JUNE 2010 VOL 18 NO 6

NSC

NEW STEEL CONSTRUCTION

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Jersey's energy first
Steel best for thermal mass

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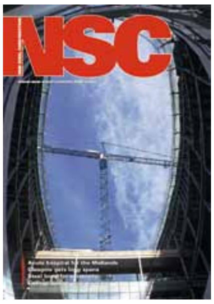

New Steel Construction keeps designers and contractors abreast of all major steel construction related developments and provides detailed technical information on key issues such as the introduction of the Eurocodes. NSC will be the first place most people hear about advances made by the extensive research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

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

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

A recent development has been the introduction of Steel Industry Guidance Notes, SIGNS, with each issue of NSC, a loose leaf insert series aimed at students and designers new to steel construction. SIGNS provide essential introductory explanations of basic steel related design topics and point the way towards where more detailed, free, support can be accessed in the steel sector.

NSC is available **free of charge each month** to subscribers living in the UK or Ireland by simply filling in the reply paid card bound into this issue, or by contacting us by email, post or fax as described on the card.

If the card has already been removed from this issue you can fill out this form and fax it to 0870 903 1248, or scan and email it to admin@new-steel-construction.com

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

Cover Image
Heron Tower, London
Main Client: Heron
Architect: Kohn Pedersen Fox
Steelwork contractor:
Severfield -Reeve Structures
Steel tonnage: 12,000t


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The British Constructional Steelwork Association Ltd
SCI

Steel's sustainable success story

Amid all the headlines about rising raw material costs worldwide pushing up the price of steel it is worth considering that even with those pressures the cost of the frame and floor of a steel-framed building is still well below 2008 levels. The recent rises constitute less than 1% of overall building costs; not an inconsiderable sum, but one that should be viewed in a proper perspective.

Clients of the industry who have managed to fund developments despite the credit crunch and its fallout have been able to take advantage of some of the best prices for years, and the return on their investments will be accordingly greater. Even before the recent price increases the steel construction sector had been sending out strong messages that now is the time to act to capture the lower prices.

With a new government in place determined to cut the public sector deficit overall construction demand looks unlikely to pick up appreciably in the short term; but hopes remain high that private sector investment in a growing economy can pick up at least some of the slack. In such a cost conscious environment the many financial and other efficiency advantages of steel construction should come more to the fore.

Steel looks like continuing to be the framing material of choice for key sectors whatever the precise shape of the market in the foreseeable future, a view that is borne out by the most recent Market Share Survey by independent researchers Construction Markets (see News). The survey shows that steel is still market leader in non-residential multi-storey buildings by a large margin, being selected as a framing material well over three times as much as the nearest rival, insitu concrete. Steel has even managed to increase its share of the key single storey industrial buildings market to over 97%.

The remarkable success story of structural steel over 25 years or so has proven to be just as remarkably sustainable, having now been tested by several recessions and the booms that went with them. Throughout this period the steel construction sector has made major strategic investments in productivity boosting technology, and shared the benefits with its customers. Investment continued despite the recession, as is seen in recently launched design guides for Eurocodes and in the Target Zero guides for low and zero carbon buildings.

Whenever worldwide pressures force rises in steel prices, which similarly affect reinforcing bars for concrete construction, the relative competitive position remains unaltered and steel invariably wins over new supporters amongst cost conscious and sustainability minded construction teams. Overall cost and sustainability benefits would be expected to protect steel's market position on their own, but factoring in the other advantages like inherently superior health and safety, as reported in the May issue of NSC, and speed, steel construction is looking forward to improving markets with confidence.

Nick Barrett - Editor

Steel still the competitive option

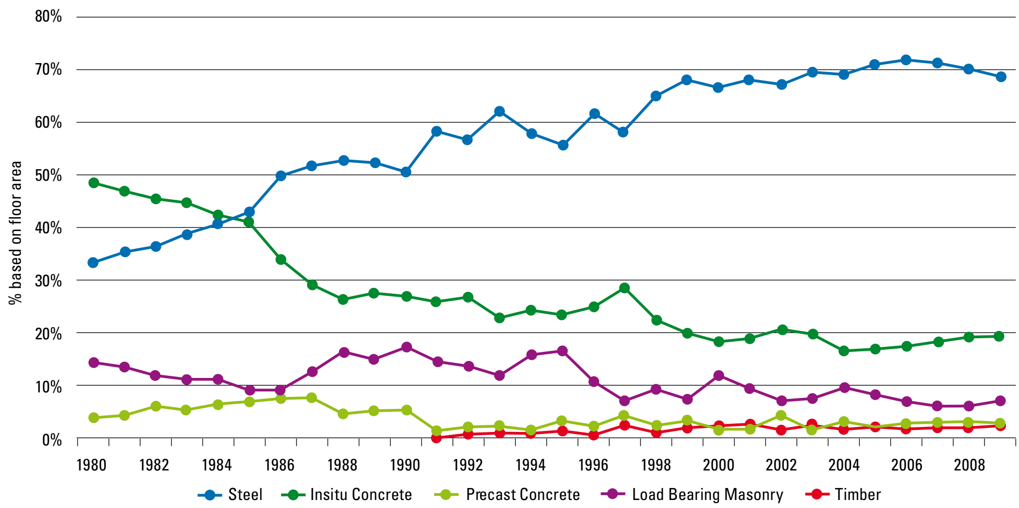
Steel is emerging from the recession as still the framing material of choice for the multi-storey buildings market.

The 2009 Market Share Survey conducted by independent researcher Construction Markets shows that in the non-residential multi-storey buildings sector structural steel frames held a market share of 69%. Steel's nearest rival, insitu concrete, remained below 20%, where it has been for some years. Steel's share of the single storey industrial buildings market rose to 97.6%.

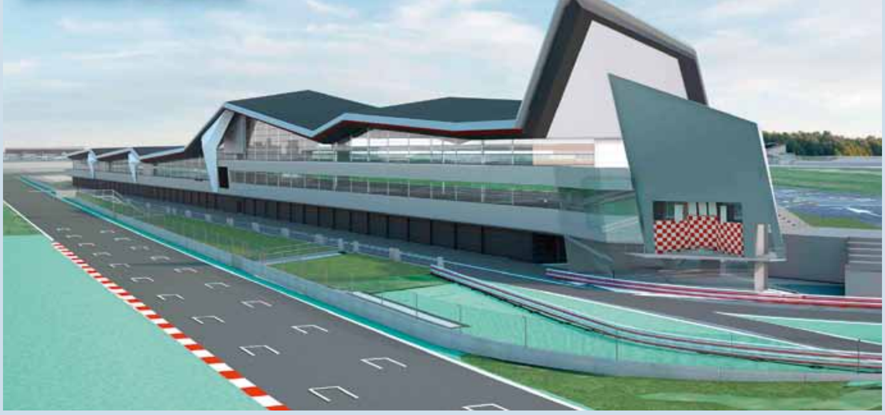
Alan Todd, Director of Market Development at the BCSA, said: "The growth of structural steel's use over the last 25 years is a real success story for the construction and manufacturing sectors in the UK."

Mr Todd said the recent increases in steel prices shouldn't affect steel's market share. "There is also upward pressure on alternative materials which means the relative competitive position will be largely unchanged. Recent steel prices are not insignificant, but they constitute less than 1% of overall typical building costs. It is also worth considering that even with the price increases the costs of the frame and floor of a steel-framed building is still well below 2008 levels.

"We believe that structural steel's overall cost and sustainability benefits as well as its speed, quality, and health and safety record will continue to make it the preferred choice of construction teams."



Steel flagged up at Silverstone



As part of a major redevelopment of the UK's premier Formula One Grand Prix Circuit at Silverstone, Barrett Steel Buildings has won a contract to provide the steelwork for the new Pit and Paddock.

Working on behalf of main contractor Buckingham Group, Barrett Steel Buildings has begun its steelwork erection programme. After a brief pause for the 2010 British Grand Prix, held during the weekend of July 10/11, the steelwork is scheduled to be completed by the end of July.

The complex is the first stage in reconfirming Silverstone's position at the pinnacle of the motorsport industry and as the home of motor racing. Included in the complex are new garages, a race control building, media centre, hospitality and VIP spectator zones and a primary paddock.

Designed by award winning sport architects HOK, the new complex will act as a catalyst for further investment across the site and set a high architectural standard for any future developments.

Joint Managing Director of Barrett Steel Buildings, John Brennan said: "I am thrilled that our company is able to contribute to such a high profile British project that will be seen by millions across the globe. The Barrett team are really pulling out all the stops to ensure the project is a complete success."

Civic hall for Guildford

Construction work on Guildford's new civic hall is on track for completion next year, with the majority of the project's steelwork now erected.

The 1,700 capacity venue is a replacement for an older premises which stood on the same site and was demolished last year.

Steelwork contractor for the project is D A Green & Sons, and its contract requires the fabrication, supply and erection of approximately 640t of steel.

The project's largest steelwork elements consist of a series of 22m long trusses which form the auditorium roof. Below this the venue has two levels of seating, a balcony and a ground floor which will include retractable seating.

"We've completed the structure's main frame and metal decking on programme," said Martin Futter, D A Green & Sons' Contracts Director. "During August we will return to site for five weeks to erect the technical level, which is high level steelwork inside the auditorium for audio, lighting and stage systems."

The new civic hall will host a mixed programme of rock concerts, classical music and theatre. It has been designed by architects Austin Smith Lord and the main contractor is Willmott Dixon.

Olympic venues on track during busiest year

The Olympic Delivery Authority (ODA) has released new aerial images of the progress on the London 2012 Olympic Park, showing construction work firmly on track during what has been described as the busiest year for the project.

The main five venues (Olympic Stadium, Aquatics Centre, Olympic Village, Velodrome and International Broadcast Centre/Main Press Centre) are all on schedule, while further progress has also been made on the new infrastructure and landscaping that will help to create the UK's largest urban park for over a century.

ODA Chairman John Armitt, said: "As we approach the halfway point of our toughest year in the construction of the Park, these new images show the visible progress being made. The structures of the main venues are already firm fixtures on the east London skyline and we remain on schedule."

The picture (right) shows the Olympic Stadium at its full height with all 14 lighting towers in place and work underway on covering the cable net roof. In the foreground the wave-shaped Aquatics Centre steel roof structure is in place with roof covering work well underway. The dive pool and two 50m competition and training pools have also been completed and tested.

The steelwork packages for both the Stadium and the Aquatics Centre have been completed by Watson Steel Structures using a total of 12,800t of structural steel.

Carlisle academy provides educational boost for Cumbria

More than 200t of structural steelwork is being supplied and erected by Caunton Engineering for the new £26M Richard Rose Central Academy in Carlisle.

The project comprises two main wings linked by a large glazed central atrium. Working on behalf of Kier Construction, Caunton is erecting fabricated box girders, which are tapered in profile, to span the atrium.

Spanning between 19m and 26m, the girders are an architectural feature with top boom channels and plated webs connected by countersunk bolts. The web plates are tapered from 1m at the centre to 0.6m at the ends. Each beam was fabricated in two pieces with a central splice designed as a feature and also requiring countersunk bolts.

The Academy is scheduled to be completed early in 2011.

Medical research relies on steel

A new Laboratory of Molecular Biology (LMB) is under construction in Cambridge, which will replace an older laboratory and keep the Campus and the City at the forefront of world scientific developments.

Sir Leszek Borysiewicz, the Medical Research Council (MRC) Chief Executive said: "The LMB has an outstanding track record as an innovator in medical research. The new building will allow the MRC to build on the LMB's position as a globally competitive research centre and continue to attract the best researchers."

The new state-of-the-art building consists of two kinked laboratory blocks joined by a central atrium, in a shape reminiscent of a chromosome, measuring approximately 160m x 65m. The total usable area will be approximately 27,000m^2 of fully air-conditioned space, on three main floors.

There are some substantial steel structures included within the building, such as four external stainless steel clad towers which house the majority of services.

Within the structure's atrium, offices and seminar rooms are positioned at the two central crossing points, where staircases also connect the floors and provide access to informal coffee areas at the interstitial level.

The offices, formed with structural steelwork, are housed within four accommodation boxes which span the atrium. For aesthetic reasons all staircases and bridges within the atrium are made from structural steelwork, while the roof is formed with 30m-long cellular beams.

Steelwork is being erected by Fisher Engineering.

AROUND THE PRESS

Construction News
6 May 2010
Heron tops out to tower over the capital
The steel structure gives the the north side of the building a distinctive look, with huge steel diagrids each spanning three floors emphasising the office 'village' inside.

Project Scotland
April 2010
Taking wing to suit building constraints
(Kirkcaldy's Victoria Hospital) An interesting element of the project, which has a total steel content of 3,700t, is how something as mundane as a window cleaning gantry, which runs the length of the wave-like facade at roof level, has been turned into a feature.

Construction News
13 May 2010
Mabey/Bourne to target nuclear work
It is estimated each site will need 25,000 tonnes of structural steelwork, including traditional building steelwork, heavy plate work and pipework.

Construction Manager
April 2010
Water wings
(London 2012 Aquatics Centre) Here, a full 3,175 tonnes of steel has been configured into a dense maze of curving trusses and cross beams up to 11m deep. The 120m clear span between supports makes the roof structure more akin to a bridge than a building, points out Mike King of structural engineering consultant Arup.

Construction Manager
March 2010
End of the pier show
(Weston-super-Mare pier) Building a 21st century pier meant designing the structure to cope with heavy, variable loads created by new thrill rides, while steel fabricator William Haley Engineering had to adapt beam designs to fit with the existing structure that had not been destroyed by the fire.

Four and half years of steel guidance

This month sees the Steel Industry Guidance Notes (SIGNS), distributed with issues of New Steel Construction since January 2006, complete four and a half successful years.

SIGNS are short, two page inserts that give practical advice on technical, commercial, legal, marketing, and health and safety issues that build into a comprehensive set of notes on key aspects of steel construction.

