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NSC

STRUCTURAL STEEL DESIGN AWARDS 2011

Vol 19 No. 7 July/August 2011

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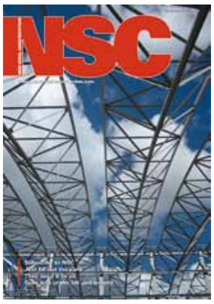

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American Express Community Stadium, Brighton
Client: Brighton & Hove Albion Football Club
Architect: KSS
Steelwork contractor: Watson Steel Structures Ltd (Severfield -Rowen Plc)

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July 2011 Vol 19 No 7

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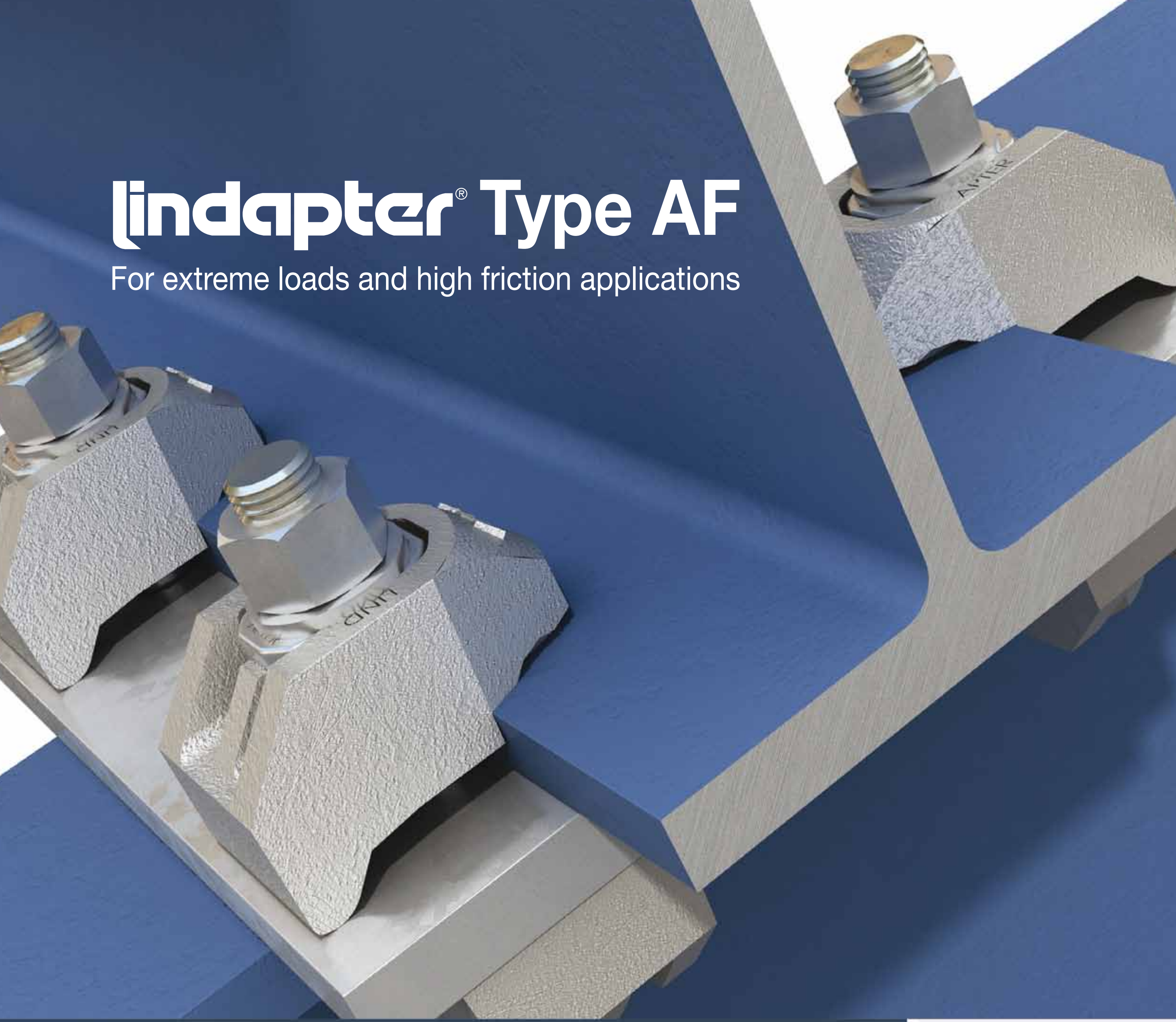

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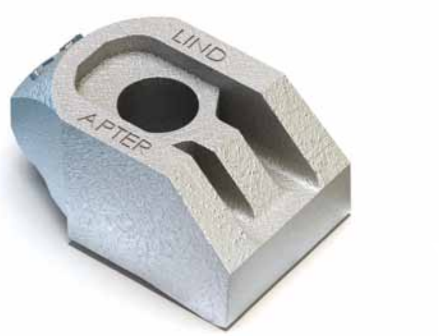

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Steel's best keeps getting better

Nick Barrett - Editor

The Structural Steel Design Awards has been highlighting the best of steel construction for an unbroken run of 43 years, and the best keeps getting better as attendees at this year's awards event will testify. The judges were able to pay tribute to as exciting a crop of outstandingly high quality, innovative, successful projects as has been seen, despite all the constraints of recession.

There may have been slightly fewer entries for the 2011 awards, unsurprisingly given the fact that recession means there are fewer projects under way, but the 18 shortlisted projects provide as creditable a snapshot of the capabilities of steel construction as has been seen in the awards' history. The comments of the judges, all with substantial experience of architecture and engineering on which to base their opinions, on the projects that won awards, commendations and merit awards were as appreciative as ever.

For Chairman of the judges David Lazenby the entries demonstrate steel's adaptability and economy, and its relevance to a wide range of diverse situations, including commercial buildings, sports stadia, public buildings and bridges. Others included a key railway station, a very large distribution centre and a waste to energy plant. The world of the arts values steel not just for providing iconic housing and staging for works of art, but also for making some ambitious artistic visions realisable at all, as can be seen in the two remarkable sculptures that featured in this year's awards.

The SSDA consistently provides a wide range of answers to questions about why steel is the material of choice for the overwhelming majority of noteworthy projects. Annual market share studies consistently show steel having around 70% of the multi storey buildings market, often allowing architects and engineers to realise visions that otherwise would never get beyond the conceptual design stage. As this year's award winning entries show, steel is appealing to designers in new growth areas like waste to energy plants.

Next year's event can be relied on to feature a crop of entries at least as strong as this years' as the industry consolidates during 2011. Beyond this year there are now well-founded expectations that the worst is well behind us and industry demand will start growing again.

At the BCSA's Annual General Meeting President Jack Sanderson predicted growth of 4% next year followed by 5% in 2013 (see News). This will bring steel construction back to the one million tonnes of output a year level, unimportant as a number in itself, but after what the industry has been through one million tonnes of quality constructional steelwork has a nicer ring to it than the bell tolling of recent years. Expect the SSDA entries to ring the changes and keep getting better and better.

NSC

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STRUCTURAL STEEL DESIGN AWARDS 2011

Steel projects prove their worth at awards

The Structural Steel Design Awards celebrated its 43rd year showing yet again that steelwork is the framing material of choice for imaginative and high profile projects.

Awards were presented by journalist and television presenter Susanna Reid at a ceremony at Kings Place, London on 7 July. Judges selected the Award winning entries from a shortlist of 18, all of which scored highly in efficiency, cost effectiveness, aesthetics, sustainability and innovation.

Judges Chairman David Lazenby said the 2011 entries compared well with those of any year since the awards scheme was launched in 1969. He said: "The old saying "when the going gets tough, the tough get going" is well illustrated by the entries for this year's Structural Steel Design Awards. The skill, imagination and determination of these project teams is remarkable, at a time when the steelwork industry has inevitably been affected by the current economic climate.

"We have seen very high quality commercial offices, stadia and other sports facilities, large public buildings and interesting bridges. Adding a key rail station, an enormous distribution centre, a waste-to-energy plant and two remarkable structural sculptures, we have as good a collection of projects as most of us can remember."

"I have no doubt that the SSDA scheme has been an important stimulus to the steelwork industry over the years, and the results are clear to see. All the teams can be proud of the outcomes which are really praiseworthy and the judges have been heartened by them. We hope that everyone will share our enthusiasm."

The evening's opening address was given by Dr Henrik Adam, Chief Commercial Officer of Tata Steel Europe. He said he was proud of steelwork's success and attributed this to Tata Steel's work with customers and trade associations, such as the BCSA.

"Our close partnership is one of the reasons that the UK construction industry has the highest structural steel intensity in the world. Over 70% of multi-storey commercial buildings and virtually all single-storey sheds have a steel frame. We also see here tonight, that steel is the choice for bridgeworks, stadia and other iconic structures."

Chairman of the Judges, David Lazenby

Host, Susanna Reid

Chief Commercial Officer for Tata Steel Europe, Dr Henrik Adam

AWARDS

- American Express Community Stadium, Brighton
- Cannon Place, Cannon Street Station, London
- Exposure, Lelystad, The Netherlands
- Marks & Spencer Distribution Warehouse, ProLogis Park, Bradford

COMMENDATIONS

- ExCeL Phase 2, Royal Victoria Dock, London
- The Hauser Forum, Cambridge
- The St Botolph Building, London,
- River Suir Bridge, N25 Waterford Bypass
- The Rose Bowl, Southampton

CERTIFICATES OF MERIT

- New Cross Gate Flyover, East London Line
- 2010 Festival of Speed Sculpture, Goodwood

The award winning teams

American Express Community Stadium, Brighton

Cannon Place, Cannon Street Station, London

Exposure, Lelystad, The Netherlands

Marks & Spencer Distribution Warehouse, ProLogis Park, Bradford

Students show innovation in steel design

The 2011 Tata Steel/BCSA Student Awards, organised by the Steel Construction Institute and supported by the Institution of Structural Engineers and the Institute of Civil Engineers were also awarded at the same ceremony as the SSDA's on 7 July.

The competition, as always, was divided into two steel categories - Structures and Bridges. The Structures category required students to prepare an outline design for an aquatics centre, while for the Bridges category students had to design a single carriageway structure across a loop in a river.

The Structures first prize went to the University of Sheffield, whose entry was described by the judges as well presented with a very clear artist's impression. Second place went to University of Manchester, with Queens University Belfast collecting the third prize.

The Bridges category was won by the University of Bristol, with the judges panel, chaired by Barry Mawson of Capita Symonds, commenting that the multi-arched open spandrel structure suited the site well.

Second place in the Bridges category went to University of Southampton with University of Liverpool collecting the third prize.

Winners of the Bridges category, University of Bristol, collect their prize flanked by Jack Sanderson, BCSA President (far left), Dr Henrik Adam, Chief Commercial Officer of Tata Steel Europe and Susanna Reid

University of Sheffield pose with Susanna Reid after winning the Student Awards' Structures category

AROUND THE PRESS

Construction News
19 May 2011
Dramatic challenges on new BBC studios
"Since the BBC decided on this site we have worked closely with its programme-makers to ensure they get exactly what they need," says Bay Associates Director Martin Watkins. Steel frame trusses with typical spans of 25-30m help support the large imposed loads delivered by the studio lighting, camera and air-conditioning systems.

Building Magazine
27 May 2011
Shard
At level 70 the structure switches back to steel as this area accommodates a triple-height viewing gallery. Above this sits the 15-storey high prefabricated spire. This houses a second triple-height viewing gallery at its base which is partially open to the elements at the sides. Level 87 is the top storey. Above this steelwork continues to support the Shards' shards of cladding that terminate at different heights to give people the impression the building fades into the clouds.

Transportation Professional
July 2011
Glasgow cheers completion of vital M74 link
Port Eglinton viaduct is the largest bridge on the project. It is 750m long and carries the M74 over a number of streets and railway lines including the West Coast Mainline. For much of its length the steel box girders were lifted into position using a 1200t crane positioned at street level, but a 200m section was built by launching the beams, using jacks to pull them over the roads and rail lines.

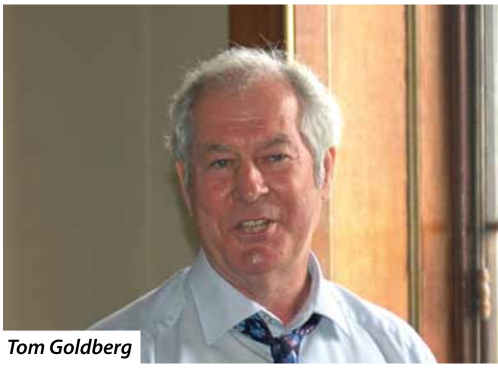
Construction News
23 June 2011
Farringdon on track for the Olympics
But this is no ordinary steel framed building - as the huge 60-tonne prismatic girders that provide the support for the street level slab show. Encased in concrete, these elements have been craned into position by steelwork specialist Bourne Steel with the help of a 600-tonne capacity crawler crane sitting on the site.

Positive outlook for steel construction


Ivor Roberts, BCSA's new President


Ian Hoppé, BCSA's new Deputy President


Oliver Tyler


Tom Goldberg

Steel construction output, for small and medium sized projects in the private sector, is expected to see a significant improvement during 2012.

Speaking at the BCSA's Annual General Meeting (AGM), Jack Sanderson, BCSA President, said: "Output fell slightly last year from 926,000t to 919,000t and is expected to remain relatively stable in 2011. We expect output to increase by 4% in 2012 and again by a further 5% the following year, taking us back to around the one million tonnes level by 2013."

