaranteed to have a steel framed structure to be proud of.

"We took a BIM approach for the design of this project and this saved us a lot of time as everyone from the architect to the M&E contractor and the steelwork contractor all shared the same model and information."

A large sloping curved roof fits into the site's topography

A beacon for the arts

Installing a vast array of time-consuming acoustic pads was the key to a successfully completed steelwork programme on a new arts venue. Martin Cooper reports.

The arts centre is located on the historic Clyde waterfront in Greenock

FACT FILE
The Beacon Arts Centre, Greenock, Renfrewshire
Main client: Greenock Arts Guild
Architect: LDN Architects
Main contractor: Graham Construction
Structural engineer: Buro Happold
Steelwork contractor: Walter Watson
Steel tonnage: 475t
Project value: £8.5M

Part of a larger redevelopment of the waterfront at Greenock, a new multi-million pound arts centre is set to give the former shipbuilding town a much needed boost.

Located on the site of the old Lamont dry dock, adjacent to the town's historic Georgian Customhouse, the centre's design has taken full advantage of unobstructed views across the River Clyde while an illuminated façade will highlight its nautical heritage by acting as a beacon to the arts.

Aptly known as the Beacon Arts Centre, the venue will replace an older venue in Greenock which has been home to the local arts guild for over 60 years. The new building will house a 500 seat main auditorium, a smaller studio theatre, dressing rooms, rehearsal rooms and other back-of-house facilities. Overlooking the river there are meeting rooms set above the main entrance foyer and a cafe.

The structure has a compact design arranged in a rectangular plan, although the mass of the theatre with its fly tower gives the structure an irregular form. A hybrid construction methodology has been employed, with concrete walls enclosing both the auditorium and studio theatre, and steelwork then tying the structure together by forming the front elevation, the entire roof as well as the innards of the venue.

A view into the auditorium from the control room located at the rear of the circle

Photo by Brian Gavin

"We've used concrete for its acoustic properties needed for enclosing the theatre spaces," explains Neil Dely, Buro Happold Project Director. "While steelwork provided the best solution for the required long spans, as well as offering a lighter and economic solution for other areas."

As the frame of the building involved two materials going up simultaneously, teamwork and coordination played key roles on this project. Before steelwork erection started, a concrete basement and a ground floor slab had been completed. This allowed the theatre walls to be cast with steelwork erection following on closely behind in this area.

"In other areas steelwork was erected first, such as the northern elevation containing the entrance and meeting rooms," says Graham Construction Project Manager Stephen Bradley.

Using two materials for this bespoke design threw up the main design challenge associated with this project - how to acoustically isolate steel from concrete.

Each steel to concrete connection - there are a lot of them requiring approximately 2,500 bolts - needed a specially designed connection. Cast-in plates with pre-drilled holes to accept the steelwork were installed as the concrete was formed, this allowed steelwork to be fitted directly to the plates without the need for welding.

However, once it came to installing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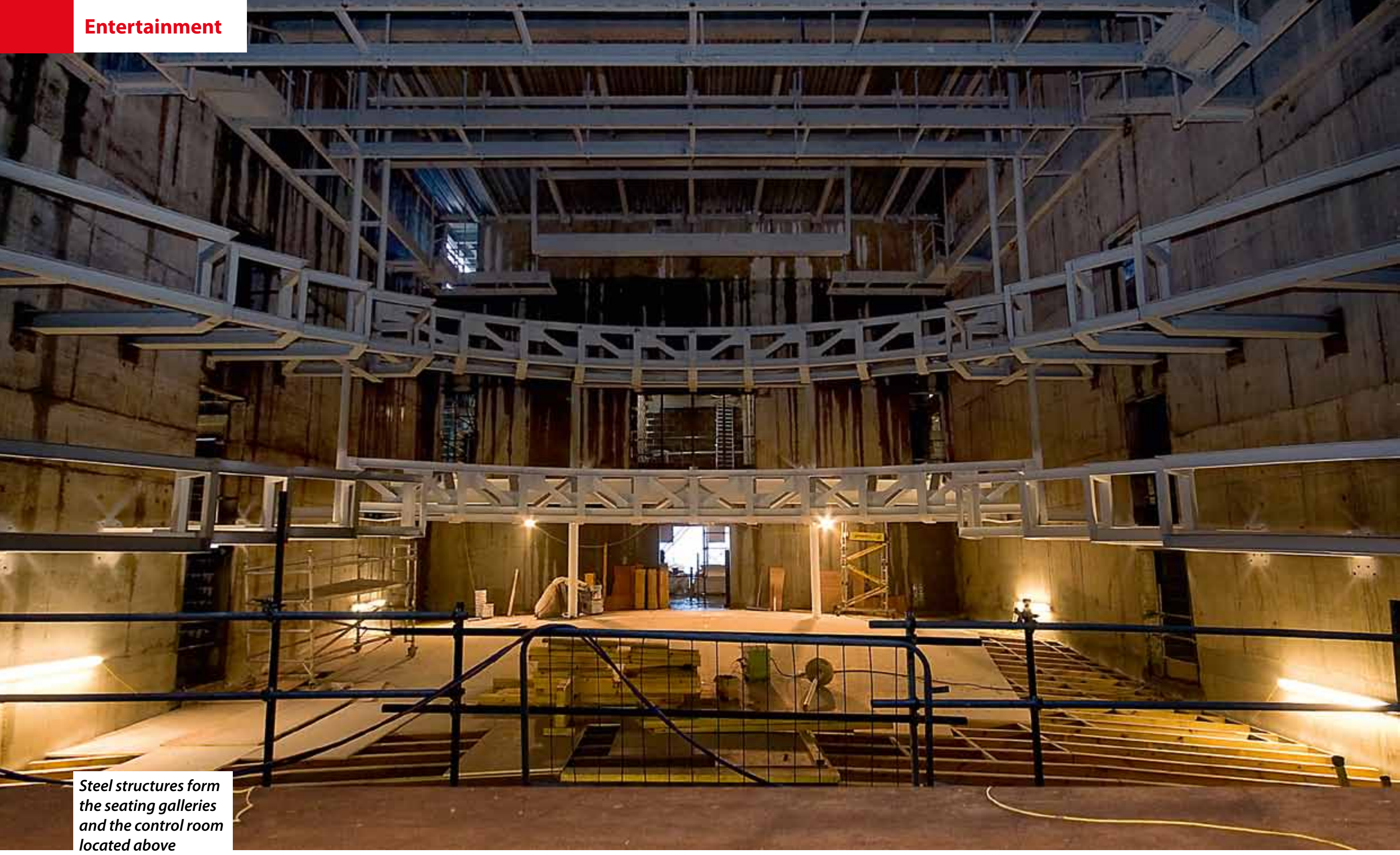


Steel structures form the seating galleries and the control room located above

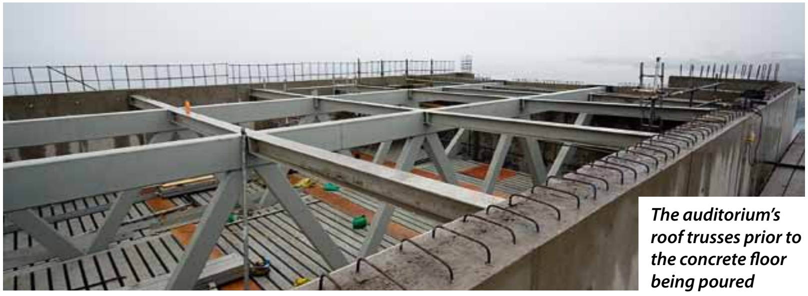
Steelwork ties the structure together, forming the front elevation and the entire roof as well as the innards of the venue.

steelwork externally to the auditoria concrete walls, each steel member's connection had to include acoustic pads.

"Because of the acoustic isolation process the steelwork erection process took much longer than a tonnage of this size would normally take," says Trevor Irvine, General Manager Structural Division for Walter Watson. "All of the connections, including those on the outside of the theatre's concrete box, had to be individually set-out before the steelwork could be installed."

Forming the interior and top of the concrete box of the main auditorium is an array of steelwork. Two 20m-long box section trusses were installed at roof level above the auditorium, and craned into preformed sockets in the concrete walls.

A 170t capacity crane lifted each 10t proscenium truss into place, and once they were in place they were bolted up and the connection concreted up.



The auditorium's roof trusses prior to the concrete floor being poured

Photos by Brian Gavin

Each truss is multipurpose, supporting the steel roof beams above, accommodating a technical gallery within its 1.9m depth, and finally below, catwalks that circle the auditorium are suspended from them.

The auditorium's stage is formed by a raised steel frame platform of columns and beams, while the two upper seating levels are also steel. A topmost seating gallery is cantilevered from a steel frame at the back of the auditorium. Below this, a complex steel framed balcony level is suspended from just two CHS columns.

The architectural balcony design was formed with a series of semi circular box trusses bolted together on site. To get the balcony's shape, faceted sections were later added on site and bolted to the completed trusses.

Within the studio theatre there is more steelwork as a series of 14m-long steel beams form the roof, a structure that also supports a steel framed control box, which gains additional stability by being connected to a concrete wall.

Facing the riverfront the entire northern segment of the arts centre is entirely steel framed. This two-storey area contains at ground floor level the main entrance, a lobby and cafe, ticket office and the general theatre administrative rooms. A steel feature staircase leads upstairs to a first floor circulation area and access points for the upper seating. Adjacent to this, and overlooking the water, there are three meeting rooms.

With the aid of moveable partitions, all of the meeting rooms can be converted into larger spaces, or even one big meeting room. Walter Watson fabricated a series of bespoke roof beams for this area, with openings to accommodate services and to keep the structural void to a minimum.

Graham Construction started on site during November 2010 and work is scheduled to be completed this coming August.

Commenting on the work, Elliott McKelvie, Chairman of Greenock Arts Guild, said: "When it is finished, the community of Inverclyde will have one of the finest mid-sized arts venues anywhere in the UK. The building will also play an important role as part of the wider regeneration of the area."