The audience for SIGNS includes clients, architects, M&E contractors, quantity surveyors and engineers. Advice contained within each issue is easy to locate, assimilate and apply. A contact point is included should further information be required and a list of up-to-date references clearly identify where additional guidance can be found.

Each guidance note is periodically reviewed and updated to ensure that only the most relevant and up to date information is available.

Since January 2006 there have been 46 SIGNS with the last ten consisting of:

SN45 Preloaded Bolt Assemblies
SN44 SIGNS
SN43 Shallow Floor Solutions in Steel
SN42 Curving Steelwork
SN41 Appraisal of Steel Structures
SN40 Corrosion Protection
SN39 Inspection Documents
SN38 Life Cycle Assessment of Buildings
SN37 Web Openings in Composite Beams
SN36 BS9999: A New Approach to Design of Fire Precautions in Buildings

All of the above are available for free download at the following websites:
www.new-steel-construction.com
www.steelbiz.org
www.steelconstruction.org
www.corusconstruction.com

Wigan gets a big lift

A 1,000t capacity crane lifts a 40m-long truss into place on the Wigan Life Centre project, a scheme which will ultimately bring much needed employment and investment into the town.

Weighing 53t, the truss will support two floors and the roof above the centre's new 25m long swimming pool. Steelwork contractor Elland Steel brought the truss to site in sections, assembling it on the ground, prior to the lift which took approximately 10 hours to complete.

The multi-million pound PFI scheme will create a state-of-the-art leisure, health, learning and information complex spread across two sites. Facilities also include a learning pool with a moveable floor, a fitness centre, open plan offices, three libraries and a 'one-stop shop' for health, social care, council services and community associations.

Working on behalf of main contractor Morgan Ashurst, Elland Steel will eventually erect 2,500t of structural steelwork for the project's two sites.

Anglo French collaboration for steel design guides

SCI and CTICM of France have completed a 20 month project to produce a range of guides and technical commentary for the steel construction sector.

Jointly supported by Arcelor Mittal, Corus and Peiner Träger, the two institutes collaborated to produce some 21 deliverables, covering many aspects of multi storey and single storey structures and ranging from concept guidance to detailed technical commentary.

The intention is that the guides and design tools are translated and localised for a number of European countries, with the objective of supporting steel construction in those markets.

A number of workshops were held as part of the project, highlighting national differences in practice and the opportunities that steel offers for long span, lightweight, adaptable construction.

Guidance targets distribution centres

TARGETZERO®

The second of five Target Zero guides, covering distribution warehouses, is due to be published shortly and will be available for download in pdf format from *www.targetzero.info*

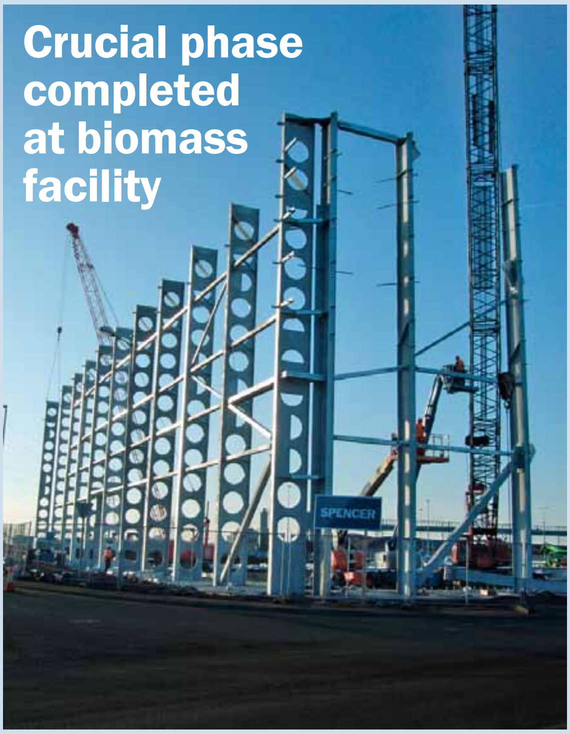
The distribution warehouse guidance provides invaluable information for designers, construction clients and their professional advisors on how to design and construct sustainable warehouses.

Target Zero is a steel construction sector project designed to provide guidance on design and construction of sustainable, low and zero carbon buildings. Five non domestic building types are being analysed in the project funded by Corus and the BCSA.

A further three building types are being analysed, and these guides are due to be published later this year. Retail buildings is due in July, medium-to-high-rise offices in September and guidance on mixed use buildings will be published in November.

To download these guides and find more information about reducing carbon emissions in construction visit: *www.targetzero.info*

Crucial phase completed at biomass facility



A bespoke biomass loading facility at the Port of Tyne is now well underway after the 1,200t steel frame for the project's main structure was completed by Atlas Ward Structures.

The scheme as a whole will be the largest of its kind in the world and came about following an agreement between the Port of Tyne and Drax Power.

Under the agreement, the Port's facility will have the provision to handle and store up to 1.4 million tonnes of biomass per annum.

The biomass from sustainable resources will be co-fired at the Drax Power Station in Selby. The Port of Tyne will be responsible for the unloading of vessels containing up to 70,000 tonnes of biomass, transfer to storage facilities and subsequent reloading to train for dispatch to Drax.

Engineering firm Spencer are acting as EPC (engineering, procurement and construction) contractors at both ends of the project, constructing the rail loading and unloading facilities at the Port of Tyne and at Drax.

Investment ensures seamless Eurocode changeover

Software investment has aided the industry to negotiate a seamless transition to structural Eurocodes since they came into force in April this year.

"After almost 25 years of discussion, planning and development, the Eurocodes are now a reality," said Barry Chapman, Sales Director for CSC. "The cost to rewrite the Eurocode versions of our software has been substantial, but we see this as a strategic investment and it's already paying dividends."

Many CSC customers are now actively using Eurocodes on public projects such as schools, academies, health care schemes and prisons. And those customers designing residential, commercial, or retail developments in the private sector appear keen to explore alternative Eurocode designs.

CSC customers are reporting that the transition to Eurocodes has been painless. Richard Hawthorn from RJH Construction Design, a user of CSC's TEDDS calculation software comments, "TEDDS' transparent calculations are proving invaluable as we transition to the Eurocodes. I was dreading the transition, but with TEDDS' calculations, you can see all the workings, minimising any potential risk."

In practice, using the new Eurocode version of CSC's software is very similar to using the old BS version, and the ability to switch easily between Eurocode and BS designs has been hailed as a great success.

Demand for CSC's Eurocode training courses has risen sharply as customers seek to understand how to use the new software effectively on real projects. Over 80% of the training provided in Q1 2010 was for Eurocode training and this is forecast to increase in Q2 2010.

NEWS IN BRIEF

From May a new on-line service is available to **SCI** members. One click of the information icon, on all SCI on-line resources, will trigger an advisory form for submission. This new electronic system now forms the heart of SCI's advisory service – all advisory questions and answers are now recorded in this system. When a question is of general interest, the question is re-written in a non-specific way, and the answer made "public" on Steelbiz. Members can see both questions and answers – non-members only have access to the question.

The first joint **Galvanizers Association** and **BCSA** course was held on 29 April. The course provided information on modern steel specifications, steel metallurgy, steel cracking mechanisms, case studies and post-galvanising inspection methods. Further joint courses are to be held in the future.

WellMet2050(*www.wellmet2050.com*), a five year project based at the Department of Engineering at the University of Cambridge, held a one day briefing on 28 April to discuss the opportunities of re-using metals such as steel and aluminium. The aim of the project is to investigate options for manufacturing industries to reduce their carbon emissions through streamlining metal fabrication, using less metal and reusing rather than recycling.

Tim Stokes, Managing Director of **Tension Control Bolts** has completed a charity 86 mile walk along the length of Hadrian's Wall. As part of a team, he raised £85,000 to fund a research student's enrollment at St Barts Hospital in London.

The demand for **Eurocode** knowledge has reached India, and three SCI training sessions have been arranged for companies in Bombay and Hyderabad. The companies concerned had previously sent individuals on SCI courses and concluded that the best approach was to invite the lecturers to India. This approach also seems to be favoured in the UK, as SCI is running a series of regional in-house courses for a number of major UK consultants. For more information on SCI courses email: *s.gentle@steel-sci.com*

Wolvercote Viaduct slides into place

More than 5,000t of steel composite bridge deck has been slid into place in Oxfordshire as part of the reconstruction of the Wolvercote Viaduct, which carries the A34 over the A40, the Oxford Canal and a main railway line.

The 250m long deck was moved 16m from a temporary position towards new viaduct piers. Vertical jacks lifted the structure before hydraulic rams were used to push the deck in 500m increments across eight steel slide paths coated with a low friction material.

Costain Project Manager Darren Dobson said: "The bridge slide was a huge success and was carried out with only limited disruption to road users."

One of the main objectives of the entire scheme was to replace the old concrete viaduct with a new steel composite structure, while maintaining peak time traffic flows. To achieve this a dual lane offline temporary viaduct, carrying southbound A34 traffic, was initially constructed adjacent to the existing southbound bridge.

Northbound traffic was diverted to the old southbound structure, while the old northbound bridge was demolished and replaced. Once complete, northbound traffic was diverted back to the new bridge and this in turn allowed the old southbound structure to be demolished.

New piers were constructed and the temporary bridge's deck was slid onto these to form the new southbound structure. Steelwork contractor for the project was Mabey Bridge.

SCI awards NHBC certificate to MIB FrameSpace

SCI has awarded MIB FrameSpace SCI/ NHBC Stage 1 System Certification to build residential buildings up to 30m (eight storeys) in height.

This accreditation also confirms that the MIB FrameSpace system is suitable for use in the construction of dwellings in accordance with NHBC Standards Chapter 6.10 "Light steel framed walls and floors".

Robert Clark, Director, MIB FrameSpace said; "This assessment offers buyers added independent assurance that MIB FrameSpace constructs to a very high standard. The accreditation supports us in the marketplace at an exciting time as we commence some recently won projects in London and the South East."

Andrew Way, Manager of Light Gauge Construction, SCI, added: "SCI's NHBC Certification is a time conscious and highly cost-effective assessment scheme open to companies operating in the residential construction sector."

Steel lady to transform Scottish town

International public artist Andy Scott will unveil a striking 10m high steel sculpture of a woman for the Scottish town of Cumbernauld this summer.

The brainchild of Campsies Centre Cumbernauld - a company established by North Lanarkshire Council to oversee the redevelopment of the town - the sculpture will overlook the A80 and will be seen by more than 70,000 people every day.

Ian Nisbet, Head of Property Services at North Lanarkshire Council, said: "We are delighted with the progress Andy is making on the sculpture. The completion will be a huge milestone in the Cumbernauld Positive Image Project."

The steel lady sculpture incorporates two large swooping arcs which are inspired by the original name for Cumbernauld, "comar nan allt", which means 'coming together of waters' in Gaelic.

The sculpture's head stands 1.5m high and 1.5m wide, with hair sculpted in a 1960s style reflecting the early days of Cumbernauld as a new town.

Diary

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For all SCI events contact Jane Burrell tel: 01344 636500 email: education@steel-sci.com
For SSDA Presentation contact Gillian Mitchell tel 020 7747 8121 email: gillian.mitchell@steelconstruction.org

8 June 2010
Steel Building Design to EC3
Nottingham

17 June 2010
Stability of steel framed buildings
Glasgow

24 June 2010
Steel connection design
Watford

8 June 2010
Steel essentials
Manchester Conference Centre
Free half day seminar

22 June 2010
Steel essentials
Hilton Hotel, Castle Donnington
Free half day seminar

8 July 2010
Structural Steel Design Awards Presentation
Imperial War Museum, London
Evening reception

Retail boost for Wakefield

The Trinity Walk project will provide a welcome boost to Wakefield as well as forming an integral element of a much larger regeneration scheme for the West Yorkshire city.

FACT FILE
Trinity Walk shopping centre, Wakefield
Main Client: Trinity Walk
Architect: DLA
Main contractor: Shepherd Construction
Structural engineer: BWB Consulting
Steelwork contractor: William Hare
Steel tonnage: 6,500t

Above: The Debenhams and Sainsbury's structure nears completion

Below: Retail units will be located along three levels

One of the most high profile casualties of the recession in the retail property sector is back on track and scheduled for completion next Spring. Work on the 46,451m^2 Trinity Walk shopping centre in Wakefield restarted earlier this year, after nearly 12 months in which the city centre site stood half built.

Main contractor Shepherd Construction recommenced construction after a new partnership comprising AREA Property Partners, Sovereign Land and Shepherd Construction purchased the site from the administrators in December 2009.

Anchored by major stores Sainsbury's and Debenhams, the partially enclosed shopping centre covers a 13.5 acre plot and will provide more than 40 large retail units over three levels.

This is a prestigious project for Wakefield and forms part of a wider city centre regeneration programme, including a new covered market hall which Shepherd completed more than a year ago (see NSC April 2008).

"Wakefield has the potential to become a major regional shopping destination, and the first choice for regular shopping trips for those that live within the area," says Nigel Moore, Shepherd Construction Project Leader. "Many people currently travel elsewhere for shopping, Trinity Walk will reverse that trend."

Some of the major steelwork elements of the project were approaching completion when construction work ceased last year. Now the majority of the project's original subcontractors are all back on site and steelwork erection is progressing towards a November completion date.

As with the majority of large retail developments, Trinity Walk is a steel framed scheme because of its speed of construction. The project consists of three main retail structures and a further two smaller buildings which will accommodate retail on the lowest levels with offices above in one structure and a library in the other.

> *"The need for long spans as well as flexibility were two of the main reasons for choosing a steel frame solution."*

Each of the buildings are structurally independent, but are all linked by a T-shaped ETFE covered mall. The largest structure (Block A) and the project's main anchor, houses a Sainsbury's supermarket on the ground floor with Debenhams on the two levels above.

An adjacent car park will offer approximately 1,000 spaces on two levels as well as direct access from the town's ring road. Because the site is sloping, Sainsbury's actually occupies a level below the main retail mall area. However, as the site

Above: The main anchor structure has three feature steel-framed stair modules

stretches westwards, this basement level ceases and the mall connects into the existing nearby thoroughfares at street level. Overall approximately 80% of the mall is suspended above retail zones and a large service yard.