Mr Sanderson also reminded Members of the work the Association has been doing, this includes the joint cooperation with Tata Steel on steel construction market development which is now firmly established.

"During the past year our work on sustainability has been dominated by the Target Zero project," he said. "This £1M study, which determines the most cost effective combinations of materials and technologies needed to make low and zero carbon buildings is now complete."

Guidance reports are available at *www.targetzero.info* covering a variety of building types.

At the AGM it was announced that Ivor Roberts, Managing Director of Nusteel Structures has been elected as Mr Sanderson's successor as BCSA President. Ian Hoppé, Director at Rowecord Engineering was also elected as the new Deputy President.

On the same day, the BCSA also hosted its Annual Lunch where Tom Goldberg, former BCSA President and Oliver Tyler, Director at Wilkinson Eyre both gave presentations.

Mr Goldberg gave his views on China and India, and whether these markets were a threat or an opportunity to the UK steel construction sector. Mr Tyler presented some of his favourite structures and explained how they had influenced some of his designs, while also pointing out his views on the good and bad points of steel.

Fire protection laboratory creates centre of excellence

International Paint has opened its new £6.4M fire protection laboratory in Tyne & Wear, creating 14 new jobs and safeguarding a further 30.

"The facility significantly improves our ability to develop new fire protection products for the market," said Dipak Mistry, Technical Manager for International's Protective Coatings business. "The new laboratory will give us a state-of-the-art centre of excellence for fire protection product development."

The fire protection market for steel structures is expected to grow rapidly, according to International Paint, due to increasingly stringent fire protection regulations. Forecasters expect demand to double by 2018.

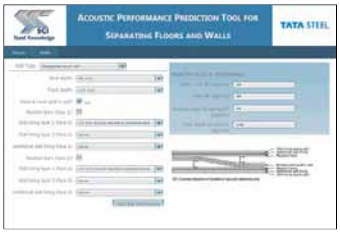
The new laboratory will complement International Paint's current fire protection capabilities, which include structural and fire engineering experience, estimation expertise and corrosion performance knowledge. By integrating into design contract chains and working alongside owners, architects, design engineers and steel fabricators, International says it draws on these resources to offer a much broader fire protection service than just coatings supply.

On-line tool for acoustic performance in construction

Tata Steel and the SCI have jointly developed an on-line tool to provide structural engineers and architects with a quick and easy-to-use system for working out the likely level of acoustic performance for various forms of construction.

The new tool is able to estimate the acoustic insulation provided by different combinations of materials used in the construction of steel walls and floor systems, allowing the user to carry out a 'what if' analysis before embarking on a detailed design.

Flooring choices include Tata Steel's Slimdek system, composite flooring and a number of light steel systems. Users can



also select from a range of floor treatments and ceiling options. Wall forms involve single or twin studs, with or without acoustic quilting, and a range of different boarding options.

The values predicted by this on-line tool are only intended to be used for preliminary design purposes because there are many other factors besides specification of the wall or floor format that will affect acoustic performance such as junction details, exact specification of products, adjoining construction form and workmanship during construction.

The tool uses empirical interpretation of test data from structures in the residential, health and school sectors to predict the acoustic performance of the user's chosen arrangement so although these additional factors are not specifically included, their effect is built in to the underlying data allowing a realistic assessment to be made.

To access the tool go to: *www.tatasteelapps.com/*

Fire seminars to boost industry awareness

The British Constructional Steelwork Association will be bringing together a number of fire engineering specialists at two free seminars, to be held in London and Leeds, to raise industry awareness of their work and to discuss some recent projects.

"Extensive research on the behaviour of steel structures in fire has created a situation in the UK where fire engineering specialists can offer increasingly sophisticated and cost effective solutions for fire precautions in buildings," said John Dowling, BCSA Sustainability Manager.

The events will feature speakers from fire engineering experts Buro Happold, Arup, and WSP explaining their latest techniques, and giving case examples.

There will also be a presentation given by Wilf Butcher, Director of the Association for Specialist Fire Protection, highlighting the work that his organisation is doing to promote and maintain standards within the fire protection sector.

Other contributions will include speakers from the BCSA's technical staff, and fire engineering experts from Buro Happold, WSP and Arup.

The seminars will be held at the Thorpe Park Hotel, Leeds on Wednesday 14 September, and at the Wellcome Conference Centre, 183 Euston Road, London on Wednesday 21 September.

To register or for more information contact: *events@steelconstruction.org*

Steel frame quickens hospital extension

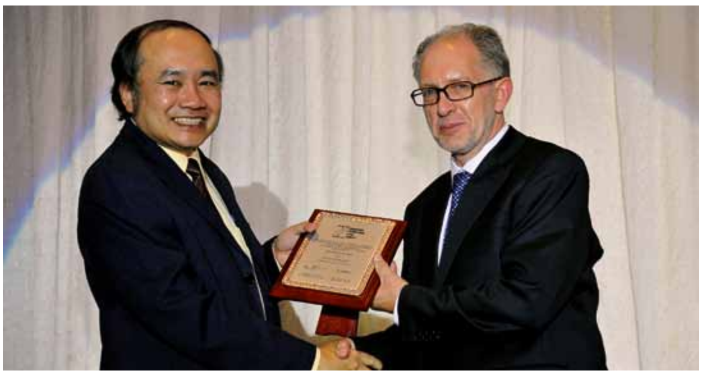
Due to open next year, steelwork has been completed on a £30M extension at Kettering General Hospital.

Working on behalf of main contractor Interserve, Hambleton Steel has erected 300t of structural steelwork for the three-storey building. The extension, which is a stand-alone structure, will be linked into the existing hospital buildings via a steel footbridge.

The project was awarded as part of the ProCure21 framework and involves the hospital improving and relocating its intensive care facilities and children's wards into the new purpose built unit. The new facilities will include an intensive care unit with 16 beds and two isolation rooms, and an integrated paediatric unit with a total of 32 beds including surgical and medical wards.

Dr David Moore, BCSA's Director of Engineering (right) is made an Honorary Fellow of the Singapore Structural Steel Society (SSSS), at its annual dinner, held in the city state on 27 June.

The honour, presented by Ho Wan Boon, President of the SSSS, was given by the society in recognition of his technical expertise and outstanding contribution to developments in structural engineering.



NEWS IN BRIEF

Tata Steel has supplied 1,500m² of Colorcoat Prisma and Colorcoat HPS200 Ultra pre-finished steel to Anglian Water for replacement roofs at two reservoir drinking water storage units. Colorcoat Prisma is the first steel product to have been independently certified in accordance with the Water Regulations Advisory Scheme as being suitable for use in contact with drinking water.

SCI engineers Mark Lawson and Andrew Way have been awarded the Howard Medal for their paper 'Durability of Light Steel Framing in Residential Applications' which appeared in ICE Construction Materials. Additional authors were Remo Pedreschi of the University of Edinburgh, Sunday Popo-Ola of Imperial College and Trevor Heatley, who worked at Tata Strip prior to retiring. The paper was the outcome of monitoring of various test buildings and showed that galvanised steel has a design life of more than 100 years in an internal environment and in the building envelope.

Tata Steel has announced the publication of its new technical paper – 'The Role of the Building Envelope in Part L 2010 Compliance' – which takes an in-depth look at the latest amendments to Part L 2010 and considers the specific role of the building envelope in achieving CO2 emissions compliance. The recent 2010 amendments to Part L2A (Conservation of Fuel and Power) of the Building Regulations requires an overall or aggregate 25 per cent reduction in CO2 emissions from non-domestic buildings. The technical paper provides a detailed evaluation of the carbon emission reductions generated by improvements to the building lighting efficiency and control systems compared with the reductions that can be achieved through building envelope enhancements.

Big launch completed at London Bridge

Work to increase train capacity in and around the busy London Bridge Station continues apace as a new steel bridge was launched into position during the recent Bank Holiday.

Fabricated and installed by Watson Steel Structures, the bridge is 72m long, 6m high and weighs 1,200t. Moving the assembled steel bridge started at 2am on Saturday morning and the adjacent road was then re-opened to traffic by 5am the following Tuesday.

The complicated engineering operation saw the bridge travel an average of 7mm per second using specialist jacking machinery, provided by Mammoet, before being lowered into place, creating a new landmark.

Martin Jurkowski, Network Rail Project Director said: "The new bridge will double the number of tracks coming out of the western end of London Bridge station, unlocking a major bottleneck and allowing us to provide two dedicated tracks for Thameslink services."

The bridge is part of the 507m-long Borough Viaduct which runs above the highly built up Borough Market area of south London.

Projects in challenging environments triumph at Galvanizing Awards

Winners of the eighteenth annual Galvanizing Awards, announced at a ceremony held at the Royal Aeronautical Society, London were all traditional structures located in challenging locations.

There were five winners with Heron Court in Thamesmead [1], south east London picking up the Architecture Award. The project by Bell Philips Architects is situated in an area long vilified for its rapidly built council housing. The judges said the use of galvanized metal frames and stairwells are a joy to behold as well as producing a sublime combination with the timber cladding.

LSI Architects' use of galvanized steel in combination with timber for a house on a flood plain in the Norfolk Broads [2] was enough to win it this year's Sustainability Award.

The other winning projects were Elder and Cannon's Housing Association offices in Glasgow [3] which won the Detail Award; Daragh and Muldowney's Clongriffin Dart Station in Dublin [4], winner of the Duplex Award; and the Exposure statue [5] (See also SSDA Awards page 16) which won the Engineering Award.

Jan-Carlos Kucharek of RIBA Journal and a member of the judging panel, said: "Galvanizing, highly suited to use in more robust and unforgiving environments, is constantly challenged to prove its mettle, and in various ways this year's winners do exactly that."

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Diary

For all SCI events contact Jane Burrell, tel: 01344 636500 email: *education@steel-sci.com*
For BCSA Events: To reserve your place e-mail your contact details to *events@steelconstruction.org* quoting your preferred venue e.g. 'Birmingham'. For queries, please contact the event team on 0207 747 8131.

BCSA TATA STEEL

14 September 2011
Fire Engineering Seminar
Thorpe Park Hotel,
Leeds

BCSA TATA STEEL

21 September 2011
Fire Engineering Seminar
Wellcome Conference Centre,
183 Euston Road,
London

Structural Steel Design Awards 2011

Introduction

by David W. Lazenby CBE - Chairman of the Judges

The old saying "when the going gets tough, the tough get going" is well illustrated by the entries for this year's Structural Steel Design Awards. The skill, imagination and determination of these project teams is remarkable, at a time when the steelwork industry has inevitably been affected by the current economic climate..

The judges selected 18 projects for the shortlist, spread across the UK and the Republic of Ireland and Holland, covering a wide range of structural types, and once again demonstrating steelwork's adaptability and economy, and its relevance to so many situations. We have seen very high quality commercial offices, stadia and other sports facilities, large public buildings and

The Judges

Chairman of the Structural Steel Design Awards judges **David Lazenby CBE** had a distinguished career as a consulting engineer before taking a new turn in the late 1990s to give British Standards new focus and direction. He also led the huge pan-European exercise to develop the Eurocodes, as Chairman of the lead European committee.

David Lazenby's career began with Balfour Beatty in 1959. In 1964 he moved to consultant Andrews Kent & Stone, where he stayed for 30 years and became managing partner and subsequently a director. In 1990–91 he was one of the youngest ever Presidents of the Institution of Structural Engineers.

In parallel he had become involved in developing codes and standards, advancing from technical committees and sector boards to become a non-executive director of BSI Group.In 1997 he became the Director of British Standards, one of three executive directors of the group responsible for over 5000 staff in 100+ countries, and a budget of £300+M.

His experience both as a user of standards and as a committee and board member helped him to bring a new focus on market relevance and he is credited with bringing global success to the organization. Establishing it as a world leader in its field, as well as making it profitable, has been almost unique among national standards bodies.

Since 2003 he has operated his own consultancies, Eurocode Consultants, and DWL Consultants, in the fields of company management, and certification

Martin Manning is a Structural Engineer.

He is an Arup Fellow. He joined the firm directly from university and for over 40 years has worked in Arup offices, and on projects, around the world, most recently on buildings in the transport sector.

He is the Chairman of the SCI, a Fellow of the Royal Academy of Engineering and a Member of The Institution of Structural Engineers

Gerry Hayter has spent his career in transport, mainly in London. He joined London Underground as a civil engineering graduate in 1975, working on the design of railway bridges, lifts and stations. After 10 years he joined the Bridges Engineering Division of the Department of Transport where he developed new standards for the design, assessment of highway bridges and structures for 40 tonne lorries. In 1994 he joined the London Network Management Division of the Highways Agency, responsible for the maintenance of highway structures in West London. A number of senior technical posts at the agency interesting bridges. Adding a key rail station, an enormous distribution centre, a waste-to-energy plant and two remarkable structural sculptures, we have as good a collection of projects as most of us can remember.

Client satisfaction, always the key to success, has been the trigger to motivate team cooperation. Technical boundaries have been extended on some schemes using the latest codes and technologies, thus providing new benchmarks for the future. The challenge of international cooperation has become an unavoidable part of life in many industries, and we see some aspects in the steelwork for the overseas projects.

I have always encouraged a "can do" approach by the whole team. The judges have been impressed by the positive attitudes so well displayed on these projects, as well as vigour, professionalism, innovation and responsiveness. This has never been more important, nor has it been more demanded by clients.