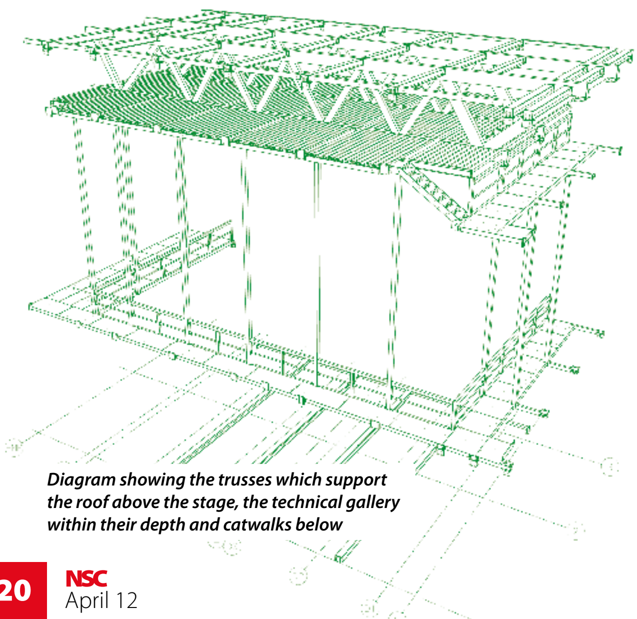


Diagram showing the trusses which support the roof above the stage, the technical gallery within their depth and catwalks below


outdoor
living

Arts and education boost for Orkney

Structural steelwork is playing a major role in the construction of a new grammar school and theatre in Kirkwall. Martin Cooper reports from the Orkney Islands.

FACT FILE
Kirkwall Grammar School, Orkney Islands
Main Client: Orkney Islands Council
Architect: Keppie
Main contractor: Morrison Construction, part of Galliford Try
Structural engineer: A.F. Cruden Associates
Steelwork contractor: BHC
Steel tonnage: 1,200t
Project value: £35M

A multi-million pound schools investment programme is currently underway on the Orkney Islands, a scheme making full use of structural steelwork's inherent advantages for its main buildings.

Overall the project will see main contractor Morrison Construction deliver a new grammar school and arts centre, a halls of residence, and a swimming pool and squash courts, all in Kirkwall, as well as a new primary school in Stromness (see box story).

With a population of just over 8,000, Kirkwall is the biggest town and capital of Orkney. It is a centre of education and a focus for the local arts scene, both of which will be accommodated within the new Kirkwall Grammar School (KGS), the largest component of the programme.

Under construction on the existing KGS site, on land previously occupied by playing fields, the new school has been designed to create a distinctive focal point, not just for pupils but for the local community as a whole.

To this end the school structure includes, within its overall footprint, the 350 seat Orkney Arts Theatre. This will replace an existing theatre and has been designed as a public performance venue as well as a facility for pupils to use during school hours. For security reasons, the design of the theatre and its surrounding rooms incorporates a 'locked down' element to allow any outside users access without compromising the

Intricate connections are needed where the theatre adjoins the school's atrium

Three two-storey teaching wings are connected to the school's main structure

privacy of other areas of the school.

The KGS project comprises of one large building consisting of three teaching wings connected by an interlinking curved 'street' - which also accommodates social and dining spaces - with the oval shaped Arts Theatre located at the head.

Providing 15,000m^2 of floor space, the building is large and one of the biggest structures in Kirkwall. It has a curving and irregular shape and so movement joints have been placed at strategic points to break up the mass. There are five in total, one each where the wings join the main block, one running straight through the middle of the main block, and finally one isolating the theatre.

Designed as a pin jointed steel frame, cross bracing, located in partition walls, cores and risers, provides all of the structural stability.

"Much of the steelwork is quite complex with a lot of curved members in the theatre," explains David Custer, Morrison Construction Design Manager. "However, even though we've experienced some extreme conditions, especially the windy weather last December, the steel erection remained on target and was completed during March."

"We reviewed all materials but went with steel as deliveries would be easier and construction would be quicker."

As well as the relative ease and speed of construction, a number of other factors were in steelwork's favour when it came to the decision to choose the framing material for KGS.

"We reviewed all materials but went with steel as deliveries would be easier and construction would be quicker. The steelwork is prefabricated and just has to be lifted and bolted into place, while the use of cellform beams has allowed us to keep the weight of the frame down which in turn kept costs down," says Adam Lauchlan, A.F. Cruden Associates' Project Engineer.

"Initially the project's cores were to be concrete, but we changed these to steel framed as it was cheaper and allowed us somewhere to place bracing," he adds.

Steelwork contractor BHC started on site last November and by arranging the job into six phases, it was able to work its way down the structure, in a sequential manner allowing the follow-on trades to get started on areas where the steelwork had been completed and the metal decking and precast stairs installed.

Each phase contains a core and plenty of cross bracing, which meant that as each area was erected it was immediately self supporting and stable. This was useful considering the windy conditions the frame had to endure, and was another reason why steel proved to be the right choice. ▶

The 350 seat Orkney Arts Theatre takes shape

Shuttering to form an irregular shaped concrete structure would have been more expensive and may not have fared so well in the Orkney conditions.

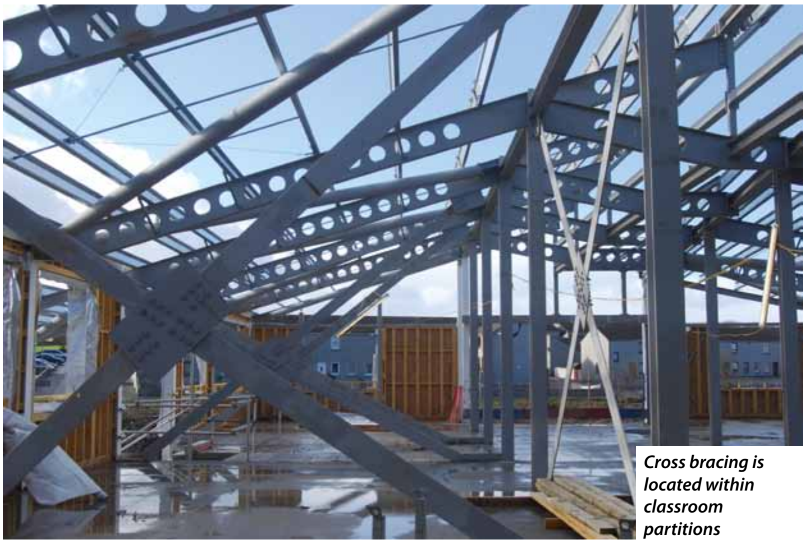
The erection sequence began with the sports hall and BHC then worked its way down the structure completing the three wings and the main teaching block and atrium, before finishing off with the theatre.

"The entire shape of the school presented a challenge as the grid changes regularly, but the final sector - the theatre - was the most complex requiring a thousand individual steel pieces," comments BHC Project Manager Eddie Brown.

The oval shape of the theatre required a number of curved beams to be supplied to the project. These members not only form the curved perimeter of the venue, but they were also used to construct two-storeys of classrooms that wrap around a portion of the theatre.

The complexity of the steel frame is at its greatest where the theatre joins the main school building. Here a large entrance foyer, which connects into the main central atrium, has curved members adjoining a straighter line of steel columns and beams.

Forming the open plan column free space of the theatre are two 17m-long trusses, positioned on either of what will become the main stage. These large steel sections were brought to site fully assembled and erected during one weekend, after getting a police escort through Kirkwall's narrow streets from the ferry terminal.



Cross bracing is located within classroom partitions

Working on the Orkney Islands means all of the project's materials have to be transported from the mainland, with the steel arriving by ship from Aberdeen. BHC had to limit each load to 25t, with the longest individual load being 24m-long.

"We generally allowed four days for each delivery to arrive after leaving our yard in South Lanarkshire," says Mr Brown.

Two locally supplied mobile cranes were utilised during the first stages of the job, when two erection gangs were employed. But as the work came to end and only the theatre remained to be erected, just one 200t capacity crane needed to remain on site.

Elsewhere on the project steelwork continues to follow an irregular grid pattern. Each of the three two-storey teaching wings for instance, are different lengths and accommodate classrooms that are based around a 7.1m grid but get slightly smaller the further away they are from the main building. This design feature creates more circulation and breakout space and is formed by the central dividing corridors in each wing splaying outwards.

The main feature of the school is the centrally positioned and naturally lit three-storey high 'street' or atrium. Overlooked by corridors from the adjoining three-storey teaching areas, the 'street' is connected to the dining hall and a dance studio. Both of these areas can opened up into larger spaces by using moveable partitions. Spans across the 'street' are a maximum of 24m, and have been formed by a series of cellular beams.

Aiming for a BREEAM 'Excellent' rating, the new KGS school is scheduled to be operational by spring 2013. This will then allow the existing buildings to be demolished, creating space for the school's new playing fields.

In at the deep end

Work is also currently progressing on the steel framed extension to Kirkwall's Pickaquoy Leisure Centre. The new build will house a six lane 25m-long swimming pool, a leisure pool, steam room and squash courts with a viewing gallery.

One 32m-long spliced steel truss, weighing 14t, forms the central spine of the extension, supported by two main columns, one at each end. Aside from this, the extension is a braced steel frame, with the main truss connected to a series glulam beams which span the pool. Terraced seating overlooks the main pool, formed with precast steps supported on steel rakers.

Cellular beams have been used for economic reasons to create the open areas of the squash courts. Behind these courts the extension connects into the existing building's steel frame. Interestingly, Morrison Construction also built the first phase of the Pickaquoy Centre in the late 1990s.

Recently the predominantly timber framed Stromness Primary School was completed, while the steel framed Papdale Halls of Residence, part of the programme, has just entered the preliminary ground works stage.

Full marks for steel design

Triangular in plan, a new and iconic steel framed Academy is taking shape in south Liverpool.

FACT FILE
Enterprise South Liverpool Academy
Client: Jointly sponsored by Enterprise Managed Services, Liverpool City Council, Liverpool University, the Catholic Archdiocese and the Anglican Diocese.
Architect: BDP
Main contractor: Lend Lease
Structural engineer: BDP
Steelwork contractor: The AA Group (TAAG)
Steel tonnage: 700t
Project value: £23M

Improving students' educational performance often goes hand in hand with the regeneration of a local community, especially with the construction of a new school.