Steelwork, including large plated beams, has been erected around an open plan 20m x 16m grid pattern for the majority of Block A. The exception being some upper levels in Debenhams which house plant areas, and here the grid was broken down to a 16m x 16m pattern.

"The need for long spans as well as flexibility were two of the main reasons for choosing a steel frame solution," explains Richard Osbond, BWB Consulting Business Unit Director.

The steel frames get their stability not from cores but from moment frames mostly positioned along shop fronts.

Flexibility has been designed into retail Block C, as an eight-storey residential block could be added to the top of the structure in the future.

"This isn't on the cards at present, but the foundations have been installed to accept it and the potential extra levels have been designed into the steelwork," adds Mr Osbond.

The grid then slightly decreases to a 10m x 8m for the other two retail blocks (B and C) and this was to maximise the available space for tenants not needing the large expansive areas of the anchor stores. For ease of fabrication as well as to give the scheme a degree of continuity the remaining structures (D & E) are also based around a 10m x 8m grid.

With little need for large stairwells and lifts, as the majority of the circulation will be in the mall, the steel frames get their stability not from cores, but from moment frames mostly positioned along shop fronts. Large fabricated plated beams help spread the loads, especially around the larger grid patterns.

"There are some large beams and columns on this project, with many of the beams up to 2m deep," comments Steve Duffield, William Hare UK Operations Manager. "Each of the five blocks have a similar grid pattern, but each structure's steelwork differs due to different load paths and structural requirements."

The use of steel has also allowed easier modifications to the design to take place. The original scheme although mostly the same as the present one, envisaged an open mall. Since work has been restarted, this has been altered to an ETFE covering supported on 10m wide trusses which in turn are supported off of the main steel frame.

Steelwork contractor William Hare has had to redesign many of the shear connections along the mall, while the mall itself has been narrowed from an original 20m width.

Wakefield Trinity Walk is scheduled to open in time for Easter 2011.

City centre facelift

As well as constructing Wakefield's Trinity Walk shopping centre, Shepherd Construction also completed a new covered market hall in 2008. The old market hall, which stood on part of the Trinity Walk site, was then demolished along with a number of former industrial units to clear an area for the new shopping centre. The town's ring road originally bisected the site and so Shepherd also had to construct a new road to bypass the northern part of the project. Preliminary work began on site during August 2006 and also included re-routing sewers and remediation, as a large portion of the area was originally occupied by a gas works.

A new tower of London

With a structural height of 202m Heron Tower, which recently topped out, is already dominating the City of London's skyline. Martin Cooper reports from the 46th floor.

Over the years the City of London's skyline has continually evolved as higher and more prominent buildings take shape in the nation's capital. The latest structure in this continuing process in the Square Mile is Heron Tower, currently under construction close to Liverpool Street Station.

When complete the 46-storey steel and glass tower will be 202m tall, with a mast adding a further 28m to its overall height, making it the highest building in the City.

A significant milestone was reached on 12 April this year when Heron and Skanska held a topping out ceremony to mark the structural completion of the tower. The project is on schedule to be completed in February 2011.

Designing and constructing a new high profile tower such as this always brings with it a host of unique challenges. In the City of London, the complex layout of ancient streets and lanes often impacts on a project, and has made deliveries to the Heron Tower site challenging at times.

The Heron Tower has an offset core along its southern elevation which creates a structure with clear and open floor plans.

However it is sustainability and prestige which have driven this project. The fact that the structure will create over 3,000 workspaces within walking distance of ten underground stations means the project is a model sustainable development.

Companies based in the City of London are also looking for modern flexible workspace, ideally located in a prestigious setting. The architectural vision for Heron Tower has taken this into account by creating a building which is based around a series of three-storey office villages, at the heart of which is a triple height atrium. These three-storey office villages begin above the building's three-storey high ground floor retail arcade and entrance lobby, and then extend up to the 36th floor. Below the arcade there are three basement levels, adding to the structure's three floor symmetry.

More offices are located on level 37 and a public restaurant and skybar will occupy floors 38-40. Above this, the tower's topmost floors accommodate plant areas.

Kohn Pedersen Fox the project's architect says, in contrast to a typical monolithic appearance with a centre core, the Heron Tower has an offset core along its southern elevation which creates a structure with clear and open floor plates.

By positioning the service core along the entire south face of the tower it also shields the

Prefabrication plays a central role

Much of Heron Tower's structural frame has been prefabricated by Severfield-Reeve at its Yorkshire facility and brought to site in erectable sections. The stability frame sections, weighing 18t each, have been delivered to site on bespoke trailers, fitted out specially to carry this unique steelwork. The single storey frame sections comprise of two columns and one 12m-long beam along the top, all fully welded, which form the perimeter for one and half structural bays. The sections arrive at site and can be lifted straight off the trailers by tower crane and erected immediately.

"There is no site welding necessary and we've reduced the amount of bolted connections, which means a faster erection process," explains Richard Tarren, Severfield Contracts Manager.

The tower's steel framed off-set core has also been erected with prefabricated sections. The core has been formed with a number of fully welded T-shaped sections, each one floor high and weighing 16t. Again, with less on-site bolting and less steel members the core's erection has easily kept pace with the rest of the structure.

"Prefabrication has played a significant role in the construction programme," sums up Skanska Project Manager Jonathan Inman. "We have a 189 week programme and the speed of the steel frame construction is vital. The decision to bring less steelwork pieces to site for erection by the utilisation of large prefabricated sections has made the process quicker and significantly reduced our programme risk."

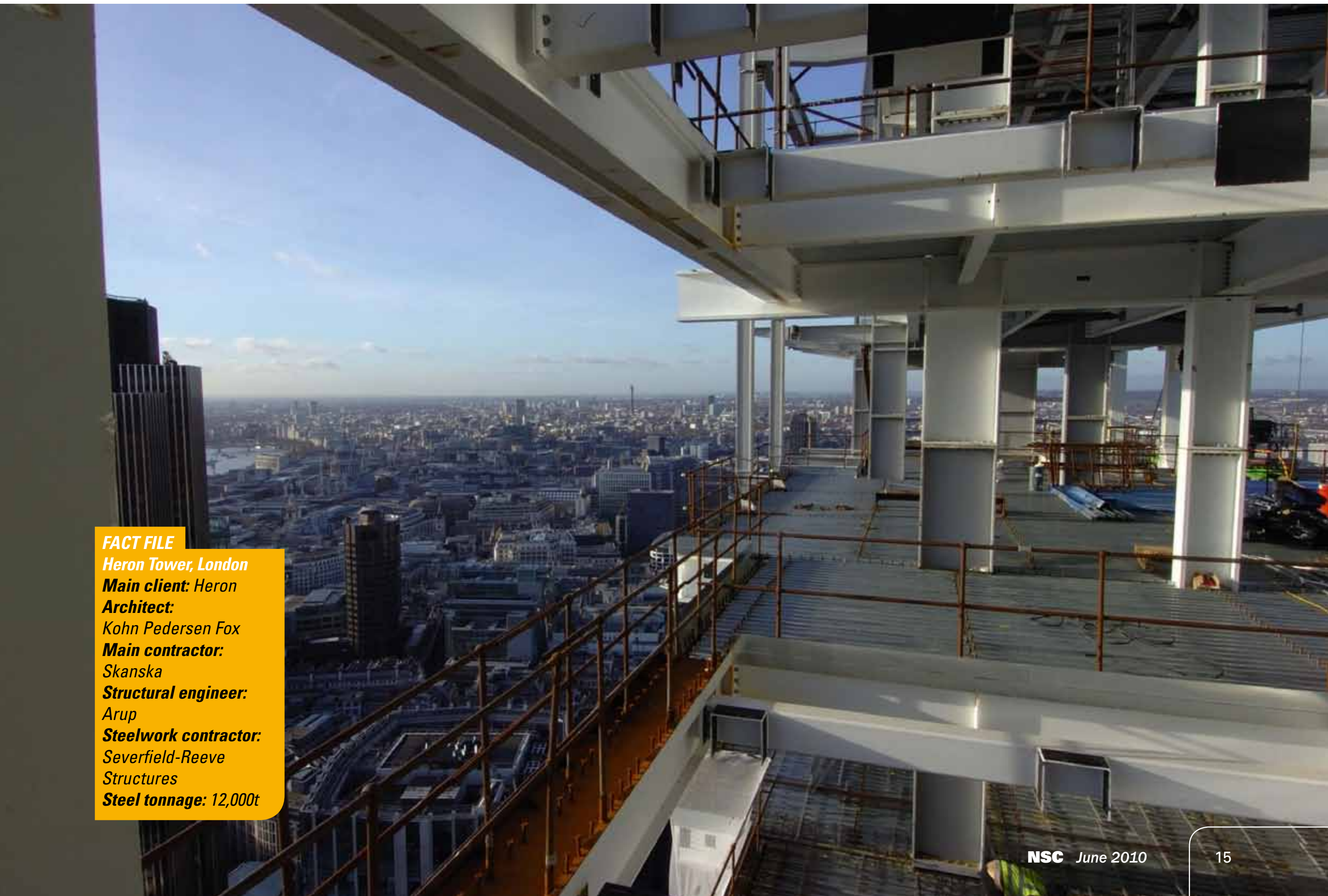
offices from unwanted solar gain. In contrast, the village atria are lit by triple height windows along the Bishopsgate elevation allowing north light to penetrate the workspaces. Each atria features diagonal steel bracing - encased in concrete - along this elevation.

Building such a tall landmark structure in the centre of one of the world's busiest financial districts obviously requires plenty of planning. In order to minimise deliveries of steelwork (12,000t of structural steelwork has been used) to a site surrounded by busy roads and lacking a large delivery area, pre-fabrication has come to the fore (see box above).

It is sustainability and prestige which have driven this project.

However, before any of the prefabricated steelwork was erected the groundwork and foundations had to begin. Two buildings had to be demolished to clear the site and then a top-down construction method was employed which allowed the three basement levels to be piled and excavated while the steelwork was erected - at the same time -

Below: The uppermost levels of the tower will accommodate all of the plant areas



FACT FILE
Heron Tower, London
Main client: *Heron*
Architect: *Kohn Pedersen Fox*
Main contractor: *Skanska*
Structural engineer: *Arup*
Steelwork contractor: *Severfield-Reeve Structures*
Steel tonnage: *12,000t*

Far left: Triple height windows light up the building's atria

Left: Three storey high office villages are based around an atrium up to Level 36

Heron Tower is excellent

A BREEAM 'Excellent' rating has been awarded to Heron Tower. The building will have photovoltaic cells to generate renewable energy that contributes to the overall power requirements of the building and help to create a solar shield and triple skin glazed façades to reduce heat gain by 45% over a standard glazing solution.

Commenting on the award, Steven Evans, Development Director for Heron Tower, said:"Heron Tower's beauty is not just skin deep. Our focus has been on developing a building which will be one of the most advanced buildings in the world, setting a global benchmark for quality in commercial office space.

"Environmental issues are increasingly high on the corporate agenda and sustainability has become a central factor in building design. Heron Tower has met this challenge head on employing a variety of environmentally conscious strategies. We are delighted to have achieved a BREEAM rating of Excellent."

for the three-story high ground floor arcade.

"We had one 800t mobile crane on-site installing the up to 45t basement columns on to pile caps 12m below piling mat level," explains Jonathan Inman, Skanska Project Manager. "The same crane then helped erect all steelwork up to second floor, using a temporarily braced core for stability before the ground floor concrete was cast. After this the site's tower cranes took over."

Above the arcade the tower's village office scheme area was then erected along with the adjacent off-set core. The perimeter of the office area, which consists of three elevations and the dividing line between the offices and core along the south side, is formed by a series of single storey high fabricated sections.

The perimeter of the office area is formed by a series of single storey high fabricated sections.

Brought to site in erectable pieces and fabricated from plated sections, they form a stability or moment frame around the office plate. Much of the tower's stability is consequently derived from this frame, as opposed to the core which is braced but gets its stability from the frame.

Erecting the stability frame required two-storey high temporary braced steelwork to be installed. When two floors of steelwork were complete (including the office's long span Fabsec beams which allow for the clear column free office space) and the concrete floors cast, the temporary works were removed. The temporary steelwork was then lifted up to the next level as permanent stability had been reached once the concrete floors below had cured.

Above the village scheme and the stability frame, from the 38th floor upwards, the construction of the tower is somewhat more conventional. "Here the construction is more of a traditional beam and column format," explains Richard Tarren, Severfield-Reeve Contracts Manager. "The exception being the two three-storey high glazed pavilions on floor 38 which both required slender sections."

A total of 12 lifts will be housed within the off-set core, five of which will only extend up to the 23rd floor. Five others will carry on up to the 41st floor, while another two will whisk guests non-stop up to a 40th floor restaurant.

Powering these lifts are individual motors, each weighing 10t each. Five of these motors are housed on the 23rd floor and the others on the 40th. "That's an extra 50t deadweight on two of the core's floors and this needed a innovative solution," says Mr Tarren. "We had to suspend these floors from above via a series of steel hangers."

All in all, the construction of Heron Tower has utilised a number of innovative steelwork solutions to create a new London landmark.

FACT FILE
St Johns Square, Seaham
Main client: Durham County Council
Architect: Mouchel
Main contractor: Gentoo
Structural engineer: Capita Symonds
Steelwork contractor: Hambleton Steel
Steel tonnage: 190t
Project value: £4.5M

Activating thermal mass

A steel frame has proven to be the answer for a multi-use building where natural ventilation and thermal mass needed to be incorporated in order to reduce running costs and strengthen the scheme's sustainable credentials.

Creating an environmentally friendly building, lowering its running costs and keeping a structure's carbon emissions as low as possible are just some of the important criteria which have to be considered when designing a building for today's market place.