I have no doubt that the SSDA scheme has been an important stimulus to the steelwork industry over the years, and the results are clear to see. All the teams can be proud of the outcomes which are really praiseworthy and the Judges have been heartened by them. We hope that everyone will share our enthusiasm.

Pictured: The St Botolph Building, London

followed, culminating in his present position as Group Manager of the Knowledge Management Group, with responsibility for the development of the Agency's £23m knowledge programme.

Bill Taylor joined architect Michael Hopkins in 1982 straight from Sheffield University School of Architecture and became his partner in 1988. He worked on and was responsible for a large number distinguished, award winning projects including The Mound Stand at Lord's, Inland Revenue Headquarters and the University Jubilee Campus, both in Nottingham, City Art Gallery, Manchester and the Applied Research Facility at Northern Arizona University. After completing the National Tennis Centre at Roehampton, Bill left his role as Managing Director with the practice in Spring 2010 to concentrate on his own projects. A recipient of a number of Structural Steel Design Awards, he is a member of the RIBA Awards Group, is an Assessor for the RIBA Competitions programme and was a founding member of Tensinet, the pan European research organisation which researches lightweight structures and membrane architecture.

Joe Locke retired in 2004 from his position at William Hare, where he was responsible for the engineering aspects of the company's activities and also Executive Director of subsidiary Westbury Tubular Structures; having previously retired in 1998 as Chief Executive Officer of Watson Steel. Joe was an apprentice with Watson and sat his associate membership of the

Institution of Structural Engineers at only 23. Joe worked at home and overseas on a considerable number of high prestige contracts, including Sellafield nuclear power station's massive thermal oxide reprocessing plant and the terminal building of Kansai airport, Japan. Joe Locke was awarded an MBE in 1990 for his contribution to the structural steelwork industry. In 2007 he recieved a Gold Medal of the Institution of Structural Engineers.

Oliver Tyler joined Wilkinson Eyre Architects (WEA) in 1991; he became an Associate in 1997 and then a Director in 1999. He has over 25 years experience in architectural practice and extensive experience in leading and coordinating the design and construction of high profile buildings and infrastructure projects.

Oliver has led a number of prestigious projects at WEA including Stratford Market Depot and Stratford Regional Station in London for the Jubilee Line Extension; the Dyson Headquarters in Wiltshire and the Arena and Convention Centre in Liverpool - the centerpiece for the city's 2008 Capital of Culture celebrations.

He is currently Director in charge of WEA's Crossrail Liverpool Street Station Project, the proposed new cable car crossing over the River Thames and a number of major sport and commercial developments.

American Express Community Stadium, Brighton

Brighton's new football stadium sits comfortably within the South Downs and its curving roof shows off the extremely well executed steelwork.

One of the longest running stadium sagas in English football has now ended with the completion of the American Express Community Stadium. Brighton & Hove Albion will kick off this coming season in a new 22,500 seater stadium after a torturous 14 years of ground-sharing and numerous public enquires which finally resulted in work beginning at the Falmer site.

Martin Perry, Chief Executive at Brighton & Hove Albion FC describes the construction of the new stadium as a dream finally being turned into reality. "We've fought long and hard for this project. There have been a few false starts along the way but now we can definitely plan ahead for life in our new stadium."

Steelwork provides the signature element of the project, in particular the roof which is an undulating and sloping structure said to reflect the local land fall of the South Downs. Two large 170m long arched roof trusses span either side of the stadium, above the West and East Stands. The smaller North and South Stands have conventional cantilever roofs, but all four sides are interconnected.

"The trusses support the roofs over the two main stands," explains Watson Steel Structures Contracts Manager Peter Riley. "But tying the whole roof structure together is a ring of steel which passes around the back of the entire stadium. Until the whole roof steelwork was up, the roof structures had to be supported by temporary works."

The roof trusses were delivered to site 'piece small' and then assembled into three liftable sections each weighing approximately 120t. These sections were then lifted onto a pair of 20m high temporary trestles located at 'third-points' on the concrete terracing.

Holding the truss in position at either end are two heavily reinforced 'thrust walls' which have been partially buried into the ground. Cast-in plates connected to steel bearings, weighing seven tonnes each and designed to resist a thrust of 20,000kN (2,000t) - connect to either end of the steel truss.

"Only when the entire roof structure was completed could it be de-jacked and the temporary trestles removed from below the west and east roofs, allowing the 'thrust walls' to take up the load," adds Rob Hazell, SKM Project Manager. This process was carefully controlled with each iteration of the de-propping carefully monitored against predicted loads and movements.

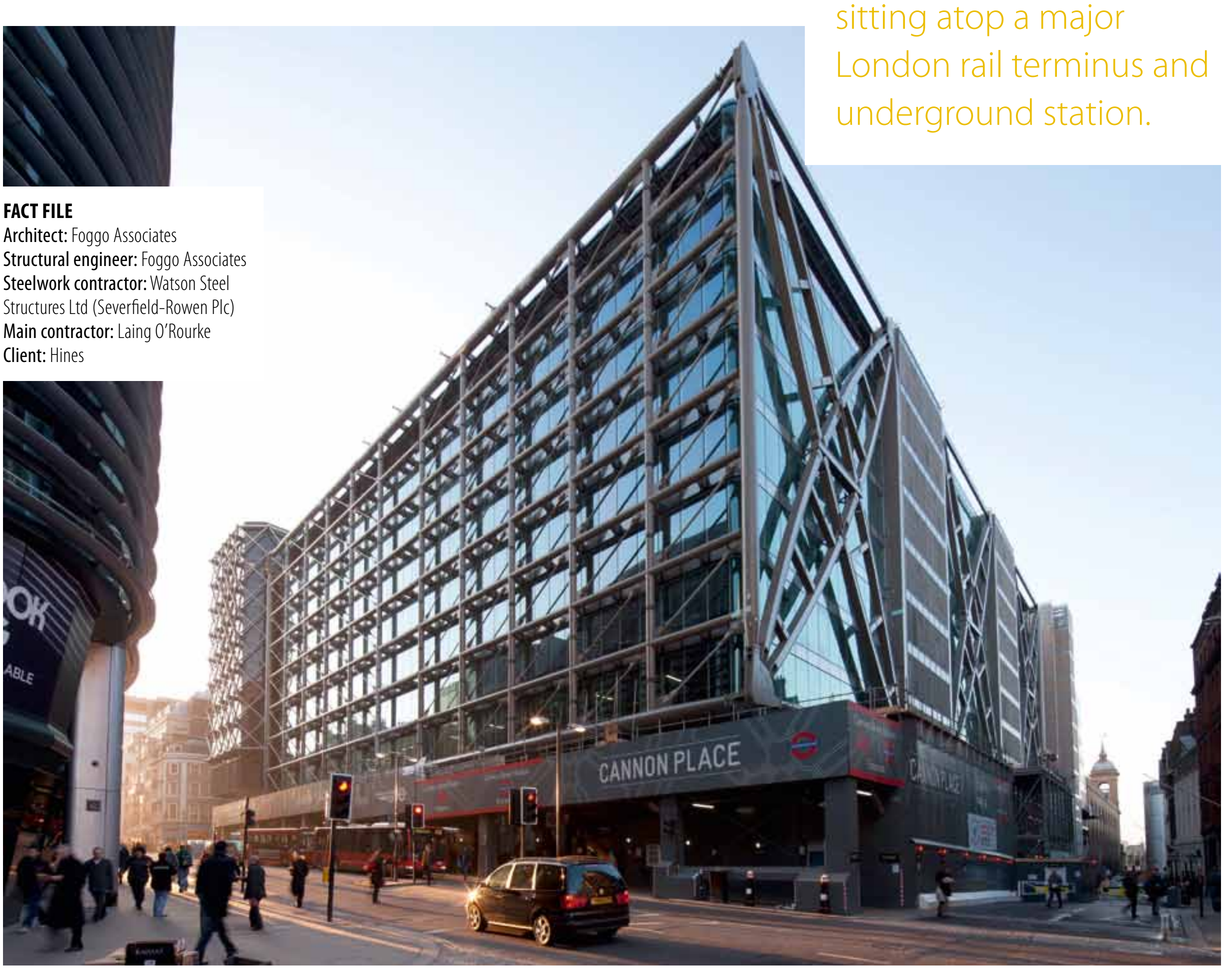
Initially the weight of the roofs were transferred onto sets of jacks installed on four temporary trestles. The roofs were then lowered in approximate 20mm increments at each of the four trestles in turn. Extreme caution was required to ensure that the loads remained equally distributed between the trestles and that temporary forces being induced into the truss members above each trestle did not approach the safe capacity.

The judges say this is a well conceived and executed steelwork project, demonstrating close and effective cooperation in the team, bringing success for client and public.

FACT FILE
Architect: KSS
Structural engineer: SKM (Europe) Ltd
Steelwork contractor: Watson Steel Structures Ltd (Severfield-Rowen Plc)
Main contractor: Buckingham Group Contracting Ltd
Client: Brighton & Hove Albion Football Club

Cannon Place, Cannon Street Station, London

A highly innovative steel design was required for an eight-storey commercial project sitting atop a major London rail terminus and underground station.



FACT FILE
Architect: Foggo Associates
Structural engineer: Foggo Associates
Steelwork contractor: Watson Steel Structures Ltd (Severfield-Rowen Plc)
Main contractor: Laing O'Rourke
Client: Hines

As with most construction projects in the City of London, Cannon Place had to cope with a host of challenges such as limited space, busy surrounding streets and, uniquely in this case, a functioning railway station in the midst of the site.

Sitting above Cannon Street Station, one of the capital's busiest rail terminuses, a new eight-storey office building has been constructed along with a new concourse and tube station entrance.

"The project's location was one of the main challenges," says Giles Fazan, Hines Construction Director. "We had to keep everything open to commuters and this was achieved by doing much of the work during nighttime and weekend possessions."

Before work could start on the new structure an existing 15-storey office block situated above the station had to be demolished.

"We then had to programme the next stage to suit the best way of keeping the station functioning normally," adds Andrew Veness, Laing O'Rourke Project Director. "A new deck was installed during nighttime shifts to avoid any passenger disruption, using a series of 21m long Fabsec cellular beams."

This new station roof or deck has been described as resembling a giant table as it is supported by four large 17m long steel columns which were threaded through the station platforms.

"We needed a lightweight solution and that's why we chose steel for the framing material," explains Mr Veness. "The cores are also steel because we needed a lighter solution as they are founded on old foundations and we had to limit the loads."

The tabletop deck, which measures 67.5m along its north and south elevations, supports the majority of the steelwork for the new structure.

Watson Steel Structures' steel erection programme, initially involved erecting the central area of the building (above the tabletop) up to the topmost eighth level. Once this was completed, two 21m wide x 67.5m long cantilevers were erected to the north and south elevations.

From the completed middle part of the frame, the cantilevers were formed by first erecting the tips of the cantilever and the bottom boom of the lowest floor, supported on temporary works. These were then attached by strand jacks to the top of the completed frame, thereby holding the cantilever in place and allowing temporary works to be removed.

There were 12 hydraulically computer operated jacks positioned on each elevation and as the two cantilevers were progressively erected, the increased loads meant the jacks absorbed the extra loads and deflected them into the already completed parts of the structure.

The east and west elevations of the structure both feature three large cross bracings, known as X-frames, formed by two 16m long beams bolted together in the middle. Meanwhile, the front elevations of both of the cantilevers are formed by storey high trusses which help keep the spans rigid and pick up the loads from the secondary beams and transfer them to the X-frames.

In summary the judges say, the structural concept was heroic, the appearance is striking, and the site constraints were remarkable. A huge challenge, outstandingly well answered with steelwork.

Exposure, Lelystad, The Netherlands

FACT FILE
Artist: Antony Gormley Studio
Structural engineer: Haskoning Nederland BV
Steelwork contractor: Had-Fab Ltd
Main contractor: Had-Fab Ltd
Client: Municipality of Lelystad

A complex arrangement of hundreds of galvanised angle sections form a steelwork sculpture inspired by an artist's own crouching body.

Standing 25.6m-high, Antony Gormley's crouching man sculpture, known as Exposure, contains 500 steel nodes with connections requiring some 16,000 bolts.

A remarkable structural sculpture, say the judges and one which became a 'labour of love' for the whole project team.

The sculpture, based on Antony Gormley's own body, was designed in collaboration with Cambridge University and Royal Haskoning in The Netherlands. This design was then transferred directly onto Had-Fab's Tekla software package for detailing.

Had-Fab says it has many years experience of producing complete structures, fixtures, fittings and towers for power and telecommunications. However, with a project as complex as this one a web viewer tool was essential to provide the structural engineers with 3D details of the nodes, so they could confirm that the construction met their design requirements.

"We'd been in contact with Mr Gormley discussing this project for about five years," says Had-Fab's Managing Director Simon Harrison. "Numerous companies were initially contacted by him to produce the complex steelwork but most refused the job after completing feasibility studies."

The sculpture is constructed entirely from steel angle profiles with every single one a different length and produced from sections varying in size from 60mm × 60mm up to 200mm × 200mm.

It is made up of 547 nodes, the largest of which were known as the 'heart' node, weighing some 280kg and the 'brain' node, which weighed 56kg. "Producing these 2.5m diameter nodes was extremely time consuming as some of them had 29 angles meeting together to form locating points around the structure which had to be bolted and welded into position," explains Mr Harrison.