An example of this is the Enterprise South Liverpool Academy (ESLA), a new landmark educational facility under construction in Garston, Merseyside. The four-storey structure is being built on a prominent site and its architecturally inspiring design, which brings structural steelwork's qualities to the fore, means the Academy will quickly become a source of pride to students and the local community.

The Academy initially opened in 2010 on two different sites following the closure of two local schools. The new facilities are due for completion in February next year.

The construction project began in July 2011 and the work is taking place on former playing fields belonging to one of the Academy's campuses. Once the new structures are complete and students have decamped, the old buildings on the site will be demolished by main contractor Lend Lease. This area will then be converted into car parking and student allotments.

Structurally the main part of the new building is a triangular four-storey element featuring a large full height atrium in the middle. This part of the Academy houses the main entrance, social facilities including dining, learning cafe and sixth form area on the ground floor, with classrooms arranged on the levels above. Each of the upper floors feature break out zones, which take the form of curved balconies, arranged along each of the atrium's three sides.

Despite the triangular shape of the main structure the steel grid pattern is still quite regular, which had benefits for the steel erection programme and design. "For economy we managed to keep the grid based around a three sided equilateral triangle that forms the central atrium, with each side split into five bays of 7.65m," says BDP Project Engineer Andrew Williams.

The wings of each side of the triangle are made up of a classroom bay of 7.7m and a corridor bay of 4.2m, the only exception being around the corners. Two precast lift shafts are located in two of the building's corners; installed with the precast stairs by The AA Group (TAAG) as it erected the steelwork frame.

The Academy design has taken into account possible future needs of the school and how these needs may alter. "A fair amount of future-proofing has been designed into the project and some classroom partitions could be removed, changing the room's configuration if the Academy's needs required bigger teaching spaces," says Neil Sargent, Lend Lease Project Manager.

Upturned T-sections span the classrooms between the perimeter columns and the internal corridor columns. Running parallel with the precast units, these beams are set at the same depth as the planks, giving a flat soffit within the teaching spaces and so allowing partitions to be easily removed and clear distribution of services.

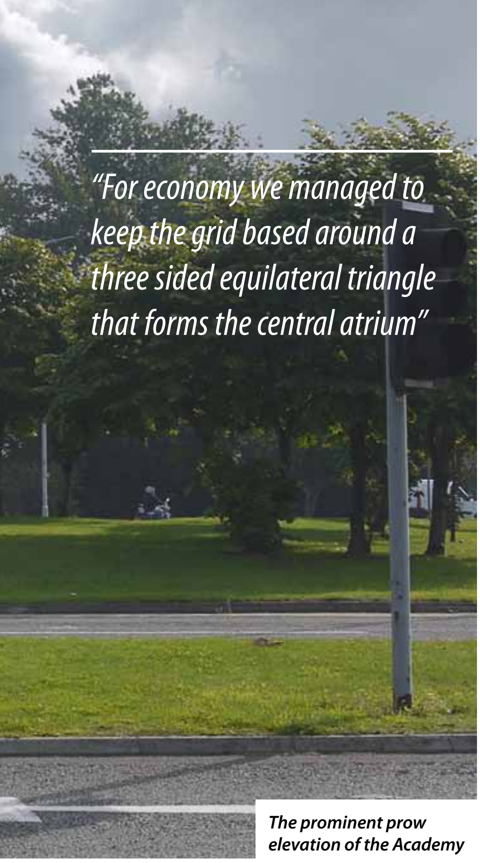
Forming the atrium void are a series of 22m-high 406mm diameter CHS members. Used for their aesthetic appeal, these columns will remain in full view within the completed building. They were brought to site in two pieces and then bolted together on the ground before being erected as one single piece. For architectural reasons the column's splice is hidden within the second level floor zone.

As well as social facilities, the ground floor of the atrium also accommodates a dining area and a faith space - the latter being a place that reflects the Academy's Christian ethos. Circular in plan with a 9m diameter, the steel frame for this pod has been formed with a series of curved beams. The roof to this circular drum structure is sloped so the steel beams to the head of the frame are both curved and slope, requiring double curvature members.

Further upwards in the atrium a series of bolted 2m deep warren trusses span the void. Varying in length (the longest is 30m), they were all brought to site in sections before being assembled on the ground and lifted as one member. The trusses support a series of beams that provide support to a north light glazing system with integrated gutters, which will take full advantage of natural illumination for the central atrium.

"Although the grid is fairly regular the overall steel frame does have some complex geometry," says Mr Williams. "Transfer structures are needed where we have large open areas, such as a ground floor drama unit and the main entrance, while there are also some long cantilevers requiring deep beams and backspans."

One of these cantilevers is located



"For economy we managed to keep the grid based around a three sided equilateral triangle that forms the central atrium"

The prominent prow elevation of the Academy

The faith space 'pod' sits within a large atrium

over the Academy's specialist Enterprise Centre. This is an attached smaller triangular structure with a similar central void to the main building which is attached to one elevation. This area will feature high tech conferencing facilities and will be open for use to the local community.

The main triangular structure cantilevers 6m away from one large CHS column at third floor level. This column provides support to the Enterprise Centre at levels one and two, and continues up to the underside of the third floor level of the main building which cantilevers out over the Enterprise zone. This overhang creates a second floor outdoor area and design wise it resembles a prow of a ship, which is a nod to Liverpool's nautical heritage and the nearby River Mersey.

The new Academy also features a large indoor sports hall which sits adjacent to the main structure. It is linked to the Academy via a covered walkway (known as the Agora). Although part of the same large steel frame, the Agora and sports hall are separated from the rest of the structure by a movement joint.

Summing up the project, Sue Emms, BDP Architect Director, says: "In line with the sponsors vision, we wanted to create a new Academy that contributes to the local neighbourhood by creating a new community beacon and a symbol of regeneration.

"The building has been conceived as a 'ribbon', clad in shiny aluminium shingles. This form provides a visual presence to the entry vista and rises up to the main body of the building into a highly visible 'prow' before wrapping around and down to enclose the main body of learning spaces."

The structure's grid alters to accommodate a ground floor drama space

Warren trusses support the atrium's glazing

A view of Torsion – Part Three

Parts One and Two introduced the two torsion resistance mechanisms available to a steel I-section and described them separately. In this final Part of the series, Alastair Hughes discusses the interaction of the two mechanisms.

Introduction

To begin with, a reminder:

- Forget about 'warping' unless the member possesses two flanges
- The option exists to ignore St Venant and resist torsion by 'warping' alone

What follows is for designers who need to extract all available stiffness and/or resistance from a conventional I- or H-beam by taking advantage of both 'warping' and St Venant. It does not apply to shapes like angles and tees, whose warping is insignificant, nor to hollow sections, whose warping is either non-existent (in the case of CHS) or disregarded. Angles, tees and hollow sections are designed to resist torsion by St Venant alone.

As reassurance, compare the tabulated properties of 178 × 203 × 37 UKT and the 406 × 178 × 74 UKB split to make it. Whereas I_t is just under half that of the parent section (as the membrane analogy would indicate), I_w is less than a thousandth (and hardly seems to warrant a column in the table).

The problem

While each resistance mechanism is comprehensible enough on its own, and both can deliver resistance independently of one another, the proportions in which they share the burden will vary along the length of the member in a manner which is obscure to those of us not qualified in higher mathematics.

Although EN 1993-1-1 6.2.7(2) might give the impression that there are two kinds of torsional moment, there is only one – but there are two kinds of resistance, and equilibrium demands that the sum of their respective contributions must equal the torsional moment T_E at any and every point along the member. Of course T_E itself may also vary lengthwise, which adds to the complexity.

The mechanism known as warping is actually differential flange bending. Like any other beam, the flange is much more efficient when its span/depth ratio is small. Double the span and the deflection will multiply by eight. By contrast, St Venant displacement merely increases pro rata with the length. Naturally, therefore, 'warping' can be expected to provide most of the stiffness and resistance if the member is short, and St Venant will assume dominance as the length increases. In between, both have a helpful contribution to make – and their combined effect can improve on the sum of their independent efforts. Many practical beams occupy this 'in between' zone.

Formulating the problem in general terms is not too difficult. Here it is on a stamp, (top of next column) commemorating the great Ukrainian engineer S P Timoshenko, who is the hero of this episode in the story of torsion.

The differential equation on the stamp is essentially what would, in current symbolism, be expressed as:

$$T_E = GI_t\varphi' - EI_w\varphi'''$$

In words, the St Venant contribution $GI_t\varphi'$ and the 'warping' contribution $EI_w\varphi'''$ add up to the torsional moment. (Don't be concerned by the minus sign, which is as in the familiar bending formula $M_y = -EIz''$.)

I_w, the warping constant, was formerly symbolized H. The new symbol is rather regrettable, because this section property (whose units are m^6) has even less to do with inertia than I_t [which is, for a circular bar (only), numerically the same as its polar moment of inertia]. The 'warping' contribution is equal to the shear force in the flange (the rate of change of its 'warping' moment) times the distance between flanges, taken as $(h - t_f)$. The 'warping' moment is $\pm EI_f y''$ and $y = \varphi\,(h - t_f)/2$, whence $I_w = I_f\,(h - t_f)^2/2$. I_f is the second moment of area of one flange, $bt_f^3/12$, and is not very different from $I_z/2$ for the section as a whole.

The mathematicians need to be employed because the equation on the stamp must simultaneously be satisfied from end to end of the beam, taking account of any lengthwise variation of T_E, whose distribution will, in general, depend not only on the torque(s) applied but also on the two kinds of torsional stiffness in play.

The solutions

Suffice it to say that the mathematical profession has provided us with a set of solutions for a range of situations encountered in practice, and these are given in the new SCI Design Guide, P385. In P057 (the earlier publication), many of them were presented as graphs, because the formulae are heavy duty, with abundant hyperbolic functions. Twenty years on, a £7 pocket calculator will take these in its stride, so the number of graphs is somewhat reduced in P385. Some graphs are retained, however, not least because they give a visual indication of the interplay between the resistance mechanisms.