In some ways these issues can be combined with better than satisfactory results achieved by using certain materials in combination with agreed construction methodologies. This has been the case for a new multi-use four-storey council office block under construction in Seaham, County Durham.

This former mining town on the North Sea coast is getting a facelift and community boost with a number of regeneration initiatives taking place. One of the most prominent schemes is known as St Johns Square, where the multi-use building forms part of a £19M town centre redevelopment.

The new building will house a public library and cafe as well as offices for Durham County Council and Seaham Town Council.

Speaking on behalf of the main client, Alasdair Cameron, Durham County Council Design Engineer, says: "We wanted a naturally ventilated building with a design that would help cut down running costs and lower emissions. We also wanted to increase the thermal mass by exposing the floors to allow them to absorb heat during the day and dissipate it at night."

Following discussions between the Council, the architects and the project engineers, a steel framed solution, comprising metal decking and composite concrete floor slabs was decided on as the best solution to incorporate a combination of natural ventilation and thermal mass to control building temperatures.

"We were keen to have a steel framed solution for two reasons," explains Capita Symonds Associate Richard Todd. "It met all of the client's environmental requirements by ulitising the thermal mass of the floors with the added benefit of a quicker construction programme than concrete."

Until the building is complete and occupied it is difficult to put a value on savings to the client. But Mr Cameron says drastic cuts have been made as running costs for the building will have been reduced considerably.

"Steel met all of the client's environmental requirements by activating the thermal mass…"

As for the quick construction programme, Hambleton Steel completed its steelwork contract in six weeks, allowing the follow on trades to get started before Christmas. The entire frame consists of 190t of structural steelwork with 2,550m^2 of metal decking, while the company also installed 11 flights of precast stair units. For safety, as the steel erection proceeded Hambleton installed Extraguard edge protection to the perimeter of all floors and roof.

The structure is divided by a full height glazed atrium, which separates a two-storey element from the main four-storey part of the building. The atrium splays outwards and is widest - 7m - at the northern end.

Architecturally the atrium has been described as a glass shard and it does not only divide the structure allowing natural light to penetrate the structure's innards, but also affords views from within the building of the adjacent church and the nearby coast. The eco-friendly approach to the design has been further enhanced by a green sedum roof which covers the two-storey part of the building.

Meanwhile, the lower part of the main four-storey sector features a double height library formed by one large 14m long exposed feature truss. This area also incorporates a mezzanine level - with a fully glazed façade overlooking the library - accommodating offices, while above this level there are two more floors of offices and meeting rooms.

The remainder of the steelwork is based around a non-regular grid pattern with stability derived from braced bays. Much of the bracing is formed with tubular members and will remain exposed as architectural features.

Natural ventilation to the building is achieved by a series of stacks which penetrate the metal decking and floor slabs culminating at rooftop level in louvred boxes. At each level, the number of stacks increases with a total of 15 spread throughout the structure. On the top floor of the building, roof lights also aid the ventilation.

"The problem many buildings have is how to keep them cool in summer and warm in winter," says Mr Cameron. "We have heating for the winter, but much of the cooling is achieved with combination of these natural ventilation shafts and exposed soffits activating the thermal mass."

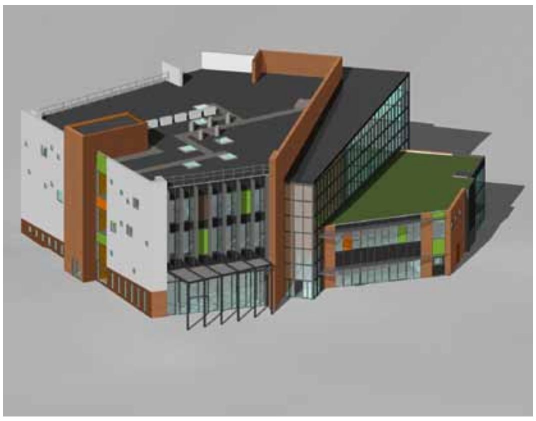
Main contractor for the project Gentoo says it will handover the completed project by November, which will bring to a close a successful 14 month programme. Prior to the new building going up the preliminary works included the demolition of an old bus station. The site also included a severe slope, with approximately 7m difference between the top and bottom of the site.

In order to achieve a level site, almost 1,800m^3 of earth was removed from the site and a retaining wall built at the southern and western ends of the site.

Once the new building is complete, work will commence on the remaining phases of the St Johns Square redevelopment. After the town's library has relocated into its new home, the old adjacent library building will be demolished along with old council buildings and a magistrates court.

This will make room for further developments, such as a new public square which will be overlooked by Seaham's steel framed, environmentally friendly and naturally ventilated civic building.

Above: The atrium divides the structure's four-storey and two-storey sections



Far left: The atrium affords views of the adjacent church and the nearby coast
Left: A 14m long exposed truss helps form the open plan library
Right: Design model of Seaham's new council building
Far right: Construction work is on schedule for November completion

Waste not want not

Representing the largest single capital project ever commissioned by the Jersey Government, a new energy from waste facility, which will provide 7% of the island's electricity, is under construction at La Collette. Martin Cooper reports.

The UK needs to find alternative sources of energy as well as methods for waste disposal that do not involve landfill sites. Many local authorities believe energy from waste facilities, where rubbish is incinerated to produce a renewable source of electricity, are the answer to both of these pressing questions.

A number of these plants are currently under construction across the UK and one such facility is at La Collette near St Helier on the island of Jersey. Once commissioned in 2011, it will replace an existing incinerator and provide the Channel Island with a reliable means of waste disposal for the next 25 years. It will also be able to produce 10MW of power, equivalent to 7% of the island's electricity usage.

The facility will be accompanied by a bulky waste recycling plant, with the capacity to pre-treat up to 40,000t of household, commercial and industrial waste per year.

Commenting on the project, the States of Jersey's Director of Waste Strategy Projects, Will Gardiner, said the plant's development represents the end of a lengthy process, involving the consideration of numerous technological options.

Energy from waste is regarded as the best option for an island with few waste management facilities and a limit on the use of compost and digestate on its unique agricultural land, which is primarily given over to the production of potatoes.

Although the new plant sits adjacent to an existing power station, with which it will share a chimney, cooling water and other auxillary services, the facility will not resemble a run-of-the-mill industrial building. The majority of the structure's steel frame will be left exposed, with the large circular columns and roof trusses aiding a modernist architectural vision.

"Steel was chosen for the structure's main frame to fit the overall architectural concept," says Will Shaw, Campbell Reith Project Engineer. "And in order to get the required open internal spans steel was the obvious option."

Working on behalf of main contractor Spie Batignolles Camerons, Bourne Steel is fabricating, supplying and erecting approximately 900t of steelwork for the project's main frame.

The frame is formed by six large 36m long roof trusses supported on 37m high CHS columns, which are spaced at 16m intervals. At roof level the main trusses are tied together by a series of 16m long secondary trusses. Each gable end is formed with a box section (500mm x 30mm with 805mm x 20mm wide plates welded either side) goal post structure which stands approximately 800mm inside of the main perimeter column line.

The majority of the structure's steel frame will be left exposed, with the large circular columns and roof trusses aiding a modernist architectural vision.

Completing the steelwork concept, the columns are connected together with seven lines of bespoke fabricated cladding wind rails, which begin 6m

FACT FILE

La Collette Energy from Waste facility, Jersey

Main client: States of Jersey

Architect: EPR

Main contractor: Spie Batignolles Camerons

Structural engineer: Campbell Reith

Steelwork contractor: Bourne Steel

Steel tonnage: 900t

Top left: Roof trusses will remain fully exposed as feature elements
Top: The gable end of the steel framed energy centre is formed with large box sections positioned inside the column line
Above: Trusses are brought to site in two pieces and welded together at the site's assembly yard. The completed 36m long sections (left) are then lifted into place

above ground level and extend upwards to the roof at 4m intervals. These rails with preformed feature openings are designed to remain exposed beyond the line of the cladding and aid the overall vision for the structure. This is further enhanced as each bay of windrails is connected to the roof structure at midspan by two vertical macalloy bars which run the full height of the elevation.

Much of the project's substantial concreting works had already been completed prior to this year's steelwork programme kicking off. Large concrete walls and structures housing offices at one end of the building, and the 30m deep refuse tipping bunker, all provide the steelwork with some stability. Where there are no concrete walls to tie back into, such as the two gable ends and near to the roof, the steelwork is braced.

Delivering structural steelwork to a site in Jersey from mainland UK has been a logistical challenge. From Bourne's facility in Poole, Dorset the steel is transported by road to Portsmouth and then shipped overnight by ferry. However, once on Jersey the loads are too big to be moved from the harbour to the site, as parking restrictions have to be put in place to make sure the loads can be manouevred around some tight bends. This means all deliveries to the site from the harbour are made only on Sundays.

The tubular columns are transported to site in three sections - two 15m lengths and a third 7m piece. The 5m deep roof trusses arrive in two equal sections, while the majority of the remaining steelwork is delivered complete.

"We have an assembly yard on site where the tubular columns and roof trusses are welded, shotblasted and painted, before being lifted into place as complete sections," explains Neil Senior, Bourne Steel Contracts Manager.

Steelwork erection has been done with a combination of the on-site tower crane and an 80t crawler crane. "We started erecting the structure from one gable end and then worked our way down the building," adds Mr Senior. "There are points further down the structure which are out of reach for the tower crane."

As well as the main concreting works having mostly been completed prior to the steel frame erection beginning, the majority of the facility's equipment, such as boilers, were also installed earlier in the construction programme.

Interestingly, as part of another separate contract, a further 400t of structural steelwork has been erected to support the internal equipment and to provide maintenance walkways. The internal steelwork is completely independent from the main frame as the two steel elements are not connected at any point.

"We've had to leave a couple of areas open for machinery installation," says Mr Senior. "But the majority of our steelwork is covering over areas which are largely completed."

Steelwork for the main facility is scheduled to be completed by July, when Bourne will begin erecting the adjacent bulky waste recycling plant. This building will comprise of a large portal shed measuring approximately 70m x 25m with a maximum eaves height of 14m.

It is anticipated the facility will be up and running, providing Jersey with a clean and renewable source of energy and waste disposal, by May 2011.

Below: Situated on a headland at La Collette, the new energy centre will share a chimney with an existing power station

Starring role for Dublin theatre

FACT FILE
Grand Canal Theatre, Dublin
Main client: Chartered Land
Architect: Daniel Libeskind
Main contractor: John Sisk & Sons
Structural engineer: Arup
Steelwork contractor: Andrew Mannion Structural Engineers (AMSE)
Steel tonnage: 600t

Above: The sloping steel and glass façade of the theatre's entrance

Built in a shape that defies description and featuring complex and challenging steel elements, the Grand Canal Theatre is Dublin's newest cultural and tourist magnet. Martin Cooper reports.

The former docklands area of Dublin, straddling both the north and south banks of the River Liffey, has undergone a huge transformation over the past decade. Once an area of wharves and warehouses, it is now home to a thriving business and leisure destination and central to this is the Grand Canal Harbour development.

Based around a large urban piazza on the southern bank of the Liffey, the development boasts a five-star hotel, offices, apartments and now, as its focal point, the architecturally stunning 2,100 seat Grand Canal Theatre.

The seven-storey, 11,700m² theatre, which officially opened in March, is part of a larger complex which includes a 21,000m² office block to the south and another 33,000m² predominantly retail block to the north.

The three buildings are treated with different cladding systems, with perforated stainless steel rain screen featuring glazed strips distinguishing the theatre from the commercial elements of the scheme.

Shape-wise the theatre's form defies naming, as its complex design doesn't lend itself to any particular shape.

The vertical walls are inclined and cantilever, the front façade is inclined in two directions and the whole building is topped with a sloping roof which is inclined in two axes.

Although the primary frame for this unusual structure is concrete, it is steelwork that has allowed the striking form of the building to be achieved, most notably the sloping and cantilevering roof.

> **It is steelwork that has allowed the striking form of the building to be achieved.**

Working on behalf of main contractor John Sisk, AMSE undertook the steelwork contract for the project. The steel elements can actually be broken down into five main areas, each with its own individual challenges. These are the auditorium cantilevered balcony supports; the roof trusses to the auditorium; a five-storey cantilevered section over the Misery Hill road; the main plant room space, and the roof.

It was last of these – the cantilevering roof at the front of the building – also known as the 'beak', and the final steel element of the steel erection jigsaw, which was the most challenging to design and erect, according to Denis McNelis, AMSE Engineering Director.

Below: Design model of the theatre

Above: The challenging cantilevering roof which culminates at the 'beak'

Above right: The five storey element which cantilevers over Misery Hill

This section of the roof is isolated from the structural steelwork supporting the structure's façade, which is positioned directly below, while it also cantilevers out by 15m from the concrete frame behind.

"A key feature of the roof was the tip of the cantilever which houses a hidden gutter and forms a horizontal edge to the roof. Due to the number of large roof lights, the primary trusses were arranged around these 'light' openings supporting secondary purlin trusses, which were orientated on plan so that they were level across the width of the building," explains Mr McNelis.

These trusses in turn supported adjustable purlin angles as this was the only location to provide tolerances into the support steelwork. This allowed the roof cladding to cater for the deflections in the main support trusses.

The cladding contractor required extremely tight tolerances on the line and level of the front edge of the roof or 'beak', and so a detail connection from the edge RHS to the trusses allowed for four degrees of adjustment, up and down, left and right, in and out, and a rotation up and down.

"The beak cantilevers out by 15m and there is limited support, so we needed a lightweight solution," adds Arup Lead Engineer Salam Al-Sabah. "Steel was the only viable solution for this part of the scheme."

Below: Opening night for the Grand Canal Theatre

Ease of construction was also taken into account when specifying the use of steel and the façade support steelwork was installed after the roof and 'beak' sections were in place. This meant large steel support members were lifted into position by threading them through and in between the roof trusses.

"This would have been very difficult if we'd gone for a solid concrete slab solution," adds Mr Al-Sabah.

Another complex zone of the project was a five-storey back-of house area that cantilevers over the adjacent Misery Hill road. This structure starts at 10m above the thoroughfare and each of the floors are hung from four diagonal ties connected to fixings cast into the concrete wall of the theatre.