The total weight of the steel structure is 60t, but this conservative total required 32,000 holes to be punched or drilled in the angle profiles.

The completed structure was trial erected at Had-Fab's facility following the hot dip galvanizing process of the 5,000 elements. The structure was then disassembled and transported to Lelystad and erected two weeks ahead of schedule. It needed approximately 17,000 nuts and bolts to complete the final assembly.

"This one-off structure epitomises the way software, machine technology and manual fabrication techniques can work together," sums up Mr Harrison. "The challenges of the design, detailing, equipment performance and fabrication were extensive."

Marks & Spencer Distribution Warehouse, ProLogis Park, Bradford

One of the largest distribution centres in the UK required a sophisticated and highly accurate steelwork design, one which also needed to include an extremely quick erection programme.

Situated on the ProLogis Park Bradford, the 92,000m^2 Marks & Spencer distribution centre measures 512m × 176m and is said to be one of the largest warehouses ever built in the UK.

Work on site began in early 2009 and the facility was officially opened in July 2010. Speed of construction was always of the essence for this project and the steel framed structure was erected in 12 weeks.

"We needed to erect approximately 30,000m^2 of steelwork every week to achieve our target," says Barrett Steel Buildings Joint Managing Director John Brennan. "Feeding the project with sufficient steel was a logistical challenge, while on site we had to have nine erection gangs."

In order to achieve the required erection programme meticulous planning was also called for and Barrett Steel Buildings - the steelwork design and build contractor - undertook a risk analysis to minimise the effect of any potential errors.

One of the main challenges associated with the steelwork design arose, unsurprisingly, due to the shed's size and proposed usage. The client wanted to maximise internal space and to that end no internal cross bracing was permitted.

Barrett had to design a complex system of roof bracings which allow the wind loads to be distributed to a series of side bracings, positioned to miss doors, offices and windows.

One of the project's main features is the roof which includes a series of rafters which are all preset for vertical deflection between the ends of the haunches. This maintains a positive slope for the entire steel roof structure. Although the roof is curved there was a client stipulation that there could not be any negative slopes, as this would create ponding.

Barrett also quickly identified that the combination of a very shallow curved roof over a huge span added up to a few unique design issues.

Firstly, the cold rolled purlins had to run straight, avoid rotation between supports, be pitched at differing points along the rafters, and had to be set vertically at exactly the correct level.

"This meant that every purlin cleat was unique and had to be individually numbered. This unique reference was scribed into the rafters during production to once again minimise the effects of assembly error," adds Mr Brennan.

Future expansion and adaptability also played a big role in the design, as BWB Consulting Project Engineer Dom Ginty explains: "The steel frame has been designed to accept an additional four levels of mezzanine tied to the portal frame at first floor level."

Summing up the project, the judges say the exterior conceals the sophistication of the engineering design, fabrication and erection for economy and speed. The extremely slender columns, at wide spacing, soar upwards to support a very light curved roof, avoiding valley drainage. The steelwork is outstandingly light and may well become a benchmark for such projects.

FACT FILE
Architect: Stephen George & Partners
Structural engineer: BWB Consulting
Steelwork contractor: Barrett Steel Buildings Ltd
Main contractor: Winvic Construction
Client: ProLogis Developments Ltd

ExCeL Phase 2, Royal Victoria Dock, London

The use of steelwork was paramount for the construction of Phase 2 at London's ExCeL, where a series of new column free spaces, which can be subdivided as necessary, have successfully remodeled the structure into a multi-purpose venue.

The construction of Phase 2 at London's ExCeL has increased the venue's overall floorspace from 65,000m^2 to an impressive 100,000m^2, making it the second largest venue scheduled for use at next year's Olympic Games.

Central to the new extension are two new halls, both featuring 86.9m column free spans. These halls can both be subdivided into smaller exhibition spaces via moveable partitions, allowing the venue maximum flexibility.

Speed of construction was important for this project and the steel framed superstructure was fully erected in just over four months and a fully covered working enclosure delivered six weeks later. With the Phase 2 venue pre-booked for the day after practical completion for X-Factor auditions, the building was fully constructed in just 22 months.

Forming the venue's clear spans are a series of 86.9m-long trusses supported at third point by structural masts (or A-frames), which also pick-up the grid of suspended demountable hall partitions.

A similar structural configuration was used on the initial ExCeL venue, but on this phase the masts have been placed within the steel frame, instead of along the perimeter.

"The mast design was different as we were constrained by the proximity of City Airport to the south and overhead power cables to the north," explains Matthew Allen, Engineer for McAlpine Design Group.

According to project architect Grimshaw, changing the mast positions also removed the need for tie down members and increased structural efficiencies through a balanced structural system. The use of ETFE pillows (largest in UK to date) exposes the main mast nodes to public view from the main boulevard.

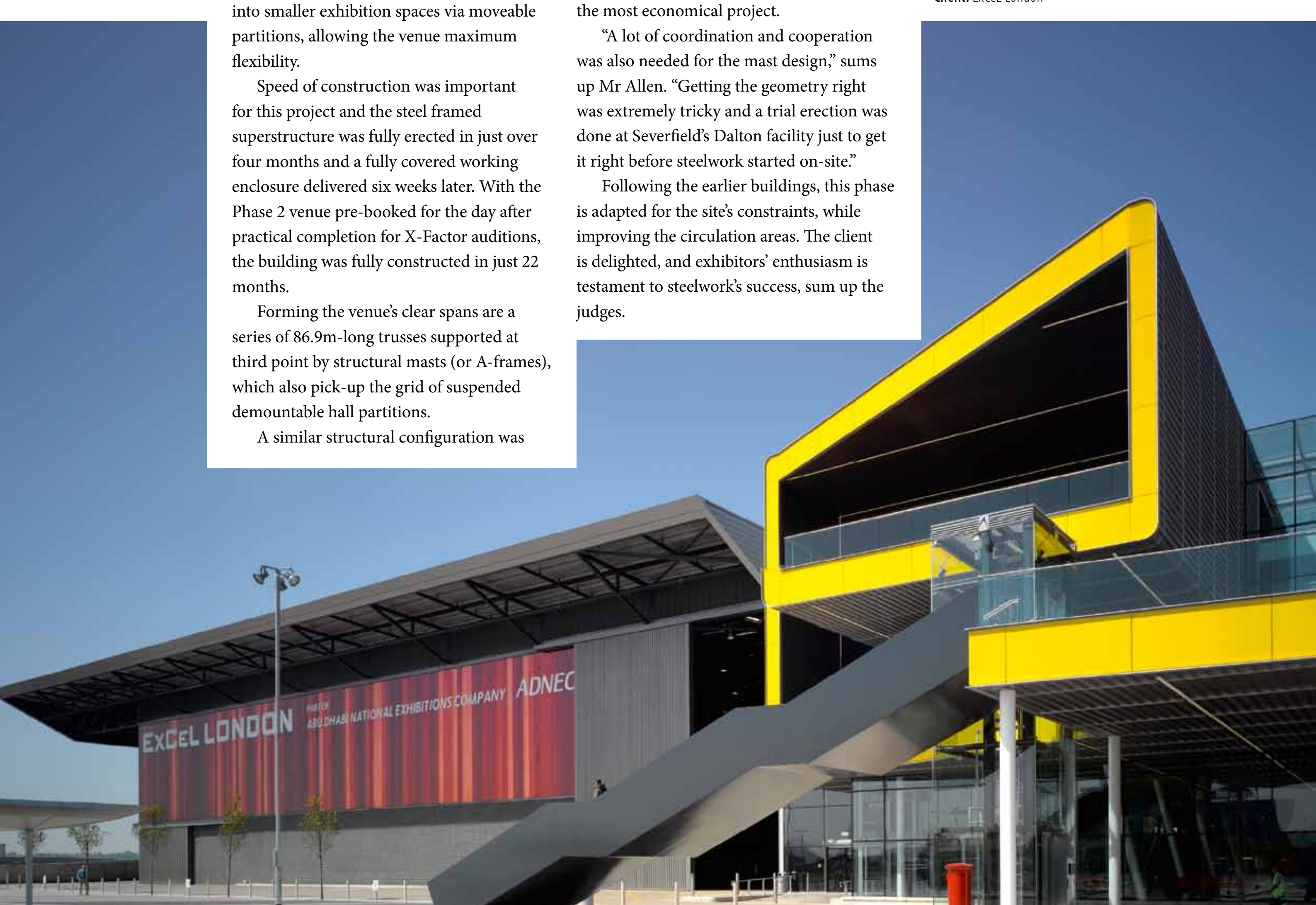
The eastern elevation of Phase 2 features a stand-out architectural feature known as the spiral, which accommodates foyer and boulevard facilities and is said to bring the facade to life. Formed with vertical raking columns, the spiral acts as a foyer floor, the mezzanine floor accommodating dining space, and a higher level foyer floor serving as a meet and greet area for the adjacent conference area.

Grimshaw says it worked with steelwork contractor Severfield-Reeve to refine structural details of the building to deliver the most economical project.

"A lot of coordination and cooperation was also needed for the mast design," sums up Mr Allen. "Getting the geometry right was extremely tricky and a trial erection was done at Severfield's Dalton facility just to get it right before steelwork started on-site."

Following the earlier buildings, this phase is adapted for the site's constraints, while improving the circulation areas. The client is delighted, and exhibitors' enthusiasm is testament to steelwork's success, sum up the judges.

FACT FILE
Architect: Grimshaw Architects LLP
Structural engineer: McAlpine Design Group
Steelwork contractor: Severfield-Reeve Structures Ltd (Severfield-Rowen Plc)
Main contractor: Sir Robert McAlpine Ltd
Client: ExCeL London



The Hauser Forum, Cambridge

FACT FILE
Architect: Wilkinson Eyre Architects
Structural engineer: Mott MacDonald
Main contractor: Willmott Dixon
Client: Turnstone Estates Ltd

Incorporating a strikingly large cantilever over an adjacent water feature, the Hauser Forum project has used structural steelwork to achieve all of its architectural aims.

A mixed-use development at the University of Cambridge's West Cambridge site, the Hauser Forum forms the latest stage in the expansion of the university's science and technology campus.

The project consists of two steel framed structures, the Cambridge Enterprise Building (CEB) that incorporates a double height cafe space which cantilevers 11m from the southern facade, and the Broers Building - a four-storey research and development office block.

Both buildings are visually connected by a high level steel canopy which covers a landscaped space between the two structures. As well as representing the connection between the two buildings, the canopy also serves a practical purpose in providing solar shading.

As well as the canopy, the project retains a large amount of exposed architectural steelwork. Aside from its aesthetic qualities, steel was chosen for both buildings to enable the project team to meet the architectural aspirations and to help achieve a very tight programme.

"The cafe cantilever was the overall the driver for steel," says Steve Buckley, Mott MacDonald Project Engineer. "It's a substantial 11m cantilever and would have been extremely difficult to achieve in any other material."

Supporting a double height fully glazed cafe, the cantilever in the CEB also includes a terrace extending beyond the building's enclosure. Delivering this architectural feature, while also meeting vibration limits for occupant comfort and deflection limitations for the proposed curtain walling system, led to significant analysis being completed by the design team.

Large steel trusses, using Macalloy tension rods as the diagonals, were used to form the cantilever. An additional pair of tie bars were added in the southern facade, these were needed to limit serviceability deflections of the 13.5m single span fabricated box floor beam.

Extensive consultation was needed with the construction team into how the cantilever could be built safely. It was erected on temporary props with a precamber of 35mm to counter overall dead load movements and to leave it with an aesthetically pleasing slight upward camber.

Once the cafe floor slab had been poured, the Macalloy rods in each elevation were stressed to lift the structure off its temporary seating, which allowed the props to be removed.

Another benefit of using steel for the entire project was the fact that the CEB's natural ventilation strategy needed to incorporate exposed concrete soffits, something readily achievable with a steel frame. "Ordinarily this would have driven us towards a concrete building, but we incorporated the concrete soffits into the steel frame by using the Tata Steel Slimflor system with voided Omnia precast slabs," adds Mr Buckley.

Summing up, the judges say this is a good example of practical steelwork design integrated into an intelligent solution.

The St Botolph Building, London

A large modern commercial building in the City of London has utilised steelwork's flexibility and long span qualities to achieve its uninterrupted floor plates and centrepiece atrium.

The client's brief for the St Botolph Building project was for a landmark City development featuring significant architectural merit, while providing flexible office space suitable for the insurance, banking and legal professions.

Overall the 13-storey building features approximately $52,000m^2$ of lettable space with a large expansive atrium, containing the world's largest twin lift installation, at its heart.

The project's steelwork is crisply detailed throughout the floors, glazed atrium bridges, and even to the slender lift core supports. This is an exceptionally stylish commercial building, showing steelwork to great effect, say the judges.

A large proportion of the project's steelwork has been left exposed, clearly displaying its structural function. In the central passenger lift core very tight construction and positional tolerances were achieved. This was necessary to get coordination between the four separate contracts that formed the building's centrepiece lift core: primary steel, architectural steelwork, cladding and the lifts.

FACT FILE
Architect: Grimshaw Architects LLP
Structural engineer: Ove Arup & Partners
Steelwork contractor: Severfield-Reeve Structures Ltd (Severfield-Rowen Plc)
Steelwork contractor for architectural feature steelwork: CMF Ltd
Main contractor: Skanska Construction UK Ltd
Client: Minerva Plc

The lift core is an innovative steel and glass structure visible throughout the building. The engineering of this structure is deliberately displayed with all of the steelwork and lift gear exposed against the calmer background of the atrium walls.