Consider, as a simple numerical example, a beam subject to point torque at midspan. Here are plots of the variation of φ and its first, second and third derivatives with respect to x. The torque T is 3.4 kNm, the span is 3.46 m and the beam is 305 × 127 × 42 UKB, S275. For this section I_t = 21.1E–8 m^4, I_w = 0.0846E–6 m^6 and $(h - t_f)/2$ = 0.148 m.

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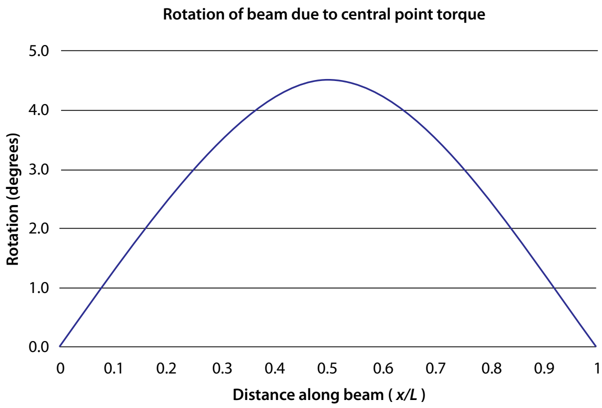
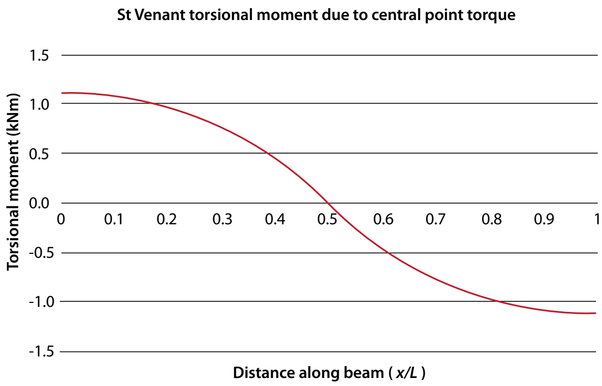


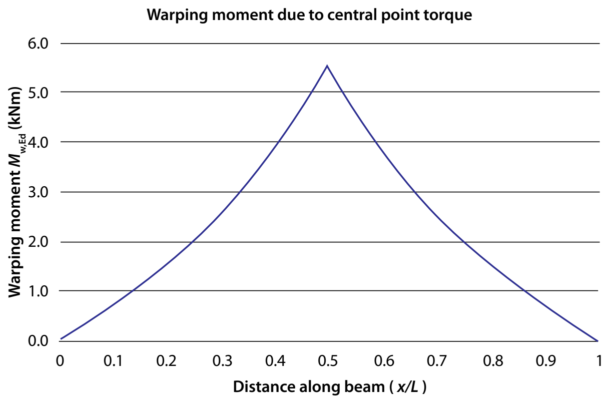
Graph 1: Beam rotation

The lateral deflection of the top flange is φ ($h - t_f$)/2, so this graph can be viewed as its deflected shape. At midspan, φ is 0.078 rad (4.5°) and deflection is 11.5 mm. This might well be judged excessive, even if *T* incorporates a partial factor of 1.5.



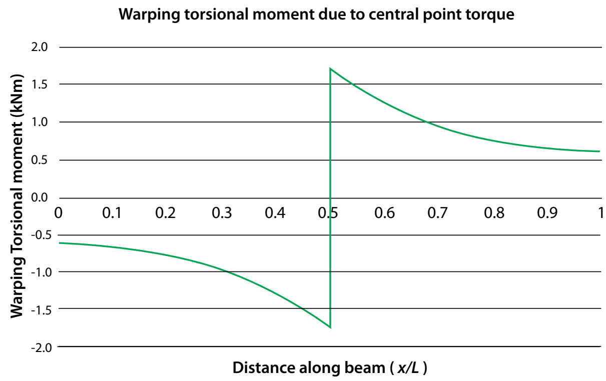
Graph 2: St Venant torsional moment

The St Venant contribution is GI_tφ', so this graph reflects its lengthwise variation. At maximum, at the ends of the beam, φ' = 0.064 m^{-1}. The peak St Venant shear stress (*Gt*φ') is 62 MPa at the flange face; 41 MPa at the web face.



Graph 3: Warping moment

'Warping' moment M_w is ±EI_wφ'', so this graph takes the shape of the flange bending moment diagram – the warping moment diagram. At midspan M_w peaks at ±5.6 kNm, a significant proportion of the flange's bending resistance $M_{pl,z,Rd}$ (which is 12.8 kNm).



Graph 4: Warping torsional moment

The 'warping' contribution to torsional moment is –EI_wφ''', so this graph reflects its lengthwise variation (which mirrors graph 2). Either side of midspan, the peak warping shear force in the flange is less than 2 kN, corresponding to a peak elastic shear stress at its neutral axis of less than 2 MPa. The shear stresses associated with warping are, in themselves, really quite trivial.

Member verification

Thanks to elastic theory and higher mathematics, the designer can now evaluate all torsionally induced stresses everywhere along and around the beam. But some head-scratching remains.

Serviceability should normally take priority, with strength checked after deformations have been judged acceptable. EN 1993-1-1 6.2.7 hints at this with its wording: 'For members… for which distortional deformations may be disregarded…' which might almost be taken to imply that if deformations **do** command regard there is no need to verify resistance. In a purely torsional design situation, that might not be far from the truth. But most practical beams have to be verified for a combination of bending and torsion.

Elastic verification using the Von Mises yield criterion is one possibility. Identifying each and every potential critical point on the beam is easier said than done, especially when stresses due to regular bending and shear have to be superposed.

Commonly, unacceptable torsional deformation of a beam will precede yield by a comfortable margin. But there are exceptions; one is a very short member in which 'warping' is dominant. Another is a beam which is subject to a large amount of regular bending plus a small amount of torsion. In a case like this, the merest whiff of torsion could 'fail' the (Class 1 or 2) beam if its presence made elastic verification compulsory.

The Eurocode is an advance on its predecessor because it does permit plastic verification of the cross-section in the normal way. This involves downgrading the yield strength if the shear force exceeds half the plastic shear resistance. The latter is subject to reduction when torsional shear stress is present (in the web, presumably) but even so it is only rarely that the yield strength, and hence bending resistance, of an I-section will have to be downgraded. In the flanges, shear stresses induced by torsion do not have the same significance.

In practice, for an I-section whose yield strength is not downgraded, it is only the flange bending moment due to 'warping' that interacts with regular bending moment. However it is often the case that an eccentrically applied gravity load (which is responsible for the torsion) continues to act vertically while the beam rotates at its point of attachment. This induces a weak-direction moment M_z (equal to φM_y) as a secondary effect of torsion. So two regular moments interact with two opposing warping moments. The regular biaxial bending formula, which takes no heed of warping moment, needs to be extended, and P385 includes NCCI to this effect.

Torsion-resisting beams habitually lack restraint against lateral-torsional buckling (LTB). In this event the compression flange is liable to fail prematurely, and EN 1993-1-1 offers a choice of complicated formulae to apply, none of which takes any account of torsion. Fortunately, Professor Lindner at the Technical University of Berlin has researched this interaction, and his formula has official status as UKNA-endorsed informative Annex A to EN 1993-6, the Part dealing with crane beams. P385 adopts this formula, not just for crane beams.

In Conclusion

This series of articles has aimed to whet the reader's appetite for SCI's P385: 'Design of Steel Beams in torsion', the long-awaited revision of P057. The emphasis has been on textbook material that Standards and SCI Design Guides take as read, but some of the changes have been previewed. The new publication covers the whole subject in far greater detail, with chapters on PFC and ASB sections (which are complicated, because the axis they twist about is not their centroidal axis) and on connection design. Also included are section property tables, warping/St Venant interaction graphs and formulae, advice on serviceability and a set of design examples.

As an afterthought, reflect that it is rare for torsion to be properly modelled in skeletal analysis. With each member represented by a single line, only the St Venant stiffness can be input. 'Warping' stiffness is there in reality but not in the model, and any incorrect distribution of stiffness is liable to distort the result of an apparently precise elastic analysis. This could be to the detriment of some members of the framework. Perhaps the poor torsional performance of conventional steel sections should be viewed less as a disadvantage, more as a saving grace.

AD 366
Bolts and Pins – Background information ASM 22.3.12

This advisory desk note provides background information on the design issues for bolts and pins, and why there are different design rules for each component.

The differences between a bolt and pin are:

- Pins may be designed to rotate
- Pins may be designed to be removed
- Bolts and pins have different clamping effects on the connected plies.

BS 5950-1:2000 (Aug 2007) intends a "pin" to cover anything from the spindle of a bridge bearing to a simple dowel, that have little or no clamping effect on the connected plies. A shouldered bolt, a fitted bolt, a threaded rod or a round bar with nuts both ends (whether fully threaded or not) would all be understood as bolts, with the potential to clamp the plies together.

A pin is unthreaded and is only prevented from coming out of the hole by ancillary means such as caps or dowels; the assembly has little or no clamping effect on the connected plies. A pin may be relatively long compared to its diameter which is why a check on moment capacity is included in clause 6.5.3.4 of BS 5950-1 and a combined shear and bending check of pins is included in Table 3.10 of BS EN 1993-1-8:2005 (Aug 2010).

Clause 3.13.2(2) of BS EN states that "generally" the reactions between the pin and the connected parts are uniformly distributed along the length in contact on each part. This method shown in Figure 3.11 of BS EN 1993-1-8 (Figure 1 below) to calculate the bending moment is rather conservative (see AD 172: Bending moment in a pin, which demonstrates how the expression in the Eurocode was derived), particularly where the plates are relatively thick. Unfortunately, the Clause does not say when or how the general rule may be modified. A less conservative approach is to reduce the length in contact (required for load transfer) based on the bearing stress as specified in Table 3.10, which will result in a reduced bending moment.

This option means that a force distribution as shown in Figure 2 below (similar to Figure 3.6 of BS EN 1993-1-8) may be assumed, rather than the conservative distribution shown in Figure 3.11 of the Standard. The simple approach illustrated in Figure 3.11 is conservative.