The columns from each floor were isolated from the floor below until the concrete had been poured, this ensured no dead loads were transfered during construction. After the floors were cured and the majority of the permanent loads applied, the columns were then spliced together to ensure that they could work as a single column, sharing loads should a diagonal tie fail.

"Steel's speed of construction meant limited road closures, which was an important consideration when deciding on which material to use," adds Mr Al-Sabah.

Right: Roof trusses for the auditorium being erected

Inside the theatre, the design of the auditorium balconies was a further sector which lent itself to the use of structural steelwork. The balconies required the fabrication and installation of six steel beams which were connected to the concrete slab, to achieve the required 200mm structural depth at the tips.

The cantilever tips, which are 8m long and weigh more than 4.5t each, were anchored using couplers to the T40 rebar in the concrete slab of the balcony.

Above the balconies, the ceiling for the main auditorium is supported on five 3.5m deep trusses with spans varying from 23m to 31m. Each of the trusses are supported on elastomeric bearings and also support the floor to the roof top plant area. Due to the acoustic performance requirements of the theatre a concrete floor was cast onto both the top and bottom booms of the trusses.

These trusses are also heavy, weighing between 15t and 40t. Due to site restrictions and the available tower crane capacity, the heaviest truss had to be installed in three pieces. To enable this a 15m high temporary tower was erected to allow the first section of truss to be erected, supported on a bearing at one end and the tower at the other. The centre section of truss was then lifted into place and cantilevered out 10m from the tower. The final section was lowered in between the concrete auditorium wall and the already erected truss and bolted up. Jacking points on the temporary tower were used to adjust the level of the splice to allow an

"This would have been very difficult if we'd gone for a concrete slab solution."

exact fit of the final piece of truss.

Above the auditorium's trusses, the plant room roof was 'probably the most standard steelwork element on the project, but it did have its own inherent complexities' says Mr McNelis.

This steelwork formed the primary support to the desired architectural scheme, with the main roof sloping from east to west with a 19 degree slope, while also at the same time sloping north to south by three degrees.

The roof structure starts at 24m OD (ordnance datum) and finishes at a maximum height of 48m OD. The cladding is supported off of hot rolled purlins spaced at 4m centres, which in turn are supported off of the main rafters. As the purlins and rafters are not orientated along either of the primary axes of the roof plane, every purlin is both sloping along its length and rotated to align to the roof plane.

"This added to the complexity of fabrication as every purlin connection to the rafter had to cater for the 16mm fall over the 300mm width of the rafter, while ensuring that the top surfaces of both purlins remained aligned," says Mr McNelis.

To achieve this, a plate was also welded to the top of each rafter to match the slope of the purlins and to ensure full support of the roof decking as it passed over the beams.

As the theatre is now open and the public have begun to enjoy Dublin's new cultural landmark, much of the internal and roof steelwork is now hidden within the completed venue. However, the main entrance and structure's façades are testament to the stunning and unusual architectural designs that can be achieved with structural steelwork.

Above Right: Balcony support steelwork being installed

Right: The completed auditorium

Steel – the never ending process

The sustainability benefits of steel in terms of multi-cycling are becoming more widely appreciated, says John Dowling, BCSA Manager, Sustainability.

Steel is the world's most multicycled material. It never loses its value and enjoys a sustainable economic life cycle that is unrivalled by any other construction material. All steel has a value, whether it is being re-used or recycled with around 500M tonnes of steel recycled globally every year. Current UK recovery rates are 99% for structural steelwork, and 94% for all steel construction products. Steel has always had a sound sustainability case and can easily be recycled or remanufactured into new products with no loss in fundamental properties. Its magnetic properties mean that it can be efficiently segregated from mixed waste streams and fed back into the system.

The outstanding multi-cycling performance of steel is well recognised, and its intrinsic value as a scrap material means it is always in demand for the production of new steel. Scrap that is collected for recycling is material that does not have to be managed as a waste or sent to landfill. It is a valuable resource that is converted into value-added commodities.

Perhaps even more importantly, the recycling of steel already in circulation saves not only the planet's valuable resources, but offsets primary production processes and their associated environmental impacts and energy consumption required to mine, crush, grind and otherwise metallurgically process virgin ore. Recycling also increases the material and energy efficiency of product systems throughout the life cycle via saving energy and associated greenhouse gas emissions through less energy intensive reprocessing and thus is good management practice.

Steel scrap can be blended, through the recycling process, to produce different types of steel – both grade and products – as demand dictates. For example, steel from redundant industrial machinery can be used in the manufacture of more contemporary products such as cars or white goods which, in turn, can be recycled into new, maybe as yet undiscovered, applications in the future.

There are thousands of different grades of steel available, each tailored to specific applications in sectors as diverse as packaging, engineering, white

New BCSA office puts sustainability into practice

The BCSA's regional Yorkshire office demonstrated steel's sustainability credentials as the building was constructed with 82t of re-used steelwork.

The office development's portal framed 1,800m^2 structure was built entirely with steel from an old warehouse which was redeveloped. All the sections were disassembled and then refabricated in to a new frame.

Recovered Teeside steel

Recycled steel turns up virtually everywhere. When Corus demolished a redundant open hearth steel plant, that had come to the end of its useful life in 2004, the 20,000 tonnes of recovered steel were tracked through the recycling process to its new uses.

Structural sections went to Heathrow Terminal 5 and the new stand at the Oval. Some was used in the manufacture of steel plate for the construction of buildings over Paddington railway station in London.

More plate was fabricated into large girders used on the construction of the A249 bridge to the Isle of Sheppey in Kent. And some was even used in the manufacture of galvanised strip steel to make light steel-framed houses. Other uses included copper-plated coins and automotive parts.

Recycling this steel saved enough energy to supply 3,700 households with all their energy requirements for a year

Heathrow Terminal 5 photo by Warren Rohner. Ford Transit by Rudolf Stricker. Paddington photo by Keith Edkins.

goods, vehicles and construction. Construction is the largest market sector for steel in the UK, accounting for 29% of consumption in 2008[1].

All new steel products in use today contain a proportion of recycled content. While these products can have been recycled through one or many previous uses, it will at the start of its life cycle been produced using iron ore. As long as steel recycling continues the life of the steel within a product is infinite, and becomes merely parts of the large life cycle of the material.

An unrivalled sustainability strength of steel is its ability to be repeatedly re-used or recycled without any degradation in the quality of the material. Other materials are often recycled only once before downgrading, and eventually find their way to landfill. Scrap is produced during the construction and refurbishment of buildings and when they are ultimately demolished and therefore material becomes available for recycling at each of these stages. As prefabricated products and systems, scrap from the manufacture of steel construction products is easily collected and segregated for recycling and, on the construction site, steel products generate very low or zero scrap. See Table 1.

While the amount of scrap steel that is collected for recycling is known, it is much more difficult to establish the amount of scrap steel arising from the construction and demolition of buildings. In the UK in 2008, 11.5mt of scrap steel were recovered (from all market sectors) for recycling. It is estimated that construction steel accounts for 8% of this total. This proportion is much lower than the share of steel going into construction (29%) and this reflects the longevity of steel construction products, implying that the stock of steel in UK buildings and infrastructure is increasing.

To establish recycling rates for steel construction products, a detailed material flow analysis (MFA) was undertaken in 2003[4]. The results were validated as part of a larger MFA study of the UK steel sector[5].

Generic product	Scrap rates (%)	
	Manufacture [2]	Construction [3]
Sections	4.1	0
Profiled cladding and decking	2.3	5
Sandwich panels (steel only)	3.9	5
Composite floor decking	1.4	NA
Light gauge steel	3	2.5

Table 1: Manufacture and construction rates for steel construction products

	Structural sections	Light gauge steel	Cladding	Metal floor decking	Rebar	Internal non-structural steel
Recycling %	86	89	79	79	91	85
Re-use %	13	10	15	6	1	2
Landfill %	1	1	6	15	8	13

Table 2: Reuse, recycling and landfill rates for steel construction products

1 ISSB, 2010
2 Life cycle assessment (LCA) for steel construction, European Commission, EUR 20570 EN
3 Site wastage rates used for the Green Guide to Specification, BRE
4 An environmental and material flow analysis of the UK steel construction sector. J. Ley, 2003.
5 Iron, steel and aluminium in the UK: material flows and their economic dimensions. Policy Studies Institute, London. Centre for Environmental Strategy, University of Surrey, 2004.

‘Blue Book’ tables for bolts, welds and webs

For the last time in this series, David Brown of the SCI looks at the resistance tables in the ‘Blue Book’ – looking this time at the tables for bolts, welds and web resistance.

No less important than bending and buckling resistance, the “Blue Book” covers the usual additional tables that designers would expect. In general, we would always say that “the steel knows no difference” and therefore we would be surprised if we found a dramatic change according to the Eurocode. Prepare to be (slightly) surprised!

Bolt resistances – Shear and Tension

We really would be surprised if bolts had suddenly become stronger or weaker – they certainly don’t recognise national boundaries. The following table covers the UK “Standard” bolt – a M20 8.8, fully threaded, non-preloaded.

M20, 8.8, fully threaded		
Resistance	BS 5950	BS EN 1993-1-8
Shear	92 kN	94 kN
Tension (simple method)	110 kN	141 kN
Tension (more exact method)	137 kN	

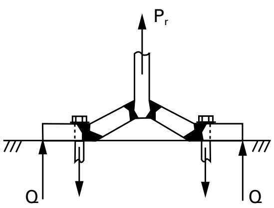


Figure 1: Prying force, Q

We notice that there is no “simple” method in the Eurocode – prying, as illustrated in Figure 1, must always be accounted for. Of course, in simple shear connections there is no prying, and in the modern approach to moment connections, the method allows for prying. In other connections with bolts in tension, prying must be considered.

Punching shear?

The tables for non-preloaded bolts, as shown in Figure 2, include a new minimum thickness when bolts are used in tension – “minimum thickness for punching shear”

Diameter of Bolt	Tensile Stress Area	Tension Resistance	Shear Resistance		Bolts in tension
			Single Shear	Double Shear	Min thickness for punching shear
d	A_s	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	t_{min}
mm	mm^2	kN	kN	kN	mm
12	84.3	48.6	27.5	55.0	4.3
16	157	90.4	60.3	121	6.3
20	245	141	94.1	188	7.8
24	353	203	136	271	9.4
30	561	323	215	431	11.6

Figure 2 Typical table for 8.8 bolt resistances

The idea that bolts in tension may pull out of the material may be new, but could be envisaged with relatively thin material. The minimum thickness quoted is that needed to deliver the tensile resistance given in the Table. The expression of this design resistance is given in Table 3.4 of BS EN 1993-1-8.

Bolt resistances - Bearing

The Eurocode is rather more complex than BS 5950 when calculating the bearing resistance. The influence of the end distance, edge distance, pitch and gauge are all taken into account and can all have an impact on the final resistance. The geometry of the existing “standard” details found in the “Green Book” on simple connections mean that the bearing resistance is limited. The “Blue Book” therefore gives the bearing resistances for the “standard” details, assuming these to be in common use in the UK, but also gives bearing resistances with increased dimensions which increase the bearing resistance. Extracts for M20, 8.8 bolts in S275 are given in Table 1 and Table 2. The increase in bearing resistance is considerable with just a modest change in geometry.

Table 1: **“Standard” geometry**

Diameter	Edge distance e_2	End distance e_1	Pitch p_1	Gauge p_2	Bearing resistance (kN) Thickness (mm)					
					5	6	8	10	12	15
20	30	40	60	60	42.1	50.5	67.4	84.2	101	126

Table 2: **Geometry arranged to increase the bearing resistance**

Diameter	Edge distance e_2	End distance e_1	Pitch p_1	Gauge p_2	Bearing resistance (kN) Thickness (mm)					
					5	6	8	10	12	15
20	35	60	80	70	74.5	89.5	119	149	179	224

A demonstration of how these bearing resistances have been calculated is worthwhile, starting with the “standard” geometry and 10mm S275 material.

The bearing resistance, as given in Table 3.4 of BS EN 1993-1-8 is: $F_{b,Rd} = \frac{k_1 a_b f_u d t}{\gamma_{M2}}$

Where a_b is the smaller of α_b, $\frac{f_{ub}}{f_u}$, or 1.0

For end bolts, $\alpha_b = \frac{e_1}{3d_o}$ and for inner bolts, $\alpha_b = \frac{p_1}{3d_o} - \frac{1}{4}$

k_1 is the smaller of $2.8\frac{e_2}{d_o} - 1.7$ or 2.5

For the “standard” geometry:-

$k_1 = 2.8\frac{e_2}{d_o} - 1.7 = 2.8\frac{30}{22} - 1.7 = 2.11$ or 2.5 (the minimum).

Therefore $k_1 = 2.11$

$$\alpha_b = \frac{e_1}{3d_o} = \frac{40}{3 \times 22} = 0.61$$

a_b is the smaller of 0.61, $\frac{800}{410}$, or 1.0. Therefore a_b = 0.61

With γ_{M2} = 1.25 (from the UK National Annex),

$$F_{b,Rd} = \frac{k_1 a_b f_u dt}{\gamma_{M2}} = \frac{2.11 \times 0.61 \times 410 \times 20 \times 10}{1.25 \times 10^3} = 84.4 \text{ kN}$$

When the geometry is changed slightly to increase the bearing resistance the following calculations result:

$$k_1 = 2.8\frac{e_2}{d_o} - 1.7 = 2.8\frac{35}{22} - 1.7 = 2.75 \text{ or } 2.5 \text{ (the minimum).}$$

Therefore k_1 = 2.5

$$\alpha_b = \frac{e_1}{3d_o} = \frac{60}{3 \times 22} = 0.91$$

a_b is the smaller of 0.91, $\frac{800}{410}$, or 1.0. Therefore a_b = 0.91

With γ_{M2} = 1.25 (from the UK National Annex),

$$F_{b,Rd} = \frac{k_1 a_b f_u dt}{\gamma_{M2}} = \frac{2.5 \times 0.91 \times 410 \times 20 \times 10}{1.25 \times 10^3} = 149 \text{ kN}$$

If the end distance were increased still further to 70 mm, the bearing resistance would increase to 164 kN. This is a massive increase compared to BS 5950 when designers would have expected the bearing resistance in 10 mm, S275 material to be equal to the bolt shear resistance, 92 kN.