RHS members have been used to frame the atrium, but as there are considerably more loads further down the structure, fabricated box sections have been utilised for the lower levels.

"The fabricated box sections are stiffer and can accept greater loads, but they have been designed to look identical to the RHS members used on the higher levels," explains Arup Engineer, Richard White.

Meanwhile, at higher levels of the structure four atrium bridges brace the steel frame and provide access to the floor plates. The adjacent structures have been designed for future installation of additional bridges, allowing for future flexibility.

"The project's efficiency could not have been achieved without steel," says Mr White. "The steel frame allowed the large structural spans and uninterrupted floor plates, while the use of Fabsec beams meant all services were easily accommodated within the frame's structural void."

Externally the form of the building is said to be articulated along each elevation by the expression of perimeter service cores framed in steel with the stairs, lifts and boiler flues on display.

The steelwork of these elements is clearly articulated internally and externally. The perimeter stairs were designed as prefabricated steel assemblies, capable of spanning between framing members and bracing the perimeter core structures. This design eliminated the need for temporary works and early completion of the stairs provided safe access for trades following on behind the steel erection.

The innovative use of steel extended to the project's temporary works. Steel assemblies built on level eight of the building transferred the load of four tower cranes directly into the superstructure. This allowed the lower crane mast sections to be removed so that completion and fit-out of the floors below could commence early.

River Suir Bridge, N25 Waterford Bypass

The new cable-stayed road bridge over the River Suir forms an integral part of the Waterford bypass, and has played a major role in alleviating congestion in and around the Irish port.

After a number of years of consultation Waterford has a new river crossing which forms an important part of the 18km-long Bypass which opened in 2010.

The overall scheme includes a number of viaducts crossing smaller rivers and railway lines, and this led to feasibility studies to identify the best route for the major crossing of the River Suir. The selected location for the bridge was chosen mainly for engineering factors, but also as the best option for port traffic and the continuity of the bypass.

A cable stayed bridge was then chosen as it would require no piers and consequently it would have a reduced environmental impact. This design also provided the option of a reduced deck thickness, offering a greater navigation clearance of 14m.

The design of the bridge consists of a central 100m-high inverted Y-shaped tower which supports the 230m long main deck via cables arranged in an asymmetrical twin fan configuration. Overall the 465m long bridge has the distinction of being one of Ireland's longest span bridges.

The ladder deck structure carrying the dual carriageway across the entire span was made up of 80 main girder sections, each weighing approximately 18t.

"The fabrication of the main girders for the cable supported section included some elements of complex geometry in the hangar locations. With large welds and complex angles, dimensional control in these areas was critical," says Richard Selby, Mabey Bridge Head of Projects.

Two box sections at the north abutment, each weighing 170t, were manufactured at Mabey Bridge's workshop in segments and welded into full lengths on site. A total of 102 10t cross girders were made in full lengths of 20m, and due to the width of the road deck and in order to maintain as low a deck weight as possible, the tops of these girders were profiled to follow the camber.

Erection of the bridge was completed in two main stages. Firstly the back span, up to the central pylon, was erected from ground level, using mobile cranes to erect the steelwork which was supported on trestles. Once the precast slab had been completed on this portion, the front span was erected in cantilever from the pylon using a modular technique.

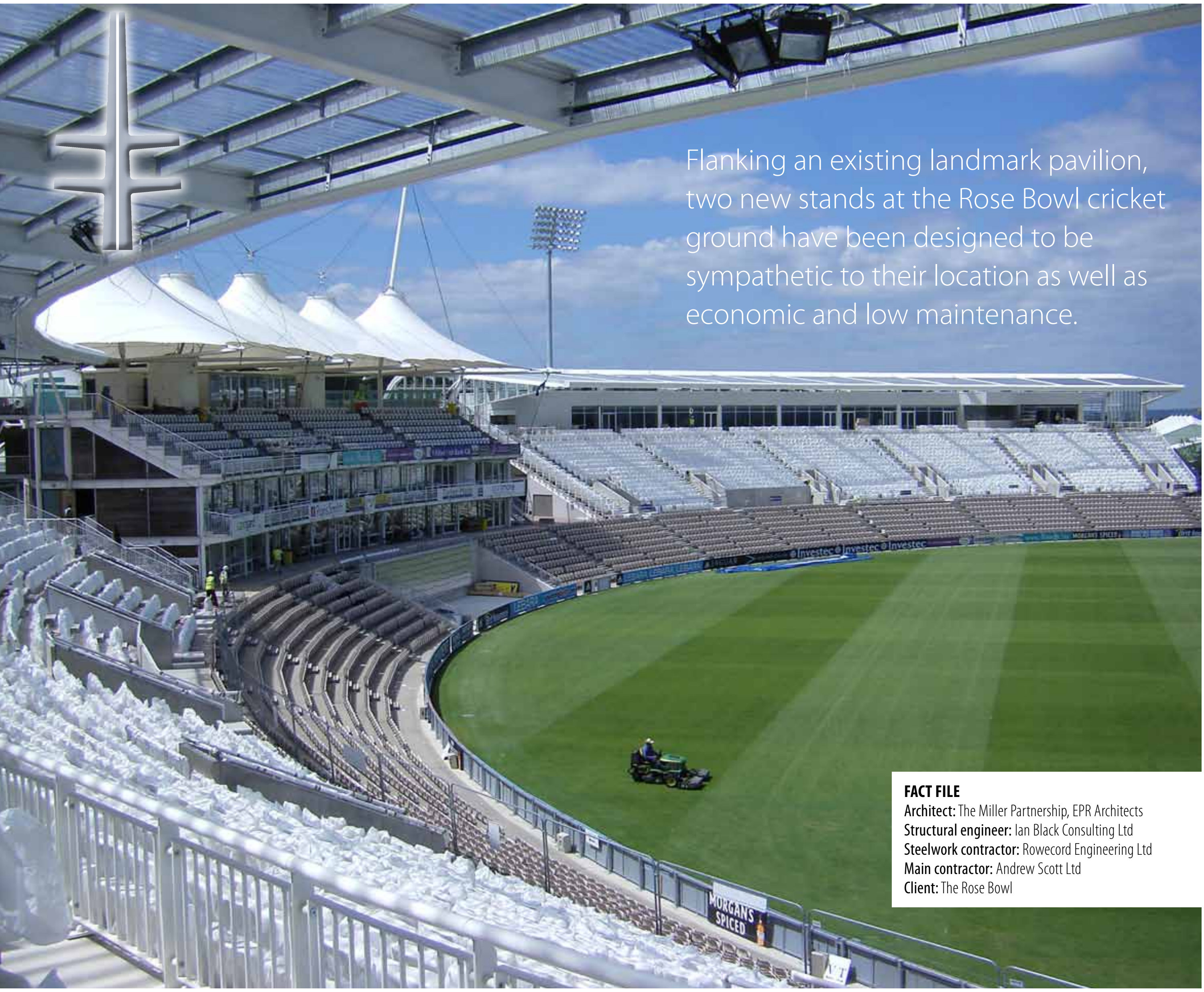
"The back span is mostly over land, so we were able to erect it in a conventional manner," explains Mr Selby. "The front span over the river required us to use a crane positioned and working on the completed bridge deck and this had to move forward sequentially as the deck was erected."

Each module, consisting of two main girders and cross members, were delivered piece-small up to the erection crane sited on the cantilevered end of the deck. Over a seven day cycle each module was erected, the cables installed and pre-stressed, and the precast concrete deck positioned. In conjunction with the modular build, a supported section of the front span was also erected, with the aid of the largest available floating crane in the UK - the 1,000t capacity Mersey Mammoth.

In summary, the judges say this is a high profile cable stayed bridge that helps to generate pride in the community and satisfies both client and users.

FACT FILE
Architect: Yee Associates
Lead engineer: Ove Arup & Partners Ltd
Structural engineer: Carlos Fernandez Casado SL
Steelwork contractor: Mabey Bridge Ltd
Main contractor: BAM-Dragados Joint Venture
Client: CRG Waterford Ltd

The Rose Bowl, Southampton



Flanking an existing landmark pavilion, two new stands at the Rose Bowl cricket ground have been designed to be sympathetic to their location as well as economic and low maintenance.

FACT FILE
Architect: The Miller Partnership, EPR Architects
Structural engineer: Ian Black Consulting Ltd
Steelwork contractor: Rowecord Engineering Ltd
Main contractor: Andrew Scott Ltd
Client: The Rose Bowl

Hampshire's Rose Bowl cricket ground has been upgraded and enlarged with the addition of two new stands, positioned either side of the site's landmark pavilion.

Central to the ground's ambitious future plans, the stands, in addition to the seating, also provide covered concourse areas, catering outlets, retail areas, press facilities, hospitality boxes, all housed in a two-storey structure situated behind and below the seating.

One of the overriding conceptual requirements for the project was to ensure the new development fitted into the ground's environment and provided a unifying structure, facade and roof.

From this client requirement, what has been called a 'sickle' structure design was born, whereby the roofs are separated from the permanent seating along the back of house area by a large timber louvered facade. This feature is said to marry into the surrounding landscape and the facade is supported by one large independent steel column.

The 'sickle' rafter, on each of the two stands, curves around the back of the main two-storey structure as an independent column and ultimately slopes back into the building forming the roof and cantilever.

The 'sickle' columns were fabricated in three sections, a straight outward leaning vertical leg which was bolted to a curved quadrant section, which in turn was bolted to a straight downward raking member which formed the roofs drainage fall and cantilevers over 70% of the terraced seating area," explains Colin Davies, Rowecord Engineering Contracts Manager.

The column was formed from a standard section with the curved portion fabricated from plates.

Structurally one of the main challenges associated with the project was providing sufficient stability to the structure, while at the same time adhering to the architectural requirements. Where to put bracing was the main problem, as the two-storey element provided little opportunity for vertical bracing and the stand's roofs were already braced along their full lengths to ensure effective transfer of lateral loads.

After much deliberation the solution chosen was for the sickle columns to be discretely connected at each floor level - including the roof - to the accommodation block. A radial prop between the columns on each line is attached to the sickle columns, while at two locations along the length of each stand diagonal members spring from the columns to third points on the adjacent floor edge beams.

Summing up, the judges say this project has clarity of structural steelwork and is a good example of 'less is more'.

New Cross Gate Flyover, East London Line

Pre-assembling a 75m-long rail bridge off-site, transporting it to its final position and then lowering it into place was the solution to a very difficult logistical challenge on the East London Line.

The recently opened East London Line is a new overground rail service which connects north and south London via the Thames Tunnel, an historic tunnel initially opened in the 1830s.

This new rail line crosses numerous obstacles such as small rivers, roads and a number of other railway lines, one of which at New Cross called for an innovative steel solution to negate a challenging logistical problem.

The single track East London Line crosses seven mainline railway lines at New Cross, and a 75m-long warren truss structure was chosen as the best option. Designed by Scott Wilson, the structure consists of 690t of steelwork comprising of eight longitudinal main girder boom sections, each 20m long and weighing between 20t and 25t, and a total of 37 crossbeams, 10m long and weighing 3t each.

Erecting the structure, quickly and safely over the Network Rail lines was the challenge, especially as a traditional erection method was ruled out because of time constraints.

"Craning the whole structure into position even without the concrete deck was ruled out due to site restrictions and size of crane required," says Chris Doyle, Scott Wilson Project Engineer.

As time was extremely important because rail possessions were only available during a weekend, pre-assembling the deck off-site was the only feasible method. "We decided to erect the bridge on a nearby plot and then transport it to site via self-propelled modular transporters and then de-jack the structure into place," explains Richard Selby, Mabey Bridge Head of Projects.

Initially the bridge steelwork was trial erected at Mabey Bridge's fabrication works and the deck crossbeams were machined to length ensuring the correct fit within the end plate connections. Steelwork was then delivered to site and the members forming the deck and the top chord of the truss were assembled and the whole structure fully bolted.

The bridge's deck was then cast and once it had achieved sufficient strength, the structure was jacked up approximately 6m to allow the self-propelled modular transporters to be positioned beneath the deck.

The distance covered from the assembly point to the bridge's final position was about 100m. In order to transport the structure across existing railway lines it was necessary to cover the tracks with a protective covering. Once the bridge structure was in place, it was de-jacked and lowered into position over the abutments.

The entire procedure was successfully achieved during a weekend rail possession ensuring no disruption was caused to the rail network.

In summary, the judges say all the challenges of constructing a large bridge over a key rail route, with numerous site constraints and to a very tight timetable, were successfully addressed here.

FACT FILE
Structural Engineer: Scott Wilson
Steelwork contractor: Mabey Bridge Ltd
Main contractor: Balfour Beatty-Carillion Joint Venture
Client: Transport for London

2010 Festival of Speed Sculpture, Goodwood

FACT FILE
Sculptor: Gerry Judah
Structural engineer: Capita Symonds
Steelwork contractor: Littlehampton Welding Ltd
Main contractor: Littlehampton Welding Ltd
Client: Gerry Judah for Alfa Romeo

Containing 32 fixed radius rolled tube sections, the Festival of Speed Sculpture is an ingenious work of steelwork fabrication and erection.

The Goodwood Festival of Speed in West Sussex is a world renowned annual celebration of motorsport history, which regularly features famous cars and drivers.

Each year a new sculpture is commissioned, a sculpture that is displayed for the duration of the festival's three days as a signature piece of artwork.