Contact: **Abdul Malik**
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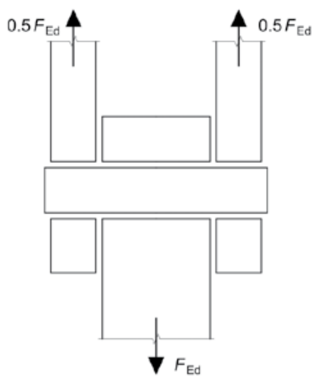
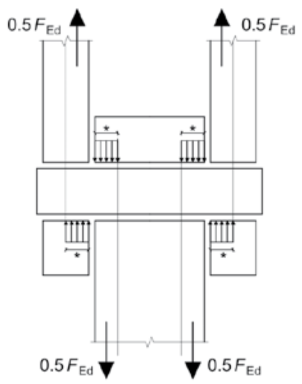


Figure 1



$$* = \frac{0.5F_{Ed}\gamma_{M0}}{1.5df_y}$$

Figure 2

New and revised codes & standards

From BSI Updates March 2012

CORRIGENDA TO BRITISH STANDARDS

BS EN 10029:2010

Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape.
CORRIGENDUM 1

BS EN ISO 18286:2010

Hot-rolled stainless steel plates. Tolerances on dimensions and shape
CORRIGENDUM 1

UPDATED BRITISH STANDARDS

BS EN 1090-1:2009+A1:2011

Execution of steel structures and aluminium structures. Requirements for conformity assessment of structural components
Amendment 1
Also incorporates Corrigendum 1

NEW WORK STARTED

BS 7419

Specification for holding down bolts
Will supersede BS 7419:1991

BS 8202-2

Coatings for fire protection of building elements. Code of practice for the use of intumescent coating systems to metallic substrates for providing fire resistance
Will supersede BS 8202-2:1992

DRAFT BRITISH STANDARDS FOR PUBLIC COMMENT – NATIONAL BRITISH STANDARDS

12/30256522 DC

PD 6696-2 A1 Background paper to BS EN 1994-2 and the UK National Annex to BS EN 1994-2

ISO PUBLICATIONS

ISO 834-1:-

Fire-resistance tests. Elements of building construction. General requirements.
AMENDMENT 1: January 2012 to ISO 834-1:1999
Will be implemented as an identical British Standard

Somalia

This desolate scene is Berbara Harbour. The foundations in the foreground have been ready since 1948 for navy warehouses that were never built. The rusted freighter is aground and abandoned and the Dhows and barges are derelict too. The whole scene reminds me of those novelist's descriptions of the desert areas of South West Africa around Walvis Bay where the bodies of ancient mariners were found several miles inland, dried up and preserved in salt dunes 100 years ago.

Taken from
STEEL CONSTRUCTION February 1992

The plane from Addis Ababa to Djibouti settles onto the tarmac and taxis in two hours late, past an outgoing DC3. I arrive breathlessly at the transit desk to confirm that it was my flight to Hargeisa that I just missed. The next 23½ hours imprisoned in the transit lounge with only flies for company, lets me read all three novels bought for the whole trip, the two newspapers, the duty free price list, all the cigarette and perfume advertisements and the instructions on how to use the broken fire extinguisher, as well as mending the toilet flush mechanism.

One particular four hour period is more frustrating than the rest. Through various chinks I can see and hear a party of French Foreign Legionnaires having an uproarious time, drinking French wine and playing with their entertainers in another lounge nearby.

Next day, despite being first in the queue by some 21 hours, the hustle and bustle of getting through various procedures mean that I nearly miss this day's plane as well.

The airport at Hargeisa is a cute little RAF station built in 1939 when Northern Somalia was British Somaliland, and has changed little since except for wear and tear, fair and unfair. Thank goodness my host has the patience to wait for the flight – because there are no phone lines between Djibouti and Hargeisa, and no maps or information booths.

The transport provided is in the motor age, but only just: an aged pick-up with no side windows, a door missing and Pepsi crates inverted over holes in the floor for seats. We rattle our way noisily along roads built by the Ministry of Building and Public Works in 1948 and not repaired since. My host apologises for the vehicle; any reasonable car would have been confiscated by the police or the army. Both these corps are officered and manned by Southern tribes from ex Italian Somaliland around Mogadishu. They have no love for the Northern tribes and a posting to the north is a punishment only alleviated by their being able to steal anything available from the locals. Nobody steals our truck!

Leaving the town, we approach a ramshackle roadblock. My host laughs, says "Watch this," and accelerates and then takes his foot off the accelerator. The rickety exhaust pipe explodes in a series of bangs. Soldiers on the road block race for cover; one caught leaving the better part of his being in the desert actually bounces away sack race fashion with his trousers around his ankles - great fun. We then stop for the road block, get scolded and allowed to proceed. "I am safe with you," says my host. "You are my white passport." Very comforting; I had hoped to be safe with him.

Reid's new buildings are the first decent constructions since the Royal navy left after World War II

We proceed thus for about a hundred miles, past several similar road blocks, past several refugee camps where a quarter of a million Somalian tribes people (who used to live in the Ogaden before the Ethiopia-Somailia Ogaden War) now reside courtesy of UNHCR, before eventually arriving at our work site, a series of grain stores with workshops, offices, ablutions, a power station and a water tower, designed, made and exported by Reids.

I inspect the local workforce provided, about 200 tribesmen, some from the refugee camps, some from the local populace, but all having in common completely open minds on the subject of construction. Simple concepts such as the nut and bolt are a source of great wonder to camel herders who have never been exposed to them, so it takes a while to get going. Levels, spades, hammers and nails are dug out and put to work and in a short time we are pouring the first footing. Two days later, in the searing heat, the steelwork is able to be erected. The columns are manhandled up; a crane provided by UNHCR mysteriously only works for short periods following the insertion of an enormous wad of Somali 100 shilling notes into the operator's overalls, so we have to put the rafters up quickly during the brief hours of lubrication. The wad has to get thicker daily as inflation is rampant.

As usual the crowd of helpers thins out to a dozen or so who are mastering right hand threads and the mystery of ladders and screwguns; erection proceeds amazingly well. In a very few weeks of such amusement the camp is up and running. Om the airfield at Berbera I meet an ageing English World War II pilot complete with moustache, now grey. With tears in his eyes he tells me of the hurricanes he flew here against the Vichy French in the war, and nothing has changed at all since then - except of course our new sheds.

I reverse my route, glad to have been there, gladder still to go home (and make my visit to the Hospital for Tropical Diseases in London). Days later, the Mogadishu government hits on the idea of arming the refugees in the camps and advising them they could kill the locals and take their homes. Frustrated from years in the camps they set about their task with gusto. The entire population of Hargeisa and most of the other towns, if not killed, is evicted to refugee camps in Ethiopia, many with pieces missing where earrings or rings prove bothersome to take off conventionally. The Ethiopian Somalis settles into their new homes. I had just missed a horrid civil war - one that is still dragging on now (February 1991).

That's exporting!

Rollo Reid, BSC., M.I.C.E., C.Eng.
Technical Director
John Reid & Sons (Strucsteel) Ltd.

Spinning wheel passing mid span on the West catwalk, during the spinning of the first strand

FROM BUILDING WITH STEEL, MAY 1962

Cable spinning for the Forth Road Bridge

On 17 November 1961 the first four wires of the cables on the new Forth Road Bridge were hauled over the tops of the 512-ft towers and securely anchored on either shore. Thus was inaugurated the most difficult and outstanding phase of the 3½ years of bridge construction - the spinning of the main cables across the river.

In a suspension bridge the weight of the deck and traffic is all carried by the cables which span between the tops of the towers, dip down over the side towers and splay saddles, and are secured at their ends in concrete anchorages built deep into the ground. These cables are each made of 11,618 parallel wires of galvanized high-tensile steel, and when completed they will be about 22½ inches in diameter.

At anchorages the wires are divided into 37 groups known as strands, each group being looped around a strand shoe which connects it to the anchorage.

Experience has shown that the most practical thickness of wire is about 0.19 in. with an ultimate strength of about 100 tons per square inch. By drawing the wire thinner the ultimate tensile strength would be less and they would become too stiff to bend round the pulleys and reels.

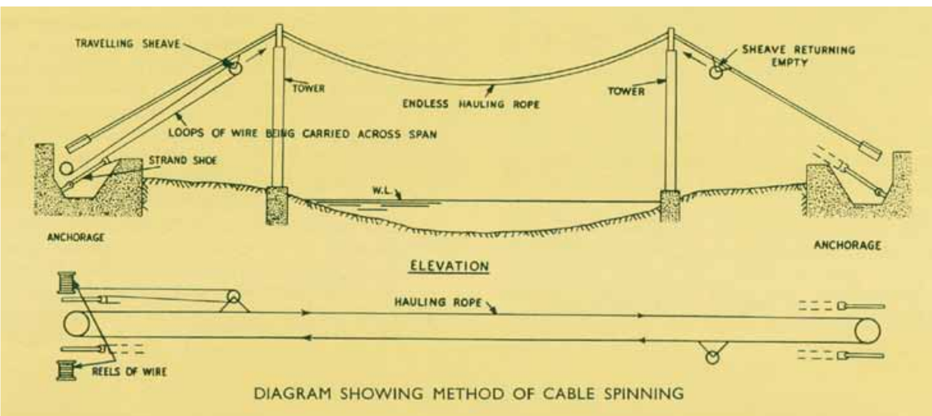
Cables of parallel wire made in this way were invented many years ago by John A. Roebling, and used by him in the famous Brooklyn Bridge (1883) in New York. This system has become the standard practice on bridges of great span in the U.S.A., where the specialised and costly plant require is all in existence. But until the construction of the Forth Road Bridge it had never been used in Europe. For this reason the contractors sought advice from Messrs Roebling of Trenton, U.S.A., who gave most valuable assistance in the design of the cable spinning equipment and the organisation to be set up at site.