The reason for this apparent jump in resistance lies in the different approaches to bearing resistance in BS 5950 and BS EN 1993-1-1. In BS 5950, although the bearing resistance was compared to ultimate loads, the bearing strength had been adjusted to limit the deformation at working load to 1.5 mm. There is no such limit in the Eurocode, and hence higher resistances result. In most cases, the increased bearing resistances will be of little value, because the practical material thicknesses used in most connections are greater than those needed to provide an adequate bearing resistance. The UK National Annex notes that "in certain circumstances deformation at serviceability might control and a γ_{M2} = 1.5 would be more appropriate". The National Annex indicates that this may be the case when a_b = 1.0.

Notice that for "standard" S275, 10 mm fittings, the bearing resistance at 84 kN is a little less than the shear resistance of an M20 bolt at 94 kN.

Preloaded bolts

The new "Blue Book" has plenty of tables covering pre-loaded bolts. It is important to select the correct bolt class and if the bolt is countersunk or not. Like BS 5950, there are two situations covered – non-slip at SLS and non-slip at ULS. A new requirement in the Eurocode is that even when considering non-slip at ULS, the bearing resistance must still be checked, which explains the additional data in the new tables. There is no significant difference in resistances between BS 5950 and BS EN 1993-1-8

Welds

The design resistance of fillet welds is tabulated for welds in S275 and S355. A comparison between the resistances according to BS 5950 and BS EN 1993-1-8 is given in Table 3 for welds in S275 steel.

***Table 3:* Fillet weld resistances**

Leg length (mm)	Throat (mm)	Longitudinal resistance (kN/mm)		Transverse resistance (kN/mm)	
		BS 5950	BS EN 1993-1-8	BS 5950	BS EN 1993-1-8
6	4.2	0.92	0.94	1.16	1.15
8	5.6	1.23	1.25	1.54	1.53
10	7.0	1.54	1.56	1.93	1.91

As expected, there is hardly any difference between the calculated resistances.

Section Designation	Design Shear Resistance $V_{c,Rd}$ kN		Design resistance of unstiffened web, F_{Rd} (kN) and limiting length, c_{lim} (mm) — Stiff bearing length, s_s (mm): 0	10	20	30	40	50	75	100	150	200	250	300	350
406x140x53 +	709	F_{Rd} (c = 0)	151	169	188	209	230	246	288	329	412	495	577	615	615
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	110	110	110	110
		F_{Rd} ($c \geq c_{lim}$)	430	442	453	465	476	486	512	537	583	615	615	615	615
406x140x46	611	F_{Rd} (c = 0)	111	124	138	154	168	181	212	242	304	355	401	405	405
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	100	100	100	100
		F_{Rd} ($c \geq c_{lim}$)	311	320	329	337	345	353	373	391	405	405	405	405	405
406x140x39	566	F_{Rd} (c = 0)	94.9	107	120	133	144	156	183	210	258	297	335	338	338
		c_{lim} (mm)	260	250	240	230	220	210	180	160	110	90	90	90	90
		F_{Rd} ($c \geq c_{lim}$)	260	268	276	284	292	299	317	334	338	338	338	338	338

Figure 4: Extract from web bearing and buckling tables

Web bearing and buckling

The Eurocode approach is rather different to BS 5950, as was explained in the NSC article in May 2008. Tables are provided in the "Blue Book" to make the designer's life easy when checking the resistance of webs to transverse forces. Figure 4 shows an extract from the "Blue Book" tables for S355 beams.

Various values of the stiff bearing length s_s are given, together with information about *c*, which is the distance from the end of the beam. Thus if the load is applied at the end of the beam, the design resistance for *c* = 0 should be taken – the top line for each beam. If the load is applied some distance from the end of the beam, the proximity to the end no longer has any influence. This dimension is described as c_{lim} in the tables, and given in the second line. As long as the load is applied at a distance greater than c_{lim}, the resistance is given by the third line for each beam.

In the May 2008 NSC article, which considered a 406 × 140 × 39 UKB in S355, the stiff bearing length was 50 mm, and the distance from the end of the beam was 2725 mm – greatly in excess of c_{lim} given as 210 mm in Figure 4. The tabulated resistance is given in Figure 4 above as 299 kN – which compares with 298 kN in the earlier NSC article – presumably some rounding difference in the two calculations.

According to the "BS 5950 Blue Book", the bearing resistance is 214 + 2.27 × 50 = 327 kN and the buckling resistance is 1 × (125 × 327)0.5 = 202 kN. The increased resistance in the Eurocode (which covers web bearing and buckling in a single check) is welcome as strengthening will not be needed as often.

Conclusions

This short series has reviewed the resistances according to BS 5950 and BS EN 1993 1. In general, as expected, resistances are generally about the same. The exception is in lateral torsional buckling, where resistances increase in the order of 25% at reasonable lengths. The intention of these articles was to compare and contrast resistances calculated to the two design Standards and offer some reassurance, but also to demonstrate that the "Blue Book" will serve as an excellent design aid, following the lead of all the previous editions, making steel design simple.

AD 346
Design actions during concreting for beams and decking in composite floors

The purpose of this AD Note is to clarify the design values of loading on decking and beams in a steel framed building with a composite floor during execution (the construction stage). The requirements of the Eurocodes are not always clear and reference has to be made to several Parts and their National Annexes. This AD sets out SCI's interpretation and recommendations for this situation.

The basis for structural design is set out in BS EN 1990. This is referred to by other Eurocode Parts dealing with the design of structural elements, including BS EN 1991-1-6, which covers actions during execution, BS EN 1993-1-1 for the design of steel structures, BS EN 1993-1-3 for the design of decking, and BS EN 1994-1-1 for the design of composite steel and concrete structures. All these Parts, together with their respective UK National Annexes, are needed to determine the value of the design effects due to combined actions.

Construction loads on profiled steel decking

Actions at the ULS

Construction loads applied during the casting of concrete

The construction loads (Q_c) during the casting of concrete are covered in BS EN 1991-1-6 clause 4.11.2 and the Standard shows the loads diagrammatically; the diagram, with text labels, is reproduced in Figure 1.

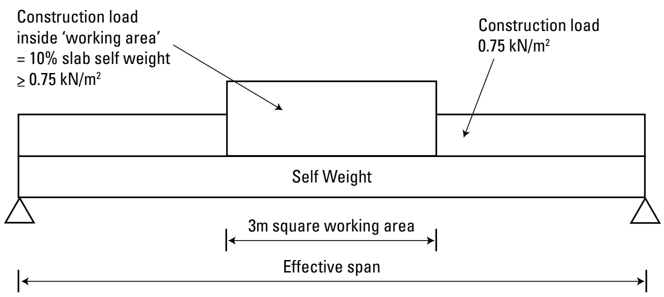


Figure 1 Construction loads during casting of concrete, according to BS EN 1991-1-6

The diagram implies that the load within the working area would be no greater than outside the working area unless the slab weight exceeds 7.5 kN/m², which is much greater than in normal composite decks. This further implies that there would be no allowance for heaping of concrete in the working area. SCI considers that the omission of an allowance for heaped concrete is unwise, and may not have been intended.

Consequently, SCI recommends the following construction loads during casting of concrete for a composite slab:

(i) 0.75 kN/m² generally

(ii) An additional load of 10% of the slab self weight or 0.75 kN/m², whichever is greater, over a 3 m × 3 m 'working area'. This area should be treated as a moveable patch load that should be applied to cause maximum effect.

This recommended loading is shown diagrammatically in Figure 2.

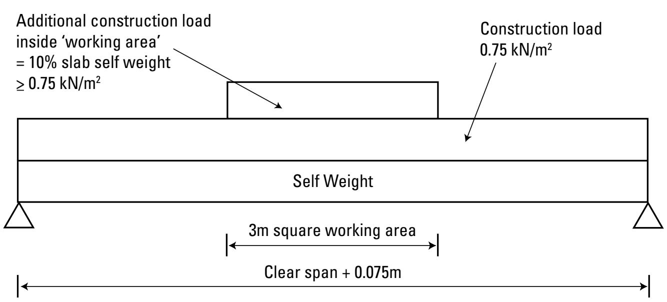


Figure 2 SCI's recommended construction loads on decking during casting of concrete

Allowance for the weight of the wet concrete and reinforcement

The densities and self weight of construction materials are given in BS EN 1991-1-1, and the data is informative. SCI believes that the increase in density of concrete due to the reinforcement of 1kN/m³ given in BS EN 1991-1-1, Annex A, Table A.1 is appropriate for reinforced concrete but not for composite floors, which have only a relatively light mesh. It is also noted that weight of the fresh concrete is to be treated as a variable action, which means that the partial factor γ_Q is applied, rather than γ_G.

For composite slabs, SCI recommends the following loads for weight of concrete and reinforcement:

(i) 24 kN/m³ for **dry** normal weight concrete and 19 kN/m³ for **dry** lightweight aggregate concrete

(ii) 25 kN/m³ and for **wet** normal weight concrete and 20 kN/m³ for **wet** lightweight aggregate concrete

(iii) The weight of the reinforcement for the specified mesh; the value should thus be determined on a case-by-case basis.

(iv) The self weight of the wet concrete is treated as a variable action for the construction condition

(v) The self weight of the reinforcement is treated as a permanent action.

Ponding:

The allowance for ponding of concrete during execution is given in BS EN 1994-1-1 clause 9.3.2. The clause states that, if the deflection of the steel decking is greater than 1/10 of the slab depth, the effect of ponding should be allowed for. It states that the deflection should be calculated under the self weight of the decking plus that of the wet concrete (it must be presumed that the weight of the reinforcement should be included, although it is not stated), calculated for serviceability (i.e. unfactored values of loads). The clause advises that ponding may be allowed for by considering an overall increase in thickness of concrete of 0.7 times the maximum deflection. It may be presumed that the extra weight of concrete from ponding should also be treated as a variable action.

It should be noted that where laser 'mass flood' levelling techniques are employed, the slab depth will be greatly influenced by the deflection of the beams, and this should be considered – see AD 344.

Expression for effects of actions on decking at the ULS:

The expression for effects of actions at the ULS is derived from consideration of the general expression 6.10 for the design combination of actions or the more onerous of expressions 6.10a and 6.10b, all set out in BS EN 1990 clause 6.4.3.2(3). These expressions may be simplified when there is only one variable action e.g. for the design of decking and beams subject to a single variable action (construction load) and permanent actions (self weight), which leads to the following expressions:

option (i)

$$E_d = E\{\Sigma\gamma_{G,j,sup}G_{k,j,sup} + \Sigma\gamma_{G,j,inf}G_{k,j,inf} + \gamma_{Q,1}Q_{k,1}\}, \qquad (6.10)$$

option (ii)

$$E_d = E\{\Sigma\gamma_{G,j,sup}G_{k,j,sup} + \Sigma\gamma_{G,j,inf}G_{k,j,inf} + \gamma_{Q,1}\psi_{0,1}Q_{k,1}\}, \qquad (6.10a)$$

$$E_d = E\{\Sigma\xi\gamma_{G,j,sup}G_{k,j,sup} + \Sigma\gamma_{G,j,inf}G_{k,j,inf} + \gamma_{Q,1}Q_{k,1}\}, \qquad (6.10b),$$

It must be verified that $E_d \leq R_d$ [see BS EN 1990, 6.4.2(3)P].

However, because BS EN 1991-1-6, Annex A1 Clause A1.1 (1) recommends $\psi_0 = 1.0$ for construction loads (and the UK NA adopts this value), expressions 6.10 and 6.10a become identical. Also, expressions 6.10a and 6.10b then only differ by the ξ factor in expression 6.10b. A recommended value of ξ is given in BS EN 1990, Table A1.2.(B), but the UK NA Table NA.A1.2(B) gives a different value, $\xi = 0.925$. Consequently, the more onerous expression is 6.10a, and it has to be evaluated using the partial factors defined by Table NA.A1.2(B). In short, during concreting, all the self weight except that of the concrete is factored by 1.35 and all the variable actions are non-independent and factored by 1.5.

The following expression is therefore recommended for determining design effects during construction at the ultimate limit state:

$$E_d = E\{1.35G_{k,1a,sup} + 1.5Q_{k,1a} + 1.5Q_{k,1b} + 1.5Q_{k,1c}\}$$

where:

$Q_{k,1a}$ is the construction load for personnel and heaping of concrete in the 3m x 3m working area (at least 0.75 kN/m², as recommended above). [This construction loading covers the action defined in BS EN 1991-1-6 as Q_{ca}, which is 'personnel and hand tools', and Q_{cf}, which is defined as 'loads from parts of a structure in a temporary state'.]

$Q_{k,1b}$ is the construction load for personnel etc. across the full area (0.75 kN/m²). [This general load is also stated in BS EN 1991-1-6 as covering Q_{ca}.]

$Q_{k,1c}$ is the weight of the wet concrete, applied across the full area, including additional concrete from ponding (where applicable). [This general load is stated in BS EN 1991-1-6 as covering Q_{cc}, 'Non-permanent equipment' and Q_{cf}, 'Loads from part of a structure in a temporary state'.]

$G_{k,1a,sup}$ is the self weight of the decking and reinforcement.