For last year's event Alfa Romeo sponsored a sculpture by renowned sculptor Gerry Judah to celebrate the company's centenary. Standing 18.5m high and with a maximum width of 25m, the design is reminiscent of the car company's Quadrifoglio badge. The sculpture features an Alfa Romeo P2 (a P2 won the inaugural Automobile World Championship in 1925) and a 2003 8C Competizione, both cradled in the steelwork.

These cradles holding each of the cars have hidden connections between the vehicles and the main supporting structure.

The structure itself may appear to be 175m of continuous tube twisted into shape, but it is actually 32 individual sections of 323.9mm diameter steel tube.

To succeed in its structural form the sculpture had to be a perfect continuous loop without visible joints or any sudden changes in direction.

"To achieve this, the geometry was created using a 3D CAD variation of an old draughting programme for constructing five-centre masonry arches," explains Bruno Postle, Capita Symonds Project Engineer. "This provided visual perfection, but also allowed the structure to be assembled from the multiple pieces, which in turn meant the sculpture was easily assembled, checked and prefabricated."

Several splice connections had to be made on site, and this called for steelwork contractor Littlehampton Welding to develop an adjustable bracket that provided alignment and structural integrity and allowed three axis adjustments before sections were finally welded together.

Each of the loops consists of 80m of CHS and weighs 6t. There needed to be eight additional connections between the tubes, taking advantage of the way the tubes turn in on themselves to provide self-bracing of the structure. Each of these connections consists of a 125mm diameter bar completely concealed and inserted using a technique developed by Littlehampton Welding.

"The setting out of the holes for these pin connections was a critical part of the fabrication process," says Steve Horrod, Project Manager for Littlehampton Welding. "To get the pins through the pre-drilled holes in the tubes we used a screw-on point to guide them."

The final result is a monumental sculpture consisting entirely of what appears to be two perfectly seamless lengths of steel tied into a huge bow.

"The structure could only have been made from steel, nothing else provides the strength, durability, flexibility and simplicity of construction," says Mr Postle.

Once last year's festival was over, the sculpture was dismantled and moved to the nearby Goodwood Sculpture Park, to be reassembled as permanent installation, minus the two cars.

In conclusion, the judges say this excellent fabrication and accurate erection have created a seamless shape in the sky. A tribute to the finesse achievable with steelwork.

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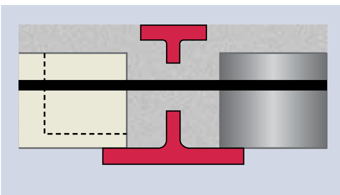
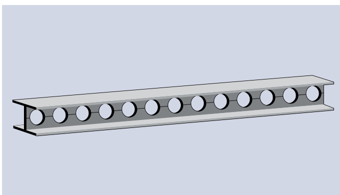
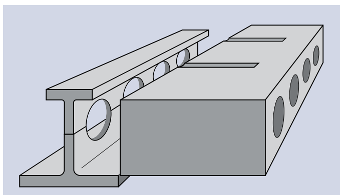
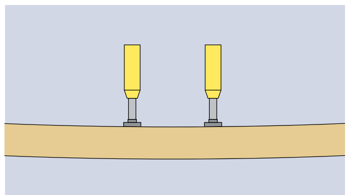

Plug composite action of slab proved to increase strength.


Plug composite USFB designed weights up to 30% lighter than non composite designs.


Steel deck + PC slabs (with structural topping) both benefit from plug composite design.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__________ Postcode:__________

Email:__________

The Point, Lancashire County Cricket Club

FACT FILE
Architect: BDP
Structural engineer: Capita Symonds Structures
Steelwork contractor: Watson Steel Structures Ltd (Severfield-Rowen Plc)
Main contractor: Morgan Sindall
Client: Lancashire County Cricket Club

Lancashire County Cricket Club's vision, for the Point development at its Old Trafford ground, was to build a 1,000 seat hospitality and banqueting venue, while also providing over 2,500 new stadium seats.

The requirement for space and height drove the unique design, which has put the events space above the new spectator seating creating shelter, unimpeded spatial flexibility and a spectacular full height glazed wall.

The use of steel was the only way such a demanding structure could have been delivered economically given the short construction programme and site constraints, says Capita Symonds. The high load capacity of steel meant that the cantilever elements could be kept as compact as possible, with steel exposed and expressed to suit the architectural requirements.

The terrace seating is formed from raking steel beams supporting precast concrete units. Above this, the second level events area cantilevers 12m over the stadium terracing and was constructed using a series of eight fabricated plate girders.

The girders are radially aligned with the terrace grid and varied in depth from 600mm deep at the cantilever tip to 1,200mm deep at the head of the raking columns.

Above this, a series of plate girder roof beams were designed to accommodate the services, folding partitions and roof loadings. These spanned 26m from the pitch side CHS columns to the rear of the structure, incorporating service openings to suit the M&E needs.

Riverside Waste to Energy Plant, Belvedere

FACT FILE
Architect: Jacobs Engineering UK Ltd
Structural engineer: Jacobs Engineering UK Ltd
Steelwork contractor: Bourne Steel Ltd
Main contractor: Costain Group Plc
Client: Cory Environmental Ltd

New South Bridge, A406 Hanger Lane

FACT FILE
Structural Engineer: Hyder Consulting Ltd
Steelwork contractor: Cleveland Bridge UK Ltd
Main contractor: Vinci Construction UK Ltd
Client: Transport for London

The New South Bridge is a replacement structure spanning two London Underground lines and four Network Rail tracks near the Hanger Lane roundabout in west London.

Steel was the automatic choice for the bridge, says Hyder, in order to span 45m, build it off -line and then manoeuvre it into place. Other benefits included a reduced weight, resulting in smaller and shallower caisson foundations.

Box girders for the bridge were fabricated in three small transportable sections, at Cleveland Bridge's yard and then welded together on site to form the 45m span. The cross girders were bolted to the box sections with non-slip tension control bolts, which allowed accurate assembly of the trapezoidal plan shape of the bridge. The box girders were 3.4m high × 1.05m wide with depth haunching to 4m at the supports.

In order to avoid disruptive track possessions the fully assembled bridge was moved from its adjacent assembly yard by Self Propelled Modular Transporters (SPMTs) that launched the structure into place.

The launch procedure comprised a two stage operation with an initial counter clockwise 90 degree turn to position the bridge to the railway tracks. This was then followed by the main push southwards to carry the structure across the railway tracks.

Two lines of SPMTs were used to enable the whole bridge to be driven and pushed into place. To span the distances, the bridge had a temporary nose at the front and a 7m long temporary tail section to accommodate counter weights. The total weight of the launch structure, including the temporary sections, was almost 1,050t.

The UK's largest energy from waste plant has been constructed on the banks of the River Thames at Belvedere. Known as the Riverside facility it will process more than 585,000t of municipal and commercial waste per year, and provide 66MW of electricity to the local grid.

The structure covers an area of over 13,000m^2, with its curved wave-form roof rising to a height of 55m. The main frame, internal plant supports and walkways were all erected using structural steelwork, which enabled the building to be constructed to its optimum height while also maximising internal space.

"The key to this project was integration," explains Nick Hayes, Divisional Director for Bourne Steel. "We, as well as all the other sub-contractors, had to work around each other. In some areas steelwork was erected first, but in other sectors the equipment was installed first and we then had to come along and thread the steel columns, some 30m long, between large pieces of processing kit."

Much of the steelwork was erected on top of concrete walls, such as the waste bunker where 20m long steel columns extend the building upwards to connect to the steel roof.

All of the steelwork used for the project's frame was galvanised for durability. This process required one of the largest galvanising baths in the UK to accommodate some of the large truss sections.

The roof was one of the most challenging aspects of the project and all of the 36m-long cellform beams which form the roof were trial erected. This ensured the correct geometry could be achieved, as there is no constant radius.

Newport Station Regeneration, South Wales

The regeneration of Newport's railway station has been successfully completed with a futuristic design which boosts capacity and passenger comfort. Finished in readiness for last year's Ryder Cup, the station features ticket facilities and platform access split equally between the two terminals, and these along with a linking footbridge are housed within continuous ETFE and aluminium clad spirals.

The use of an ETFE wrap over a steel structure not only creates a very bright and airy space but also, due to the lightness of the material, the structure requires minimal support.

Chris Pembridge, Atkins Regional Director, says this was one of the reasons why steel was chosen as the main framing material. "We looked at timber and concrete for the terminals but went for steel for its ease of construction as well as it lightness. The footbridge on the other hand was always going to be a steel structure because of the spans and its ability to achieve the organic form we were seeking."

Linking the two terminals and allowing access to a central pair of platforms, the bridge has three spans and gains its stability from a central support containing a concrete lift core. The span from the north terminal to the central core is 23m, while from the south the span is 29m. The reason for this disparity being the bridge's organic curving shape. A third, and much shorter span allows access, from the middle of the bridge and liftshaft, to the central staircase leading to the platforms.

Steelwork contractor SH Structures fabricated and then delivered the bridge decks to site in six sections.

By assembling as much of the footbridge as possible and then lifting completed sections into place the contractor minimised working at height and reduced the need for further rail possessions.

FACT FILE
Architect: Grimshaw Architects LLP
Structural engineer: Atkins Ltd
Steelwork contractor: S H Structures Ltd
Main contractor: Galliford Try
Client: Network Rail

Bridge GE19, East London Line

Bridge GE19 is an 84m-long, 8m deep truss bridge which carries two lines of the new East London Line over the railway tracks originating at nearby Liverpool Street terminus.

Working above these 'live' railway lines was only permitted during weekend and Bank Holiday possessions and so the entire structure was pre-assembled in an adjacent goods yard.

Steelwork forming the deck was made up of ten longitudinal beams measuring between 20t and 24t, and 31 × 9m-long cross girders each weighing 4t. In total the bridge required Mabey Bridge to use 880t of steel and a further 140t for a temporary nose section which was removed once the structure was in its final position.

Once the entire bridge and its nose had been assembled it was moved to its final position by two self-propelled modular transporters and then jacked (launched) over the 'live' rails onto its furthest abutment. The entire launch was completed during one weekend rail possession.

"This bridge, because of its length had to be a warren truss," explains Richard Selby, Mabey Bridge Head of Projects. "During the design we had to include all the movement stresses associated with the launch."

In order to reduce the need for future maintenance on the structure, Mabey Bridge fabricated the bottom chords from weathering steel, as this would require no protective coating before installation - thereby saving the client money.

FACT FILE
Structural Engineer: Benaim
Steelwork contractor: Mabey Bridge Ltd
Main contractor: Balfour Beatty-Carillion Joint Venture
Client: Transport for London

Museum of Liverpool

FACT FILE
Design Architect: 3XN Architects
Delivery architect: AEW Architects
Structural engineer: Buro Happold
Steelwork contractor: Caunton Engineering Ltd
Main contractor: PIHL/Galliford Try
Client: National Museums Liverpool

Located on the banks of the River Mersey, the National Museum of Liverpool has been dubbed the 'fourth grace' following on from the historic the Royal Liver Building, Cunard Building and the former offices of the Mersey Docks and Harbour Board.

It is a striking building, a low, stone and glass-clad structure with sweeping "wing" roofs and huge glass picture windows at either end. On plan, it occupies the space of a partially closed X, and is symmetrical about the diagonal axis.

"It's a very complex, unconventional form," explains Buro Happold Structural Engineer David Taylor. "The client was looking for large, open spaces, and the architect has come up with a scheme which provides this, and within a very unusual form."

The clear spans are at their most significant on the second floor, where there are two 40m long, column-free main galleries – one at either end -with the steel beams above spanning 28m across the width of the structure.

There is a total of 2,100 tonnes of steel in the building's main structure, which has been designed to resist not just self-load and the weight of exhibits and visitors, but also the substantial horizontal and uplift forces from the high winds that affect the Mersey's shores. All of this load is taken into the ground via a 4m deep reinforced concrete raft structure, consisting of top and bottom slabs joined by a series of vertical walls.

Buro Happold's structural design splits the building into three sections – the centre and the two ends – with movement joints separating them. The split is necessary as there is the possibility of differential thermal expansion across the length of the structure. Although vertical forces can be transferred across the joints, the frame has been designed to ensure horizontal and rotational movement is contained within each section.

North Stand Redevelopment, Leicester Tigers

Leicester Tigers, arguably Rugby Union's best supported team, has an ambitious 10-year programme to redevelop its Welford Road ground into a modern 30,000 seat stadium complete with a raft of facilities

The first phase of the programme has been completed and involved the construction of a new 10,500 seat north stand, which has increased the ground's capacity from 17,498 to 24,000.

During the 2008/09 season the new stand's roof, including a 108m long king truss, as well as the upper portion of the stand where erected above the existing stand. This then allowed the old stand to be demolished, clearing the ground for the lower level of the new stand to be infilled.

FACT FILE
Architect: AFL Architects
Structural engineer: WRS Corporation Ltd
Steelwork contractor: Caunton Engineering Ltd
Main contractor: Galliford Try
Client: Leicester Football Club Plc

The new stand's footprint is much larger than the old stand and steelwork contractor Caunton Engineering was able to erect the majority of the new structure without impacting on the existing stand.

Two 1,000t capacity mobile cranes were positioned at either end of the stand to lift the roof truss into place. The crowning glory of the new structure, and visible for miles around, the roof's 108m-long truss is 35m high x 12m deep and was delivered to site in more than 140 separate pieces. It was assembled on the ground and then erected in one tandem lift.