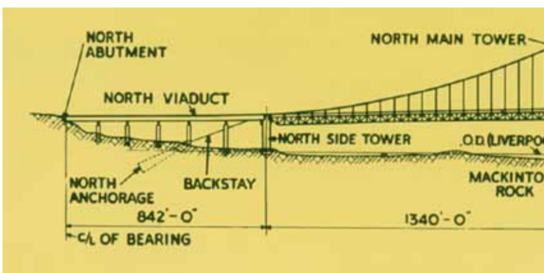
In the Forth Road Bridge some 30,000 miles of wire will be needed – sufficient to stretch about 1¼ times around the world. The whole 3,650 tons of wire has now been made. In the Reeling Shop at the south end of the bridge site the coils of wire are loaded onto swifts by the pillar cranes and reeled through tensioning devices onto big drums, 90 of which are available, each capable of taking 7 tons of wire. The individual coils are spliced together by means of cylindrical nipples, into which the ends of wire are inserted and then squeezed in a 200-ton press.

The loaded drums of wire are then mounted in turn on eight unreeling machines set up behind the south anchorage. These machines deliver the wires through a counterweight tower designed to ensure equal tension in all of them, and so to the spinning wheels that carry them over the span.

Before the spinning could start, temporary footbridges or catwalks had to be erected across the river from the anchorages and over the tops of the towers, about 4 ft below the level at which the main cable would ultimately be. Each footbridge is 9 ft. wide and supported by ten strands 1 in. thick – eight of which carry the wire mesh floor of the catwalk, whilst the other two support the wire mesh parapets.

These 20 footbridge strands, which are about 6,000 ft. long were erected by unreeling them





one at a time from a drum on a pontoon which was towed across the river. Two strands, one upstream and one downstream, were erected per tide. The timing of this work had to be agreed by the Admiralty and the Forth Conservancy, who were most co-operative. The strands were laid over the main piers and the ends connected to the tops of the side towers. Shipping then had to be warned and stopped if necessary during the lifting of each strand from the bed of the river, which was done at low water.

It was found possible to lift the strands in fast running tides and winds up to 30 m.p.h. The strands brought up with them old coils of wire and anchors from the bed of the river, which had to be removed by the site launch.

When all the footbridge strands had been erected and adjusted to the correct sag, the panels of wire mesh for the flooring and parapets were assembled on them, and they were interconnected by seven tubular crossbridges and tied down by storm guys to prevent any risk of their being blown over.

The next job was the assembly of the 'tramways', the reversible hauling ropes which carry the spinning wheels and are supported by a series of beams about 20 ft. above the footbridges. Each hauling rope or tramway carried two 4-ft diameter spinning wheels, one at the north and the other at the south end, and is electrically driven. Each wheel has four grooves on it, so that it can carry four bights or loops of wire and haul them across the span.

When the spinning starts, four wires, taken from the unreeling machines through the counterweight tower, are temporarily connected to the strand show at the anchorage and the loops of wire passed round the spinning wheel. The final wires of the last trip of the strand will later be spliced to these ends.

The tramway drive is then set in motion at the same speed as the unreeling machines and the four bights of wire are carried over the tops of the towers to the far anchorage, where they are taken off the wheel by hand and placed around the strand shoe at the end. When the tramway drive is again set in motion the wheel at the north end will return empty, but the other spinning wheel with four more loops of wire on it will be on its way from the south to the north side.

During the spinning, men are stationed at intervals of about 400 ft. along the full length of the catwalks, and it is their duty to adjust the wires as they are laid against a fixed guide wire – thus ensuring that they all have the same sag in the main span and side spans. Emergency stop buttons are provided for these men so they can stop the wheel immediately in case of necessity.

General view of the bridge, showing the catwalks illuminated for cable spinning at night

The spinning wheel travels fast, reaching a speed of 700 ft. per minute, which enables four bights (8 wires) to be placed every 18 minutes. By this means, with men working two 8-hour shifts from 8.00 a.m. to midnight, more than 300 miles of wire can be spun in place every day.

Lights are installed throughout the length of the catwalks, and make a fine sight, festooned across the river by night. In addition telephone lines are laid along the walks and electric control signals and 'come-alongs' assembled for use in adjustment of each of the wires.

After each strand consisting of an average of 314 wires has been spun, in has to be shaken out for its full length at inspection and then banded up again at intervals. The strand is finally adjusted at night, when the temperature is constant all over the bridge, to ensure that it has exactly the right sag in the main span and side spans.

During the cable spinning, some 50 or 60 men, scattered over 6,000 ft. of exposed footbridge, up to 500 ft. in the air, must work in concerted intelligent action day and night, in good weather and bad, for 8 hour shifts without a break, in order to get good production. In addition, other gangs are needed at the tower tops and anchorages to load and unload the spinning wheel and operate the adjusting equipment. The despatcher is the key man who controls the spinning from his office at the south anchorage. Good results can only be achieved by the most detailed organisation, by all men putting forth their best efforts and by teamwork of the highest order.

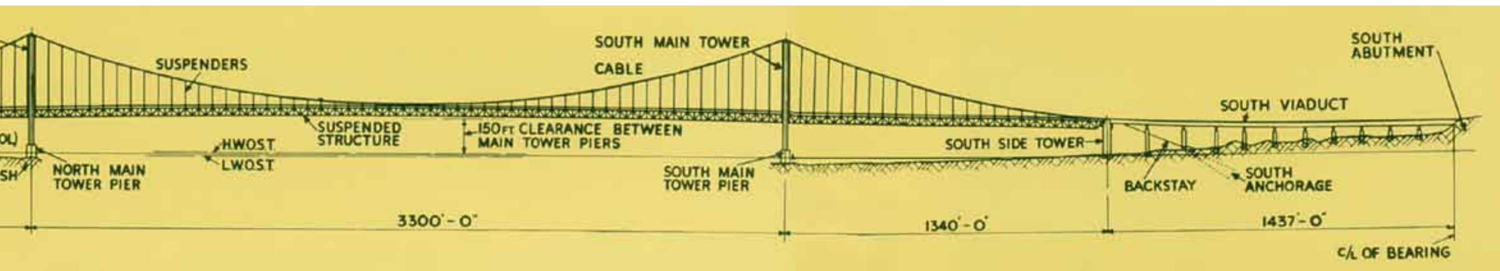
When the whole cable has been erected and the wires adjusted, they are compacted by squeezing them tightly together so as to form a compact circular section. This is done by four machines that encircle the cables and are moved along them squeezing the wires hard together at intervals of 3 ft. by means of hydraulic jacks. After completion each cable is permanently clamped in position in a machined cast steel saddle on the top of the towers.

Cable bands of cast steel are then bolted at each panel point along the cables, and over these are placed long wire rope suspenders which hang down and carry the deck of the bridge.

The last operation on the cables – which cannot be done until most of the deck has been erected – is that of painting and wrapping them around with binding wire throughout their length between the cable bands. This is performed by means of automatic wrapping machines which encircle the cables and travel up them winding on the wrapping wire as they proceed.

Throughout the construction period the safety of the steel erectors is considered of prime importance. To this end the temporary footbridges are provided with wooden slats on the flooring and wire mesh parapets 3 ft. 6 in. high; safety belts are available for any man who needs one, and the wearing of safety helmets is compulsory for everybody. Bridge construction is so mechanised today that, whereas 4,500 men were engaged on the old Forth Railway Bridge, the greatest number at any time on the Forth Road Bridge will not exceed 300.

The bridge was designed by Mott, Hay & Anderson and Freeman, Fox and Partners for the Forth Road Bridge Joint Board.



Strength from Advisory Service

Designing and building in steel has never been as straightforward as it is today, and steel still remains the material of choice for construction in the UK. The steel sector provides comprehensive and in-depth technical back up to ensure that those using steel have all the guidance and support they could need at their finger tips.

The co-ordinated and comprehensive support provided by the BCSA's Structural Advisory Serivce is free of charge to specifiers, clients and designers. Technical experts are on hand to provide an extensive range of services, including design assistance on structural form, performance of steel buildings, seminars and in-house CPD presentations, etc.

Richard Dixon, Manager, Structural Advisory Services, who heads up the network of Regional Technical Managers throughout the UK and Ireland said: "We have a team of experienced regional engineers who are on hand to offer design support and advice to designers, and to point them to the wide range of technical guidance and resources available to them and inform them in a practical way on key topics like EC3 and the sustainability of steel construction through in-house CPDs."

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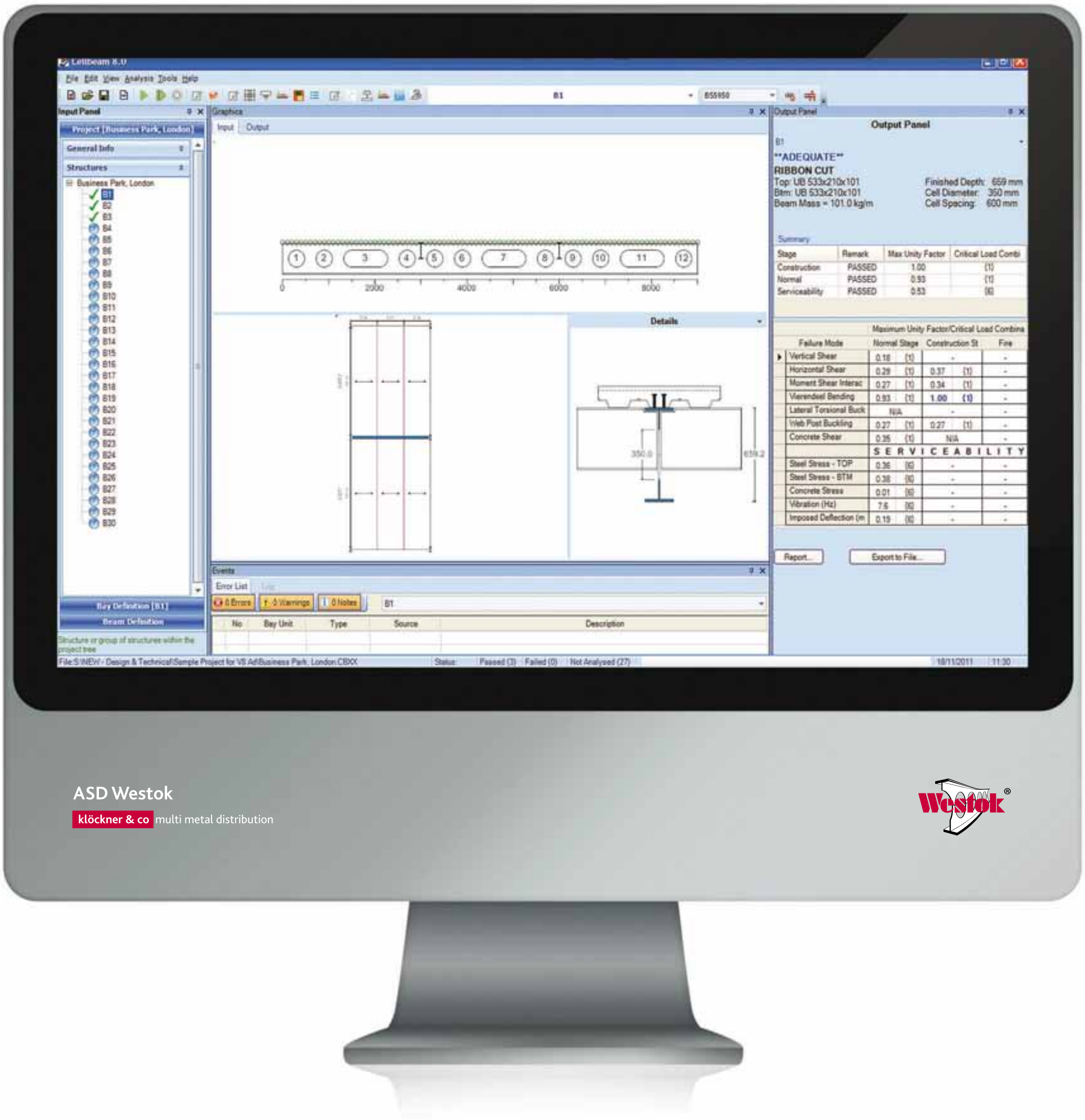
ASD Westok