Actions at SLS

BS EN 1991-1-6, clause A.1.2, states that "for the verification of serviceability limit states [for actions during execution], the combinations of actions to be taken into account should be the characteristic and the quasi-permanent combinations as defined in EN 1990". For the construction stage of composite floors, these combinations may be expressed as:

$$E_d = E\{\Sigma G_{k,j} + Q_{k,1} + \Sigma\psi_0\, Q_{k,i}\} \qquad j \geq 1, i > 1 \qquad (6.14b)$$

and

$$E_d = E\{\Sigma G_{k,j} + \Sigma\psi_{2,i}\, Q_{k,i}\} \qquad j \geq 1, i > 1 \qquad (6.16b)$$

BS EN 1990 states that the characteristic combination (6.14b) is normally used for irreversible limit states. SCI recommends that this combination, which is more onerous than the quasi-permanent combination (6.16b), should apply to verification of both deflection and inelastic deformation criteria at the SLS for decking.

SLS deflection limits

BS EN 1994-1-1, clause 9.6, notes that the limiting deflection under the weight of wet concrete and self weight of the decking may be given in the National Annex but recommends a limit of effective span/180. The UK NA recommends the lesser of the effective span/180 and 20 mm as the limit when loads from ponding are ignored, and the lesser of the effective span/130 and 30 mm when loads from ponding are included; these are the same as the limits given previously in BS 5950-4. SCI suggests that deflections should only be verified in the fully concreted state, i.e. with no patterned loading.

For actions associated with the concreting and the self weight, the recommended SLS design expression for deflections reduces to:

$$E_d = E\{G_{k,1a,sup} + Q_{k,1c}\}$$

SLS deformation limit

There is no requirement for verification of the deformation of the profiled sheeting as shuttering at the SLS in BS EN 1994-1-1, but BS EN 1993-1-3, clause 7.2, gives a deformation limit in terms of a limit on the combined effect of moment and reaction at the SLS at an internal support, when plastic global analysis is used at ULS. SCI considers it appropriate to include the construction loading within the 3m x 3m 'working area' together with the wet concrete and self weight loads for this verification. It is possible that this criterion will govern the design of the decking, but it will depend on the properties of the particular decking.

Based on the characteristic combination, and taking ψ_0 as 1.0, the recommended SLS design expression for verifying the deformation limit reduces to:

$$E_d = E\{G_{k,1a,sup} + Q_{k,1a} + Q_{k,1b} + Q_{k,1c}\}.$$

Construction loads on beams

Actions at the ULS

Construction loads applied during casting of concrete

As noted above, there are three components of construction load on the decking during casting of concrete, $Q_{k,1a}$, $Q_{k,1b}$ and $Q_{k,1c}$. In SCI's opinion, a uniform construction load of $Q_{k,1b}$ = 0.75 kN/m² would be difficult to achieve, let alone exceed, over the large area typically supported by a beam, especially when concreting operations are in progress, and the addition of $Q_{k,1a}$ = 0.75 kN/m² over the 3m x 3m working area would be excessive for design of the beams. With good site control, this allowance for heaping of concrete may be ignored because the application of partial factor for variable actions to the weight of the wet concrete is felt to be sufficiently onerous. Therefore, SCI recommends that designers take advantage of clause N.A.2.13 of the UK NA to BS EN 1991-1-6 to use "values of Q_{ca} and Q_{cc} … determined for the individual project". SCI recommends using $Q_{k,1a}$ = 0 and $Q_{k,1b}$ = 0.75 kN/m² for the design of the beams. The designer should make the contractor aware that good site practice in placing concrete has been assumed and that supervision is adequate to prevent undue heaping of concrete and concentration of men and tools.

Based on the above, SCI recommends the following design formula for actions on beams associated with concreting and self weight:

$$E_d = E\{1.35G_{k,1a,sup} + 1.35G_{k,1b,sup} + 1.5Q_{k,1b} + 1.5Q_{k,1c}\}$$

where $G_{k1a,sup}$ is the weight of the beam section.

Ponding:

BS EN 1994-1-1 does not mention allowance for ponding in the design of beams, but it is recommended that, if ponding has to be included in the design of the decking, consideration should also be given to including it in the design of the beams (in term $Q_{k,1c}$).

As noted for the design of decking, where laser 'mass flood' levelling techniques are employed, the slab thickness will be greatly influenced by the deflection of the beams. The slab thickness for the design of secondary beams is increased by up to 70% of its deflection, plus 70% of the deflection of the decking and up to 100% of the deflection of primary beams. For the design of primary beams, the increase is 70% of the combined deflections of the decking, primary and secondary beams.

However, if the levelling technique is known to be based on constant thickness rather than constant level, then it is considered that there is sufficient margin of safety to ignore the effect of ponding.

Actions at the SLS

The Principle stated in BS EN 1991-1-6, Clause 3.3(1)P, that "Operations during execution which can cause excessive cracking and/or early deflections and which may adversely affect the durability, fitness for use and/or aesthetic appearance in the final stage shall be avoided" is particularly relevant to the deflection of the supporting beams.

Where an assessment of deflection of beams is needed for this consideration, SCI recommends the following expression for determining the deflection of beams during concreting:

$$E_d = E\{1.0G_{k,1a,sup} + 1.0G_{k,1b,sup} + 1.0\, Q_{k,1c}\}$$

There is no requirement to limit stress at SLS unless verification of fatigue at ULS is required, or some form of prestressing is employed (see BS EN 1994-1-1, clause 7.2.2).

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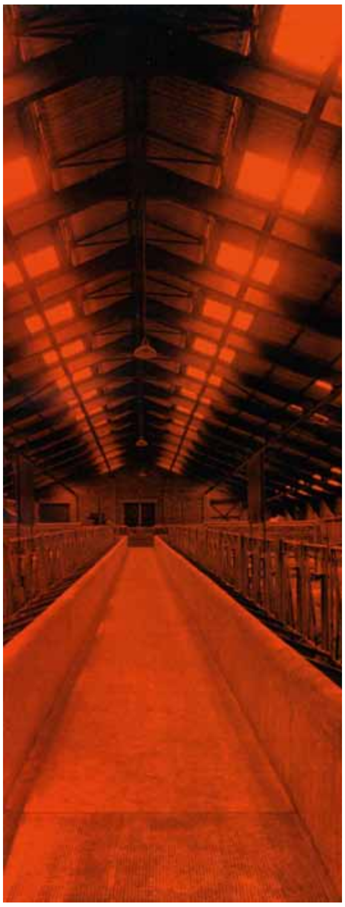
Structural steelwork up on the farm



Despite the quiet revolution which has turned Britain's agricultural industry into the most highly mechanised one in the world, only scant public attention has been paid to that indespensible adjunct of both smallholding and estate farm: the farm building. Yet to the farmer, with vaulable machinery, crops and livestock to protect, the problem of providing cheap and durable accommodation is an important one.

WHAT THE FARMER REQUIRES

What a farmer looks for, ideally is a building which can be erected speedily and simply and which, once in place, will require a minimum of maintenance and attention. He will look for a material which will not chip with misuse, nor crack with extremes of frost and heat: a material, also, which will not rot in damp weather nor succumb to the termites and fungi which may attack farm buildings. If, in addition, the buildings can be dismantled and re-erected, shortened or extended, then the farmer will probably be satisfied.

These ideal properties are not arrived at by accident; a farmer with a limited budget, supplemented perhaps by a Ministry grant, must consider all these aspects pertaining to the life and use of his buildings if he is to get full value for the amount he is prepared to spend.

Only one material can meet these specialised needs.

STRUCTURAL STEELWORK

All over Britain farmers are selecting structural steelwork for buildings ranging from the simplest barns to the largest buildings to house livestock.

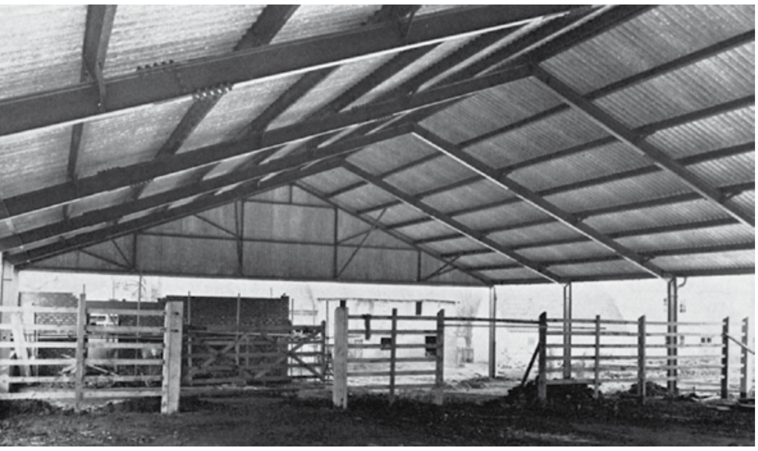
The buildings on the Gteat Yorkshire Showground, recently built at harrogate as the permanent site for one of the country's major agricultural events, are almost exculsively steel framed. As the most important collection of agricultural buildings to be erected in recent years, it is significant – and valuable testimony to the esteem in which structural steelwork is held – that this medium was chosen above all others.

MEETING THE FARMER'S REQUIREMENTS

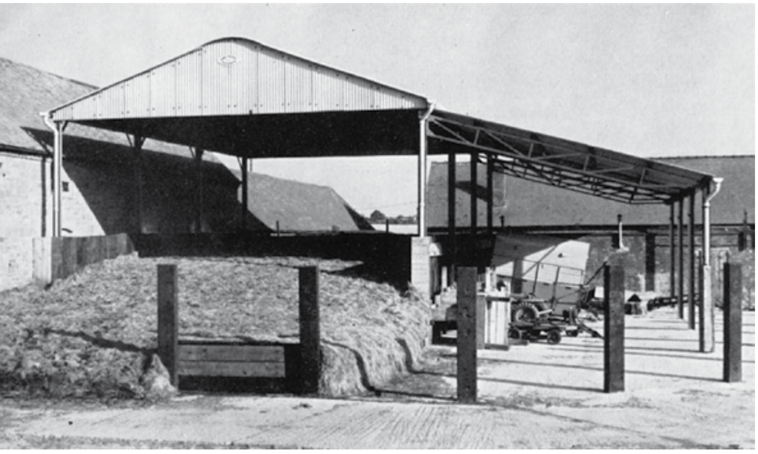
Take first the speed of erection: any building operation is likely to dislocate farming activities to some extent but steelwork, which is fabricated away from the site, can be erected with the minimum of disturbance.

Ministry of Agriculture grants for steel buildings stipulate that the columns shall be etected on concrete foundations. This preparatory work, site levelling, excavation and concreting can be carried out by the farmer himself in accordance with plans which will normallt be provided by the contractor; in neither case need it disrupt the other work of the farm. The usual prodedure is for the farmer to do the work himself.

Once these foundations are prepared the steel structure can be erected and the buildings completed by the addition of roofs, walls, doors and windows, rooflights and drainage, as required.



Above: Six bay cattle yard building, 90 ft long by 60 ft wide in one span
Left: Interior of double-span dutch barn with feeding line down centre
Bottom left: Modern cowhouse of welded portal construction giving maximum unobstructed headroom
Below: Self feed silage with pitched roof, lean-to on one side



Here again, the farmer can elect to carry out some of these cladding operations if he so wishes. Also, thanks to the adaptability of steel, he can amend his original plans at any time: innovations can be made, doors resited and widths and lengths modified.

MAINTAINANCE

This is a recurrent expenditure in all industries, and for the farmer it is essential that these costs should be kept as low as possible. Steelwork meets this condition best of all materials.

Farm buildings inevitably suffer some abuse during their lifetime. A carelessly reversed trailer can chip or break other materials and cause irreparable damage if not collapse. The worst that can happen to steel is that it may be bent, and it can be straigntened and remain as good as new.

Whereas other materials deteriorate internally in the course of time, either as a consequnce of damage by natural causes such as damp summer heat, sharp winter frosts or attack by spores, steel corrodes only on the sufrace, where the need for maintainace can be seen and quickly remidied.

It is usually protected by two coats of paint at the time of construction, of which the first coat, applied at time of manufacture, should preferably be of the rust inhibiting type and the second coat, applied at site should have a hard gloss finish and may be of any colour desired.

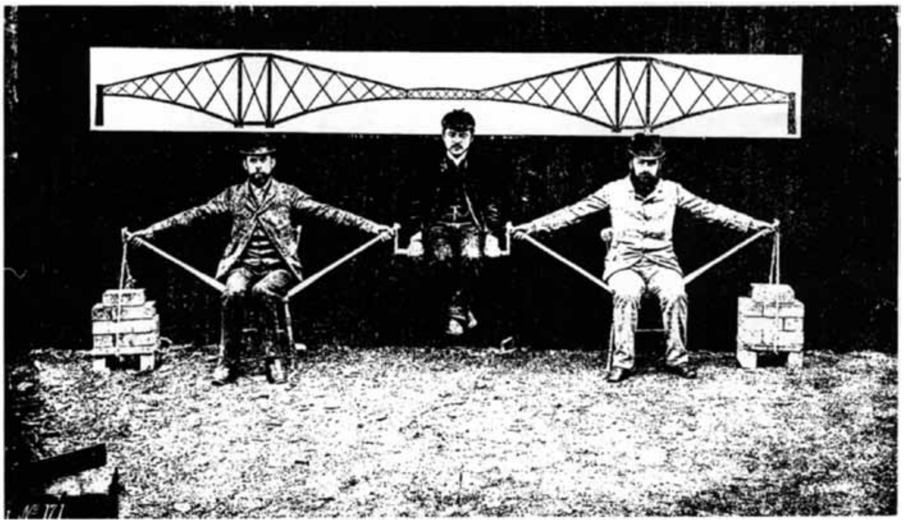
RANGE OF STEEL BUILDINGS

Any building required by the farmer can be built in steel. Lean-to's can be added, wall removed, roofs raised, and any number of alterations made without affecting the soundness or stability of the original structure under technical advice from the manufacturer, which is freely given. No other material can offer such faithful and versatile service at such low cost.

On these pages we depict just a few of the buildings produced by various manufacturers.