The roof's cantilever is formed with Westok beams erected in three sections. Caunton erected the middle 6m section with the truss, and once the truss was in place it was then tied into the back of the stand with further 31m long Westoks. The front portion of the cantilever roof was later erected with 14m-long cellular beams.

Supporting the roof truss are two 24m high support pylons, prefabricated from tubular sections and delivered to site in one piece. These were erected prior to the truss lift.

Member buckling with tension flange restraint

David Brown of the SCI explains the structural mechanics and design provisions for tension flange restraint for both flexural and lateral torsional buckling.

Introduction

Portal frame designers are familiar with tension flange restraint, often referred to using the shorthand of "Annex G", which is the relevant Annex in BS 5950. The benefit of tension flange restraint is used to increase the lateral torsional buckling resistance. Restraint to one flange can also be used to increase resistance to flexural buckling under compression.

Lateral torsional buckling

A simply supported, unrestrained beam is shown in Figure 1. The unrestrained compression flange buckles laterally, dragging the tension flange with it. The tension flange is reluctant to be displaced at all, resulting in a lateral movement and a rotation of the section. Note that the centre of the rotation is some way distant from the section.

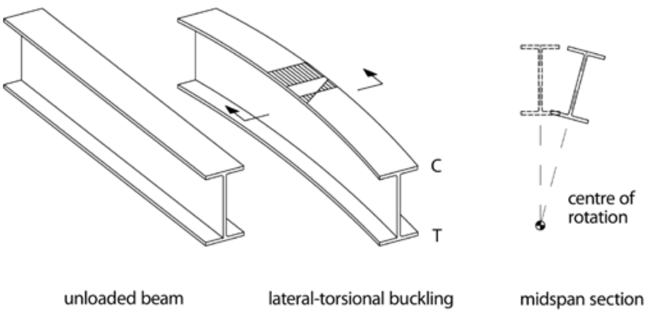

Figure 1 Lateral torsional buckling

The compression flange experiences a direct stress due to the major axis moment $\left[\frac{\text{moment}}{\text{modulus}}\right]$. Because the flange is now also curved on plan, there is a bending stress in the flange, in the section's minor axis. At the extreme fibres, the two stresses combine and collapse results if the combined stresses reach yield. This is obviously a highly simplistic explanation, as plasticity, residual stresses and second-order effects also contribute to the buckling behaviour, but the simple explanation is useful when developing the mechanics of tension flange restraint.

If restraint is provided at, or close to the tension flange, the lateral shift of the compression flange is reduced, as shown in Figure 2. The point of rotation is now forced to be much closer to the tension flange (usually the point of rotation will be some distance off the tension flange, such as the centreline of the restraint). Because the lateral shift is constrained, the additional bending stress is reduced. This translates to an increased resistance.

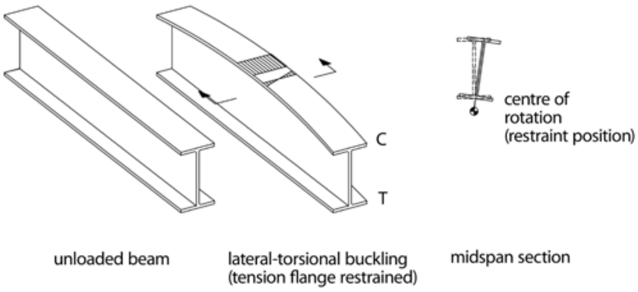

Figure 2 Lateral torsional buckling with tension flange restraint

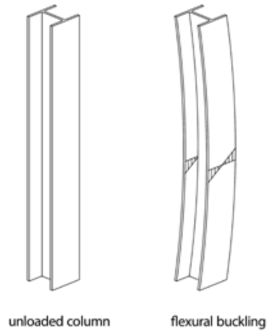

Figure 3 Flexural buckling

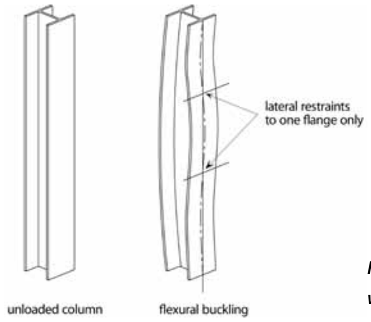

Figure 4 Minor axis flexural buckling with one flange restrained

The background theory assumes that the restraint to the tension flange is continuous, rather like a piano hinge running along the length of the member. In most cases, this sort of continuous restraint cannot be achieved in practice. Therefore design Standards have further checks, to ensure that the restraints to the tension flange are close enough to provide appropriate lateral fixity.

Flexural buckling under compression

In an unrestrained compression member, the section buckles about its minor axis, as shown in Figure 3. The cross section experiences the axial stress, but also a bending stress in the minor axis. This is again a simple explanation of a complex situation.

If intermediate restraints are introduced to one flange only, as shown in Figure 4, the unrestrained flange is free to buckle, but the extent of that displacement is reduced. The bending stress is therefore reduced, which translates to an increased resistance. Like lateral torsional buckling, the restraints to the flange must be located frequently enough to mimic the effect of a continuous "piano hinge" restraint.

What difference does it make?

The answer is always "it depends", but the benefit can be very helpful. In general, the benefit is more significant in flexural buckling compared to lateral torsional buckling. Numerical comparisons are presented in the following paragraphs. The calculations follow the Eurocode nomenclature.

Flexural Buckling Comparison

Example 1.

Consider a 610 × 229 × 113 UKB, S275 with 6.325 m between torsional restraints. The bending moment diagram is triangular, and the axial force N_{Ed} is 188 kN. There are intermediate restraints to one flange (the tension flange) at 1.6 m centres.

The verification is covered by clause BB.3.1.2(2)B. The spacing of the intermediate restraints must not be greater than L_m of BB.3.1.1

$$L_m = \frac{38 i_z}{\sqrt{\frac{1}{57.4}\left(\frac{N_{Ed}}{A}\right) + \frac{1}{756 C_1^2}\frac{W_{pl,y}^2}{A I_t}\left(\frac{F_y}{235}\right)^2}}$$

The C_1 factor relates to the shape of the bending moment diagram. For an overall triangular bending moment diagram, the lowest value (most onerous) of any of the segments in the member is $C_1 = 1.17$

Substituting the various section properties, steel strength, *etc* into the expression,

$$L_m = \frac{38 \times 48.8}{\sqrt{\frac{1}{57.4}\left(\frac{188 \times 10^3}{14400}\right) + \frac{1}{756 \times 1.17^2}\frac{(3280 \times 10^3)^2}{14400 \times 111 \times 10^4}\left(\frac{265}{235}\right)^2}}$$

$L_m = 1819$ mm

With intermediate restraints at 1600 mm, they are considered effective and the benefit of restraint to one flange may be utilised.

The elastic critical force N_{crT} for this situation, with restraints to one flange, is given in BB.3.3.1 by:

$$N_{crT} = \frac{1}{i_s^2}\sqrt{\frac{\pi^2 E I_z a^2}{L_t^2} + \frac{\pi^2 E I_w}{L_t^2} + G I_T}$$

where $i_s^2 = i_v^2 + i_z^2 + a^2$

The key variable is a, which is the distance from the shear centre of the section to the longitudinal axis of the restraints. Assuming the axis of the restraint is 100 mm off the face of the column, the distance a is 403.8 mm.

Substituting the various section properties, steel strength, *etc* into the expression,

$N_{cr} = 2365$ kN

Using curve *b*, this leads to a buckling resistance, $N_{b,Rd}$ of 1685 kN

Example 2

If the benefit of restraints to one flange had not been taken, the elastic critical force N_{cr} is given by:

$$N_{cr} = \frac{\pi^2 EI}{L^2} = 1770 \text{ kN}$$

Using curve *b*, this leads to a buckling resistance, $N_{b,Rd}$ of 1336 kN, approximately 20% less than previously calculated.

Lateral torsional buckling comparison

Example 3

Although not given in the Eurocode, the expression for the elastic critical moment of a bi-symmetric section under a uniform moment can be found in Reference **1** and is given by

$$M_{cr0} = \frac{i_s^2}{2a} N_{cr}$$

Using the same details as example 1, $M_{cr0} = \frac{225952}{2 \times 403.8} \times 2365 = 662$ kNm

The influence of the shape of the bending moment diagram is incorporated using the C_m factor in BB.3.3.1. Following this procedure gives $C_m = 1.883$.

The elastic critical moment under a linear moment is then given by

$$M_{cr} = M_{cr0} \times C_m = 662 \times 1.883 = 1246 \text{ kNm}$$

Using curve c and expression 6.57, the calculated buckling resistance $M_{b,Rd}$ = 644 kNm

Example 3

If the benefits of tension flange restraint were ignored, the elastic critical moment of a bi-symmetric section is given by

$$M_{cr} = C_1 \frac{\pi^2 EI_z}{L^2} \sqrt{\frac{I_w}{I_z} + \frac{L^2 GI_t}{\pi^2 EI_z}}$$ where C_1 accounts for the shape of the bending moment diagram.

Substituting the various section properties, steel strength, *etc* into the expression, $M_{cr} = 1167$ kNm and $M_{b,Rd} = 629$ kNm. (This calculation has ignored the benefit of the ***f*** factor given in 6.3.2.3(2))

Summary

	Flexural resistance $N_{b,Rd}$	Lateral torsional resistance $M_{b,Rd}$
With tension flange restraint	1685 kN	644 kNm
Without tension flange restraint	1336 kN	629 kNm

Conclusions

Restraint to one flange can be of benefit, especially for flexural buckling. The improvement in lateral torsional buckling resistance is perhaps not as much as commonly thought. In both cases, it is essential that the spacing of the intermediate restraints to the tension flange meet the requirements of the design Standard, to ensure they provide appropriate restraint.

1. KING, C. M. *Design of Steel Portal Frames for Europe*, P164, SCI, 2001

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Steelwork for people on the move

Britain's economic future depends on developing more efficient ways of moving people and freight between our town and cities. Steel will pay a major role in modernising our transport infrastructure. The cumulative benefits of modest improvements, like new railway stations and safer road junctions will be as important as more spectacular schemes such as new river crossings and high-speed rail links.

Steel and glass were combined to make an impressive new station building for British Rail at Redhill, Surrey. The central feature is a distinctive drum-shaped booking hall, the steelwork for which was fabricated and erected by Nusteel Structures Ltd.

Staff offices and facilities are accommodated in a single storey structure built on a framework of Universal beams. This part of the building is approximately 3m high, 27m long and 10m deep and aligned with the embankment on which the railway runs through Redhill.

The booking hall, 10m diameter and 5m high, is recessed into the front of the singles storey structure and supported by four CHS (circular hollow section) main columns, 244mm in diameter, and eight secondary columns fabricated from 60mm dia, CHS members. The main columns are braced with 114mm dia. CHS members which encircle the building at a height of 3m above floor level.

A double ring beam assembled from 24 I-section rolled steel beams, 254mm deep, is mounted on the heads of the main and secondary columns.

The building's roof frame is

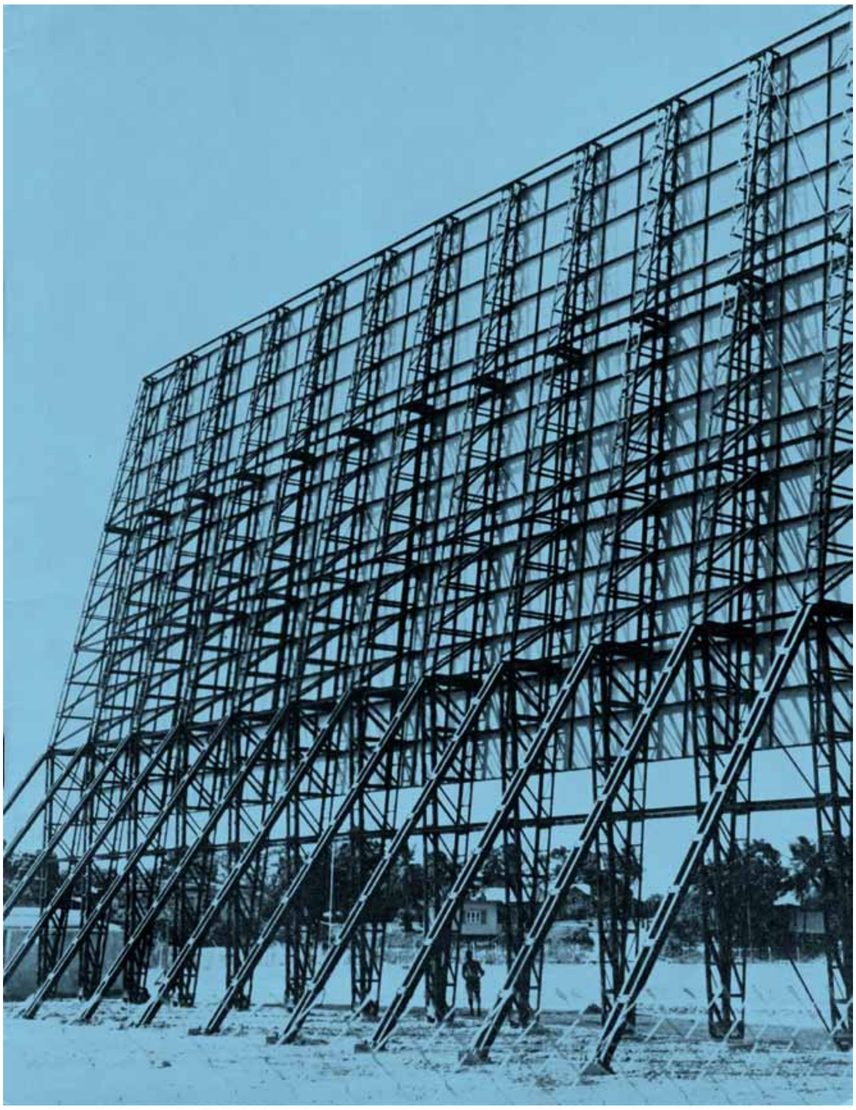
formed from six segmental units, each consisting of two perforated and tapered radial Universal beams and a rolled steel channel kerb beam. The units are cantilevered across the main and secondary columns and ring beam and project 3m beyond the perimeter of the building, providing the superstructure with a braced canopy which shelters passengers as they enter and leave the station.