klöckner & co multi metal distribution

New Cellbeam® V8

Working in conjunction with the SCI, ASD Westok have now developed **Cellbeam®V8,** BS5950 and EuroCode, the software for cellular beam design.



Cellbeam®V8 includes EuroCode and is now furnished with numerous upgrades and enhanced functionality. Below are just some of the benefits that can be found in our new software.

- Design to BS5950-1 & BS5950-3.1A1 or to the Eurocodes (UK and Ireland)
- A large number of structural configurations, including floor and roof beams, internal and edge beams, cantilevers, prismatic, curved and tapered sections
- Project-based design featuring multiple cellular beams within a single project
- A simple, intuitive and logical user interface
- Comprehensive loading configurations including uniformly distributed loads, point loads, wind loads and drifted snow
- Comprehensive 'How to...' guidance
- Detailed technical advice and background information
- Import/Export functions with Fastrack and RAM
- Software written and maintained by the SCI
- Multiple beam analysis

For more details, to get your CD or to talk to our structural advisory engineers please call:

0113 205 5270 or email **info@asdwestok.co.uk**

www.asdwestok.com

Westok®

Steelwork contractors for buildings

BCSA is the national organisation for the steel construction industry.
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
- **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	SCM	Contract Value (1)
A C Bacon Engineering Ltd	01953 850611			●	●		●											Up to £2,000,000
ACL Structures Ltd	01258 456051			●	●	●	●				●				●		● (Member)	Up to £2,000,000
Adey Steel Ltd	01509 556677				●	●	●	●		●	●			●	●		● (Member)	Up to £4,000,000
Adstone Construction Ltd	01905 794561			●	●	●												Up to £1,400,000
Advanced Fabrications Poyle Ltd	01753 531116				●		●	●	●	●	●				●	✓		Up to £400,000
Alex Morton Contracts Ltd	028 9269 2436			●	●	●	●		●	●	●			●	●			Up to £400,000
Angle Ring Company Ltd	0121 557 7241												●					Up to £1,400,000
Apex Steel Structures Ltd	01268 660828				●		●			●	●							Up to £800,000
Arromax Structures Ltd	01623 747466	●		●	●	●	●	●	●	●	●	●						Up to £800,000
ASA Steel Structures Ltd	01782 566366			●	●	●	●			●	●			●	●			Up to £800,000*
ASD Westok Ltd	0113 205 5270												●			✓		Up to £6,000,000
ASME Engineering Ltd	020 8966 7150				●					●	●			●	●	✓		Up to £1,400,000*
Atlas Ward Structures Ltd	01944 710421		●	●	●	●	●	●	●	●	●	●		●	●	✓	● (Gold)	Above £6,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●	●	●							●				Up to £2,000,000
Austin-Divall Fabrications Ltd	01903 721950			●	●		●	●		●	●			●	●			Up to £200,000
B&B Group Ltd	01942 676770			●	●	●	●	●		●	●	●		●		✓		Up to £1,400,000
B D Structures Ltd	01942 817770			●	●	●	●				●	●		●				Up to £400,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✓		Up to £1,400,000
Barnshaw Section Benders Ltd	01902 880848												●			✓		Up to £800,000
BHC Ltd	01555 840006	●	●	●	●	●	●							●				Above £6,000,000
Billington Structures Ltd	01226 340666		●	●	●	●	●	●	●	●	●	●		●		✓	● (Gold)	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●			Up to £3,000,000
Bourne Construction Engineering Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●		✓	● (Gold)	Above £6,000,000
Briton Fabricators Ltd	0115 963 2901	●		●	●	●	●	●	●	●	●			●	●	✓		Up to £3,000,000
Cairnhill Structures Ltd	01236 449393	●			●	●	●	●	●	●	●			●	●	✓	● (Gold)	Up to £2,000,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●	●	●	●	●		●	●	✓	● (Gold)	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	●		●		✓	● (Silver)	Above £6,000,000
CMF Ltd	020 8844 0940				●		●	●		●	●				●			Up to £6,000,000
Cordell Group Ltd	01642 452406	●			●	●	●	●	●	●	●					✓		Up to £3,000,000
Coventry Construction Ltd	024 7646 4484			●	●	●	●		●	●	●			●	●			Up to £800,000
D H Structures Ltd	01785 246269				●		●				●			●				Up to £40,000
Discain Project Services Ltd	01604 787276				●					●	●				●	✓		Up to £800,000
Duggan Steel Ltd	00 353 29 70072		●	●	●	●	●	●			●					✓		Up to £6,000,000
ECS Engineering Services Ltd	01773 810003	●		●	●	●	●	●	●	●	●			●	●	✓		Up to £2,000,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●	●	●	●	●	●		●		✓	● (Silver)	Up to £6,000,000
EvadX Ltd	01745 336413			●	●	●	●	●	●	●	●	●				✓	● (Gold)	Up to £3,000,000
Fisher Engineering Ltd	028 6638 8521		●	●	●	●	●	●	●	●	●	●				✓	● (Gold)	Above £6,000,000
Fox Bros Engineering Ltd	00 353 53 942 1677			●	●	●	●	●			●							Up to £3,000,000
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●				●				Up to £800,000
Graham Wood Structural Ltd	01903 755991		●	●	●	●	●	●	●	●	●	●		●			● (Silver)	Up to £6,000,000
Grays Engineering (Contracts) Ltd	01375 372411				●	●		●		●	●				●			Up to £100,000
Gregg & Patterson (Engineers) Ltd	028 9061 8131			●	●	●	●	●				●		●		✓		Up to £3,000,000
H Young Structures Ltd	01953 601881			●	●	●	●	●			●						● (Member)	Up to £2,000,000
Had Fab Ltd	01875 611711				●				●	●	●				●	✓		Up to £2,000,000
Hambleton Steel Ltd	01748 810598		●	●	●	●	●	●				●		●		✓	● (Silver)	Up to £6,000,000
Harry Marsh (Engineers) Ltd	0191 510 9797			●	●	●	●				●	●				✓		Up to £2,000,000
Henry Smith (Constructional Engineers) Ltd	01606 592121			●	●	●	●	●										Up to £3,000,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●			Up to £3,000,000
Hillcrest Fabrications Ltd	01283 212720				●			●							●			Up to £400,000

Company name Tel C D E F G H J K L M N Q R S QM SCM Contract Value (1)

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	SCM	Contract Value (1)
Hills of Shoeburyness Ltd	01702 296321									●	●				●			Up to £1,400,000
J Robertson & Co Ltd	01255 672855									●	●				●			Up to £200,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●					●		●				Up to £6,000,000*
Kiernan Structural Steel Ltd	00 353 43 334 1445			●	●	●	●	●	●	●	●	●		●	●	✓	● (orange)	Up to £4,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●						● (green)	Up to £2,000,000
M Hasson & Sons Ltd	028 2957 1281			●	●	●	●	●	●	●	●				●	✓		Up to £3,000,000
M&S Engineering Ltd	01461 40111				●				●	●	●			●	●			Up to £1,400,000
Mabey Bridge Ltd	01291 623801	●	●	●	●	●	●	●	●	●	●	●	●	●		✓	● (orange)	Above £6,000,000
Mackay Steelwork & Cladding Ltd	01862 843910			●	●		●			●	●			●	●	✓		Up to £800,000
Maldon Marine Ltd	01621 859000				●			●	●	●					●			Up to £1,400,000
Mifflin Construction Ltd	01568 613311		●	●	●	●	●				●							Up to £3,000,000
Newbridge Engineering Ltd	01429 866722			●	●	●	●								●	✓		Up to £1,400,000
Nusteel Structures Ltd	01303 268112						●	●	●	●						✓		Up to £4,000,000
On Site Services (Gravesend) Ltd	01474 321552				●		●	●		●	●				●			Up to £200,000
Overdale Construction Services Ltd	01656 729229			●	●		●	●			●				●			Up to £400,000
Paddy Wall & Sons	00 353 51 420 515			●	●	●	●	●	●	●	●							Up to £6,000,000
Painter Brothers Ltd	01432 374400								●		●				●	✓	● (grey)	Up to £6,000,000
Pencro Structural Engineering Ltd	028 9335 2886			●	●	●	●	●	●		●			●	●	✓		Up to £2,000,000
Peter Marshall Steel Stairs Ltd	0113 307 6730									●					●			Above £6,000,000*
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●			Up to £1,400,000
REIDsteel	01202 483333		●	●	●	●	●	●	●	●	●	●		●				Up to £6,000,000
Rippin Ltd	01383 518610			●	●	●	●	●										Up to £1,400,000
Rowecord Engineering Ltd	01633 250511	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✓	● (orange)	Above £6,000,000
Rowen Structures Ltd	01773 860086		●	●	●	●	●	●	●	●	●	●		●				Above £6,000,000*
S H Structures Ltd	01977 681931						●	●	●	●						✓	● (grey)	Up to £3,000,000
Severfield-Reeve Structures Ltd	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✓	● (orange)	Above £6,000,000
Shipley Fabrications Ltd	01400 231115			●	●	●	●		●	●	●			●	●			Up to £1,400,000
SIAC Butlers Steel Ltd	00 353 57 862 3305		●	●	●	●	●	●	●		●	●				✓	● (green)	Above £6,000,000
SIAC Tetbury Steel Ltd	01666 502792			●	●	●	●				●	●				✓	● (grey)	Up to £3,000,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●		●								●			Up to £1,400,000
South Durham Structures Ltd	01388 777350			●	●	●				●	●	●			●			Up to £800,000
Temple Mill Fabrications Ltd	01623 741720			●	●	●	●				●	●			●			Up to £200,000
The AA Group Ltd	01695 50123			●	●	●	●			●	●	●		●	●		● (grey)	Up to £4,000,000*
Traditional Structures Ltd	01922 414172		●	●	●	●	●	●	●		●	●		●		✓	● (grey)	Up to £2,000,000
Tubecon AESS	01226 345261						●	●	●	●				●	●	✓		Above £6,000,000*
W & H Steel & Roofing Systems Ltd	00 353 56 444 1855			●	●	●	●	●						●	●		● (orange)	Up to £4,000,000
W I G Engineering Ltd	01869 320515				●					●					●			Up to £200,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✓		Up to £6,000,000
Watson Steel Structures Ltd	01204 699999	●	●	●	●	●	●	●	●	●	●	●		●	●	✓	● (orange)	Above £6,000,000
Westbury Park Engineering Ltd	01373 825500	●			●		●	●	●	●	●				●	✓		Up to £800,000
William Haley Engineering Ltd	01278 760591			●	●	●			●	●	●					✓	● (grey)	Up to £2,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●		●		✓	● (orange)	Above £6,000,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	SCM	Contract Value (1)