At the centre of the roof the radial beams are welded to a 3m diameter hub, fabricated from rolled steel channels and Universal beams. Daylight is admitted into the booking hall through a domed rooflight above the hub.

First published in
STEEL CONSTRUCTION, April 1991

A cinema under the stars

First published in
BUILDING WITH STEEL
May 1961



All welded steel structure for supporting the cinema screen of a new 'drive-in' cinema in Trinidad. Set at an angle of 7 degrees to the vertical, the structure consists of 12 ribs, each 74 ft. high with horizontal channel members stretching across the full width to support the flat asbestos screen, 110 ft. wide by 54 ft. deep. The whole structure weighs approximately 30 tons and is designed to withstand a wind of 85 m.p.h. It was exported from Britain. Consulting Engineers: Clarke, Nicholls and Marcel, Trinidad.

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AD 360
Movement joints in steel-framed buildings

The Advisory Desk is asked, from time to time, for guidance on movement joints in steel framed buildings. Most of the queries seek guidance on the detailing of slotted holes for bolted connections. This AD Note discusses the considerations that need to be made when providing a connection between structural members at a movement joint.

If possible, movement joints should be avoided by splitting the large structure into smaller independently stable frames by use of double lines of framing, so that there is no load transfer between adjacent frames. However, non-structural elements between the frames still have to be detailed to accommodate relative movement between adjacent frames.

Another possibility is to avoid a movement joint and to design the frame and the connections for forces due to restraint of movement.

However, where a movement joint is provided, it should be properly detailed to ensure that the movement can actually take place. In most steel-framed structures, relative movement between connected elements is achieved by allowing one part to slide on the other. The sliding surfaces must therefore be suitable for the repeated movement over the life of the structure, whilst transferring forces in bearing. Any movement joint will inevitably induce additional eccentricities in the supporting members, and the person responsible for the design of the structure must take this into account.

Proprietary structural sliding bearings (manufactured in accordance with EN 1337: Structural bearings (in 11 Parts)) are the most effective means to provide a movement joint and are recommended. An example of such a bearing is shown in figure 1 below. Further guidance is available at *www.steelbiz.org* in document SS017 "Scheme Development: Movement joints in steel buildings, 2006".

It is essential to be able to predict the range of movement and to allow for the relative positions of the two elements achieved during construction: there must be a tolerance in relative position. Calculations are required for movement for the design temperature range and movement due to deflection under load (this may be more difficult to predict because of uncertainty of connection stiffness throughout the structure, etc.). Ensuring that the relative locations are within tolerance will require verification after installation – if the beam length were too long or short, then a bolt in a slotted hole might be at the end of the slot instead of the middle.

In a beam to column connection, it might be thought at first sight that a suitable detail could be achieved by providing a fin plate type connection with slotted holes and using "shoulder bolts". Shoulder bolts would be used to ensure that not even a modest preload would occur, since that would cause unwanted (and unpredictable) frictional resistance. Such a detail would be simple and inexpensive but there is a significant limitation to its applicability as it is only suitable for very light shear loads. The bearing pressure between the bolt shank and the edge of the slot will result in deformation of the slot, even at loads that are very much less than the shear resistance of the bolt. This deformation will both impede the movement and cause wear. In the extreme, this could lead to the joint locking up, with potentially harmful consequences. Such a connection is therefore not suitable for transferring anything more than infrequent and very modest forces.

Contact: **David Iles**
Tel: **01344 636525**
Email: **advisory@steel-sci.com**

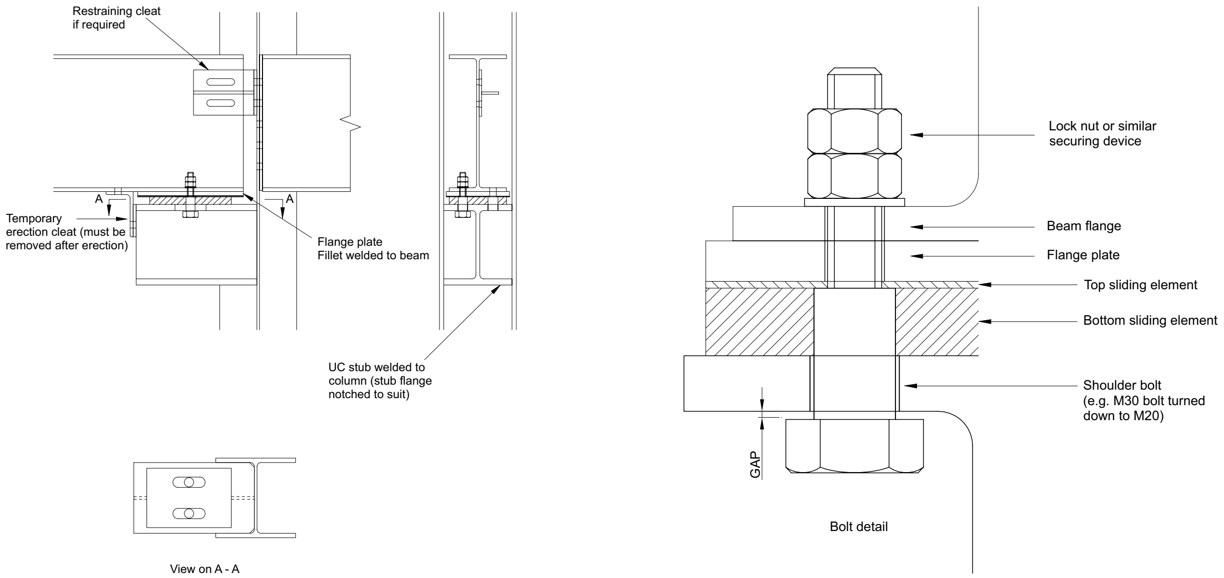

Figure 1 Movement Joint – Proprietary sliding bearing detail

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From BSI Update June 2011

BS EN PUBLICATIONS

BS EN ISO 4017:2011
Hexagon head screws.
Product grades A and B
Supersedes BS EN ISO 4017:2001

BS EN ISO 4018:2011
Hexagon head screws.
Product grade C
Supersedes BS EN ISO 4018:2001

BS EN ISO 8676:2011
Hexagon head screws with metric fine pitch thread. Product grades A and B
Supersedes BS EN ISO 8676:2001

NEW WORK STARTED

EN ISO 3581
Welding consumables. Covered electrodes for manual metal arc welding of stainless and heat resisting steels. Classification.

Total process optimization
Conceptual image courtesy of Vyonyx Limited

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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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 Directory General, BCSA, 4 Whitehall Court, London SW1A 2ES
Tel: 020 7839 8566 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
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	01924 264121												●					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
B&B Group Ltd	01942 676770	●		●	●	●	●	●		●	●	●		●		✓		Up to £1,400,000
B D Structures Ltd	01942 817770			●	●	●	●				●	●		●				Up to £800,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✓		Up to £1,400,000
Barnshaw Section Benders Ltd	01902 880848												●			✓	Silver	Up to £800,000
Barrett Steel Buildings Ltd	01274 266800			●	●	●	●									✓	Gold	Up to £6,000,000
Barretts of Aspley Ltd	01525 280136			●	●	●				●	●			●	●	✓		Up to £3,000,000
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 502277	●	●	●	●	●	●	●	●	●	●	●		●		✓	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 £1,400,000
D H Structures Ltd	01785 246269				●		●				●			●				Up to £40,000
Discain Project Services Ltd	01604 787276				●					●	●				●	✓		Up to £1,400,000
Duggan Steel Ltd	00 353 29 70072		●	●	●	●	●	●			●					✓		Up to £6,000,000
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
GME Structures Ltd	01939 233023			●	●		●	●		●	●			●	●			Up to £400,000
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		●	●	●	●	●	●				●		●		✓	Member	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 £4,000,000
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			●	●	●	●	●	●	●	●	●		●	●	✓	● (grey)	Up to £4,000,000
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●						● (green)	Up to £1,400,000
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
Robinson Steel Structures	01332 574711		●	●	●	●	●		●	●	●	●		●	●	✓	● (orange)	Above £6,000,000
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 £200,000
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 £1,400,000
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 £4,000,000*
Tubecon	01226 345261						●	●	●	●				●	●	✓		Above £6,000,000*
W & H Steel & Roofing Systems Ltd	00 353 56 444 1855			●	●	●	●	●						●	●			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
SUM	0113 242 7390
Roger Pope Associates	01752 263636
Highways Agency	08457 504030

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 – Birmingham	0121 561 6800								●		
ArcelorMittal Distribution – Bristol	01454 311442								●		
ArcelorMittal Distribution – Manchester	0161 703 9073								●		
ArcelorMittal Distribution – South Wales	01633 627890								●		
ArcelorMittal Distribution – Scunthorpe	01724 810810								●		
ArcelorMittal Distribution – Wolverhampton	01902 365200								●		
Arro-Cad Ltd	01283 558206			●							
ASD Interpipe UK Ltd	0845 226 7007								●		
ASD metal services - Biddulph	01782 515152								●		
ASD metal services - Bodmin	01208 77066								●		
ASD metal services - Cardiff	029 2046 0622								●		
ASD metal services - Carlisle	01228 674766								●		

Company name	Tel	1	2	3	4	5	6	7	8	9	SCM
ASD metal services - Daventry	01327 876021								●		
ASD metal services - Durham	0191 492 2322								●		
ASD metal services - Edinburgh	0131 459 3200								●		
ASD metal services - Exeter	01395 233366								●		
ASD metal services - Grimsby	01472 353851								●		
ASD metal services - Hull	01482 633360								●		
ASD metal services - London	020 7476 0444								●		
ASD metal services - Norfolk	01553 761431								●		
ASD metal services - Stalbridge	01963 362646								●		
ASD metal services - Tividale	0121 520 1231								●		
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								●		
Cellbeam Ltd	01937 840600	●									

Steelwork contractors for bridgework

RQSC – The Register of Qualified Steelwork Contractors Scheme

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	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 502277	●	●	●	●	●	●	●	●	✓	Silver	Above £6,000,000
Kiernan Structural Steel Ltd	00 353 43 334 1445	●	●	●	●			●	●	✓	Silver	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 £800,000
Allerton Steel Ltd	01609 774471	●	●	●	●	●	●	●	●	✓		Up to £1,400,000
Carver Engineering Services Ltd	01302 751900	●	●	●	●		●	●	●	✓		Up to £2,000,000
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 £800,000
Four-Tees Engineers Ltd	01489 885899	●	●	●	●		●	●	●	✓	Member	Up to £2,000,000
Francis & Lewis International Ltd	01452 722200							●	●	✓	Member	Up to £2,000,000
Harland & Wolff Heavy Industries Ltd	028 9045 8456	●	●	●	●	●		●	●	✓		Up to £6,000,000
Hollandia BV	00 31 180 540540	●	●	●	●	●	●	●	●	✓		Above £6,000,000
Interserve Project Services Ltd	0121 344 4888							●	●	✓		Above £6,000,000
Interserve Project Services Ltd	020 8311 5500	●	●	●	●		●	●	●	✓		Up to £800,000*
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
Cellshield Ltd	01937 840600							●			
CMC (UK) Ltd	029 2089 5260							●			
Composite Metal Flooring Ltd	01495 761080	●									
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							●			●
Fabsec Ltd	0845 094 2530	●									
FabTrol Systems UK Ltd	01274 590865		●								
Ficep (UK) Ltd	01924 223530					●					
FLI Structures	01452 722200	●									
Forward Protective Coatings Ltd	01623 748323						●				
Hadley Rolled Products Ltd	0121 555 1342	●									●
Hempel UK Ltd	01633 874024						●				
Hi-Span Ltd	01953 603081	●									●
Highland Metals Ltd	01343 548855						●				
Hilti (GB) Ltd	0800 886100									●	
International Paint Ltd	0191 469 6111						●				●
Jack Tighe Ltd	01302 880360						●				
Jamestown Cladding and Profiling	00 353 45 434288	●									
Kaltenbach Ltd	01234 213201					●					
Kingspan Structural Products	01944 712000	●									●
Leighs Paints	01204 521771						●				●
Lindapter International	01274 521444									●	
Metsec plc	0121 601 6000	●									●
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					●					
PMR Fixers	01335 347629	●									
PP Protube Ltd	01744 818992	●									
PPG Performance Coatings UK Ltd	01773 837300						●				
Prodeck-Fixing Ltd	01278 780586	●									
Rainham Steel Co Ltd	01708 522311								●		
Richard Lees Steel Decking Ltd	01335 300999	●									●
Schöck Ltd	0845 241 3390	●									
Structural Metal Decks Ltd	01202 718898	●									●
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						●				

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