Corporate Members

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

Company name	Tel
Balfour Beatty Utility Solutions Ltd	01332 661491
Griffiths & Armour	0151 236 5656
Highways Agency	08457 504030
Kier Construction Ltd	01767 640111
Roger Pope Associates	01752 263636
Sandberg LLP	020 7565 7000
SUM Ltd	0113 242 7390

Associate Members

Associate Members are those principal companies involved in the direct supply to all or some Members of components, materials or products. Associate 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
SCM Steel Construction Sustainability Charter
● = Gold, ● = Silver, ● = Member

Company name	Tel	1	2	3	4	5	6	7	8	9	SCM
AceCad Software Ltd	01332 545800		●								
Albion Sections Ltd	0121 553 1877	●									
Andrews Fasteners Ltd	0113 246 9992									●	
ArcelorMittal Distribution – Birkenhead	0151 647 4221								●		
ArcelorMittal Distribution – Bristol	01454 311442								●		
ArcelorMittal Distribution – South Wales	01633 627890								●		
ArcelorMittal Distribution – Scunthorpe	01724 810810								●		
ASD metal services	0113 254 0711									●	
Austin Trumanns Steel Ltd	0161 866 0266								●		
Ayrshire Metal Products (Daventry) Ltd	01327 300990	●									
BAPP Group Ltd	01226 383824									●	
Barnshaw Plate Bending Centre Ltd	0161 320 9696	●									
Barrett Steel Ltd	01274 682281								●		
BW Industries Ltd	01262 400088	●									
Cellbeam Ltd	01937 840600	●									
Cellshield Ltd	01937 840600							●			
CMC (UK) Ltd	029 2089 5260							●			
Composite Profiles UK Ltd	01202 659237	●									
Computer Services Consultants (UK) Ltd	0113 239 3000		●								
Cooper & Turner Ltd	0114 256 0057									●	
Cutmaster Machines UK Ltd	01226 707865					●					
Daver Steels Ltd	0114 261 1999	●									
Development Design Detailing Services Ltd	01204 396606			●							
Easi-edge Ltd	01777 870901							●			● (Gold)
Fabsec Ltd	0845 094 2530	●									
FabTrol Systems UK Ltd	01274 590865		●								
Ficep (UK) Ltd	01924 223530					●					
FLI Structures	01452 722200	●									● (Silver)

Steelwork contractors for bridgework

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
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	NHSS 19A	NHSS 20	SCM	Contract Value (1)
B&B Bridges Ltd	01942 676770	●	●	●	●	●	●	●	●	✓				Up to £1,400,000
Briton Fabricators Ltd	0115 963 2901	●	●	●	●	●	●	●	●	✓		✓		Up to £3,000,000
Cairnhill Structures Ltd	01236 449393	●	●	●	●			●	●	✓			● (Gold)	Up to £2,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	✓	✓		● (Silver)	Above £6,000,000
Four-Tees Engineers Ltd	01489 885899	●	●	●	●		●	●	●	✓			● (Member)	Up to £2,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●	●	●	●			●	●	✓			● (Gold)	Up to £800,000
Mabey Bridge Ltd	01291 623801	●	●	●	●	●	●	●	●	✓	✓	✓	● (Gold)	Above £6,000,000
Nusteel Structures Ltd	01303 268112	●	●	●	●	●		●	●	✓	✓	✓		Up to £4,000,000
Painter Brothers Ltd	01432 374400	●		●					●	✓			● (Silver)	Up to £6.000,000
Rowecord Engineering Ltd	01633 250511	●	●	●	●	●	●	●	●	✓	✓	✓	● (Gold)	Above £6,000,000
S H Structures Ltd	01977 681931	●		●	●	●			●	✓			● (Silver)	Up to £3,000,000
SIAC Butlers Steel Ltd	00 353 57 862 3305	●	●	●	●	●		●	●	✓			● (Member)	Above £6,000,000
TEMA Engineering Ltd	029 2034 4556	●	●	●	●	●	●	●	●	✓				Up to £1,400,000*
Varley & Gulliver Ltd	0121 773 2441	●						●	●	✓		✓		Up to £4,000,000
Watson Steel Structures Ltd	01204 699999	●	●	●	●	●	●	●	●	✓		✓	● (Gold)	Above £6,000,000
Non-BCSA member														
ABC Bridges Ltd	0845 0603222	●								✓				Up to £100,000
A G Brown Ltd	01592 630003	●						●	●	✓				Up to £400,000
Allerton Steel Ltd	01609 774471	●	●	●	●	●	●	●	●	✓				Up to £1,400,000
Cimolai Spa	01223 350876	●	●	●	●	●	●			✓				Above £6,000,000
Concrete & Timber Services Ltd	01484 606416	●	●	●		●	●		●	✓			● (Member)	Up to £800,000
Donyal Engineering Ltd	01207 270909	●						●	●	✓	✓	✓	● (Member)	Up to £1,400,000
Francis & Lewis International Ltd	01452 722200							●	●	✓			● (Silver)	Up to £2,000,000
Harland & Wolff Heavy Industries Ltd	028 9045 8456	●	●	●	●	●		●	●	✓				Up to £2,000,000
Hollandia BV	00 31 180 540540	●	●	●	●	●	●	●	●	✓				Above £6,000,000
Interserve Construction Ltd	0121 344 4888							●	●	✓				Above £6,000,000*
Interserve Construction Ltd	020 8311 5500	●	●	●	●		●	●	●	✓				Above £6,000,000*
Millar Callaghan Engineering Services Ltd	01294 217711	●						●		✓				Up to £800,000
P C Richardson & Co (Middlesbrough) Ltd	01642 714791	●						●	●	✓				Up to £3,000,000
The Lanarkshire Welding Company Ltd	01698 264271	●	●	●	●	●	●	●	●	✓			● (Member)	Up to £2,000,000

Company name	Tel	1	2	3	4	5	6	7	8	9	SCM
Forward Protective Coatings Ltd	01623 748323						●				
Graitec UK Ltd	0844 543 888		●								
Hadley Rolled Products Ltd	0121 555 1342	●									● (grey)
Hempel UK Ltd	01633 874024						●				
Hi-Span Ltd	01953 603081	●									● (green)
Highland Metals Ltd	01343 548855						●				
Hilti (GB) Ltd	0800 886100									●	
International Paint Ltd	0191 469 6111						●				● (orange)
Jack Tighe Ltd	01302 880360						●				
Jamestown Cladding and Profiling	00 353 45 434288	●									
Jotun Paints (Europe) Ltd	01724 400000						●				
Kaltenbach Ltd	01234 213201					●					
Kingspan Structural Products	01944 712000	●									● (orange)
Leighs Paints	01204 521771						●				● (grey)
Lindapter International	01274 521444									●	
Metsec plc	0121 601 6000	●									● (orange)
MSW	0115 946 2316	●									
National Tube Stockholders Ltd	01845 577440								●		
Northern Steel Decking Ltd	01909 550054	●									
Panels & Profiles	0845 308 8330	●									
John Parker & Sons Ltd	01227 783200								●	●	
Peddinghaus Corporation UK Ltd	01952 200377					●					
Peddinghaus Corporation UK Ltd	00 353 87 2577 884					●					
PPG Performance Coatings UK Ltd	01773 814520						●				
Prodeck-Fixing Ltd	01278 780586	●									
Rainham Steel Co Ltd	01708 522311								●		
Richard Lees Steel Decking Ltd	01335 300999	●									● (grey)
Structural Metal Decks Ltd	01202 718898	●									● (green)
Studwelders Composite Floor Decks Ltd	01291 626048	●									
Tata Steel	01724 404040				●						
Tata Steel Distribution (UK & Ireland)	01902 484100								●		
Tata Steel Service Centres Ireland	028 9266 0747								●		
Tata Steel Service Centre Dublin	00 353 1 405 0300								●		
Tata Steel Tubes	01536 402121				●						
Tekla (UK) Ltd	0113 307 1200		●								
Tension Control Bolts Ltd	01948 667700						●			●	
Wedge Group Galvanizing Ltd	01909 486384						●				