The Forth Bridge

Douglas G McBeth *BSc, CEng, MICE, FIStructE, FIHT*
Director, Kenchington Little plc, Consulting Engineers, Edinburgh



The principle behind the bridge is demonstrated using the Human Cantilever

At a recent ceremony, arranged jointly by the ICE and ACSE, a plaque was unveiled on the Forth Bridge declaring it the foremost Historic Engineering Structure in the World. It has also been named as the 8th Wonder of the World and recently it has been compared to modern technology as the 'moonshot of its day'. It was indeed a great leap forward in the art of Bridge Construction. This year (1990) we celebrate the 100th anniversary of its construction and again the attention of the world is on its mighty cantilevers.

I have always greatly admired the Engineers and Contractors that developed such an innovative and bold design in the 'climate' that existed at the time. The Tay Bridge, designed by Sir Thomas Bouch, had collapsed in 1879 with the tragic loss of a train and all its passengers. Bouch had started work on his plans to bridge the Forth and had completed work on the first pier when the Tay collapse occurred. The Directors of the Forth Bridge Company stopped the works and dismissed Bouch pending an enquiry. The general public lost faith in Engineering.

New plans were prepared by Sir John Fowler and Benjamin Baker. The whole of the Engineering fraternity, and indeed the public at large, were looking on with critical interest as the scheme developed and as construction started. Benjamin Baker was the engineer whose genius evolved the ideas behind the structure of the bridge.

He had long taken an interest in long span bridges and had lectured extensively on the subject, preparing schemes for mighty bridges. He developed the idea of using the balanced cantilever principle to span the Forth. At the Queensferry passage on the river there are two deep channels either side of Inchgarvie Island. There is a rock outcrop on the north shore and to the south of the river there is good boulder clay for foundations. The geometry of the position of the supports was therefore primarily dictated by the geology of the seabed. This did mean that the clear spans would require to be 1,710 ft (521m) which at the time was over 3¹/2 times larger than any span completed.

Each cantilever extends 681' 9" (208m) from the towers. The centre sections of the spans consist of simply supported trusses 346' 6" (106m). These are of conventional lattice construction. The simply supported spans are balanced at each end of the side spans by the weight of the masonry portal towers. The centre cantilever has to provide its own stability and the main tower legs are on a much wider base, 260ft (79m).

Baker had been carrying out research into the strength of tubular sections at Imperial College and used this principle in all the compression members on the bridge. The main tower legs are manufactured from tubes 12ft (3.3m) in diameter. The bottom booms of the cantilever are again tubular in section tapering from 12ft (3.3m) at the screwbacks to 6ft (1.8m) at their extremity. All the main tensile members and bracing on the bridge are constructed in lattice steelwork.

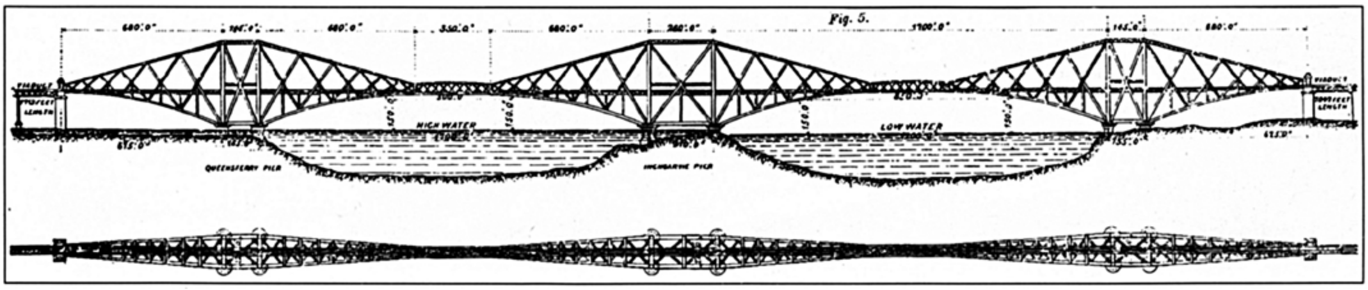
The bridge is the first major structure in the world to use steel as the main structural material. The manufacture of steel had developed rapidly on a commercial basis with the introduction of the Siemens Open Hearth process during the latter part of the 19th Century. This produced a much more consistent and commercially viable steel than that produced by the Bessemer system, Baker designed the bridge superstructure entirely in Siemens steel, specified a minimum yield strength of $33T/in^2$. There are 55,000 tonnes of steel in the bridge. To provide this quantity in a comparatively short timescale the combined resources of three steelworks had to be used (Blockairn & Newton, Glasgow, Dalzells Works, Motherwell, Landore Works, Swansea). In addition 4,200 tons of rivets were supplied.

The contract for the construction of the bridge was let to Tancred-Arrol. It was carried out under the personal supervision of William Arrol. It was probably Arrol's genius for inventiveness that led to the tremendous success of the construction. It was virtually impossible to build and temporary staging in the river from which to erect the main spans. The main structure had therefore to be built up and out from the piers. Arrol had to devise means to achieving this.

The foundations were constructed using caissons that were floated out into position and then sunk into the river bed. At the bottom of the caissons the men worked under compressed air to dig through the mud and boulder clay of the river bed before founding on rock head. To facilitate cutting the very stiff boulder clays on the river bed, Arrol developed a pneumatic clay spade that operated by compressed air. With this the clay could be cut away from under the toe of the caissons and these gradually sunk under their own weight until they rested on a secure foundation. The caissons were filled with concrete and capped with granite before the bases to the main towers were constructed.

All the steel was delivered to the fabrication yards at South Queensferry. Here at the top of the Hawes Brae a large area had been laid out with rail sidings, workshops, offices, drill yards, craneage etc. All elements of the bridge were prefabricated in the yards and dismantled and then taken out onto the river to be assembled.

Each tube truss was cut to size and then bent to shape in a specially designed oven. The plates were then assembled in place. The tubes and all the stiffening steelwork had to be pre-drilled to take the bolting and rivets. On average on the Bridge there are some 100 rivets per foot. Arrol invented a multiple drilling machine that could drill up to 20 holes at a time in the bent plates. Thus



New and Revised Codes & Standards

(from BSI Updates May 2010)

BRITISH STANDARDS

NA to BS EN 1993-3-1:2006
UK National Annex to Eurocode 3. Design of steel structures. Towers, masts and chimneys. Towers and masts
No current standard is superseded

BRITISH STANDARDS

BS EN ISO 9445-1:2010
Continuously cold-rolled stainless steel. Tolerances on dimensions and form. Narrow strip and cut lengths
Supersedes BS EN ISO 9445:2006

BS EN ISO 9445-2:2010
Continuously cold-rolled stainless steel. Tolerances on dimensions and form. Wide strip and plate/sheet
Supersedes BS EN ISO 9445:2006

BS EN 10283:2010
Corrosion resistant steel castings
Supersedes BS EN 10283:1999

BS EN ISO 17635:2010
Non-destructive testing of welds. General rules for metallic materials
Supersedes BS EN 12062:1998

BS EN ISO 23279:2010
Non-destructive testing of welds. Ultrasonic testing. Characterization of indications in welds
Supersedes BS EN 1713:1998

BRITISH STANDARDS WITHDRAWN

BS 5950-3-1:1990+A1:2010
Structural use of steelwork in building. Design in composite construction. Code of practice for design of simple and continuous composite beams
Superseded by BS EN 1994-1-1:2004

BS EN 1713:1998
Non-destructive testing of welds. Ultrasonic testing. Characterization of indications in welds
Superseded by BS EN ISO 23279:2010

BS EN ISO 9445:2006
Continuously cold-rolled stainless steel narrow strip, wide strip, plate/sheet and cut lengths. Tolerances on dimensions and form
Superseded by BS EN ISO 9445-1:2010 and BS EN ISO 9445-2:2010

BS EN 12062:1998
Non-destructive examination of welds. General rules for metallic materials
Superseded by BS EN ISO 17635:2010

NEW WORK STARTED

PD 6695-3-1
Background Paper to the UK National Annex to BS EN 1993-3-1

CEN EUROPEAN STANDARDS

EN 1998-2:-
Eurocode 8. Design of structures for earthquake resistance. Bridges
CORRIGENDUM 1: February 2010 to EN 1998-2:2005

EN 1998-3:-
Eurocode 8. Design of structures for earthquake resistance. Assessment and retrofitting of buildings
CORRIGENDUM 1: March 2010 to EN 1998-3:2005

IEC/PAS PUBLICATIONS

ISO 4986:2010
(Edition 2)
Steel castings. Magnetic particle inspection
Will be implemented as an identical British Standard

ISO 4987:2010
(Edition 2)
Steel castings. Liquid penetrant inspection
Will be implemented as an identical British Standard

The Forth Bridge

continued from p36

the whole process of the manufacture of the tubes was mechanised and for its day very highly automated.

A timber ‘slide’ was built from the fabrication yard at the high level down to the jetty at South Queensferry. Down this slide the sections were lowered and put onto the boats that took them out to the working sites.

The construction took place from the main piers with each being built quite independently. The first to be constructed were the skewbacks at the base of each tower. These complex sections formed the junction between the pier and the main structure. In all ten members up to 12 ft in diameter connected at this point. The main towers were built up from this base. Each plate, 16 ft by 4 ft, was hoisted into place and built off the previous section. Once a complete ring of plates was in place, the tubes were riveted up. Purpose made riveting cages were hoisted up the tubes within which a team of eight men worked as a riveting team. These cages contained not just the men and rivets, but a furnace to heat the rivets and stocks of coke for the furnace etc. These cages were to climb each tower until they were completed at a height of 330 ft above the river. Again the cages would be re-used as the main cantilever trusses were built out.

On completion of the three towers, work started to build out the cantilevers. These had to be built out on either side of the towers simultaneously so as to balance the structure. Again the tubes were prefabricated on shore and shipped out. They were hoisted up the bottom boom on a rail track and then lifted into place by one of the many cranes used on the bridge.

Arrol was to become world famous for his cranes. On the Forth Bridge he had to invent a whole new series of cranes to deal with the particular situations. On the main towers large lifting frames were hoisted up the legs as they were being built. On these frames were purpose made Goliath cranes spanning between each girder as well as numerous derricks. On the legs, special cranes named after Queen Victoria’s Jubilee crawled out along the tubes and trusses. All cranes were operated by hydraulics. The hydraulic fluid had to be pumped up the towers and along the cantilevers to the position of the cranes. The pipework for this had to be extended and adjusted daily as the bridge progressed.

The same hydraulic system was used for the riveting machines that were used on the bridge. Again, these machines were specially invented by Arrol. He was to describe the advantages of this tool as follows: “The Hydraulic Riveter doesn’t turn up for work late; its hands don’t shake from excess drink and they don’t strike for more pay.”

Eventually on 4 March 1890 the Prince of Wales was to drive the last rivet, the ‘golden’ rivet, and the bridge was officially open. Many eminent people visited the bridge that day (including the French engineer Gustaf Eiffel). They doubtless were impressed with the grandeur of the bright red structure. Today people still come from all over the world to look at its magnificent form. It is now (1990) celebrating its 100th birthday.

Fife Tower nearing completion

During this last century it has continued to carry the main line trains between Edinburgh and the North. No major repairs or alterations have been necessary. It is indeed a superb example of British Engineering, innovation and inventiveness and undoubtedly the finest example of construction in steel anywhere in the world.

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

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	Contract Value (1)
A C Bacon Engineering Ltd	01953 850611			●	●		●										Up to £2,000,000
ACL Structures Ltd	01258 456051			●	●	●	●				●				●		Up to £3,000,000
Adey Steel Ltd	01509 556677				●	●	●	●		●	●			●	●		Up to £3,000,000
Adstone Construction Ltd	01905 794561			●	●	●											Up to £4,000,000
Advanced Fabrications Poyle Ltd	01753 531116				●		●	●	●	●	●				●	✓	Up to £400,000
Andrew Mannion Structural Engineers Ltd	00 353 90 644 8300		●	●	●	●	●	●			●	●		●		✓	Up to £3,000,000
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		●	●	●	●	●	●	●	●	●	●		●	●	✓	Above £6,000,000
Atlasco Constructional Engineers Ltd	01782 564711			●	●		●							●			Up to £2,000,000
AWF Steel Ltd	01236 457960				●				●	●	●			●	●		Up to £400,000
B D Structures Ltd	01942 817770			●	●	●	●				●			●			Up to £1,400,000
Ballykine Structural Engineers Ltd	028 9756 2560			●	●	●	●	●				●				✓	Up to £2,000,000
Barnshaw Section Benders Ltd	01902 880848												●			✓	Up to £800,000
Barrett Steel Buildings Ltd	01274 266800			●	●	●	●									✓	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		●	●	●	●	●	●	●	●	●	●		●		✓	Above £6,000,000
Border Steelwork Structures Ltd	01228 548744			●	●	●	●			●	●				●		Up to £3,000,000
Bourne Construction Engineering Ltd	01202 746666		●	●	●	●	●	●	●	●	●	●	●	●		✓	Above £6,000,000
Browne Structures Ltd	01283 212720				●			●							●		Up to £400,000
Cairnhill Structures Ltd	01236 449393				●	●	●	●		●	●			●	●	✓	Up to £1,400,000
Caunton Engineering Ltd	01773 531111	●	●	●	●	●	●	●			●	●		●		✓	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 502277	●	●	●	●	●	●	●	●	●	●	●		●		✓	Above £6,000,000*
CMF Ltd	020 8844 0940				●		●	●		●	●				●		Up to £6,000,000
Cordell Group Ltd	01642 452406	●			●	●	●	●	●	●	●					✓	Up to £3,000,000
Cougar Steel Stairs Ltd	01274 266800									●					●	✓	Up to £6,000,000*
Coventry Construction Ltd	024 7646 4484			●	●	●	●		●	●	●			●	●		Up to £1,400,000
Crown Structural Engineering Ltd	01623 490555			●	●	●	●		●		●			●		✓	Up to £800,000
D A Green & Sons Ltd	01406 370585		●	●	●	●	●	●	●	●	●	●		●	●	✓	Up to £6,000,000
D H Structures Ltd	01785 246269				●						●						Up to £40,000
Deconsys Technology Ltd	01274 521700				●					●				●	●		Up to £100,000
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		●	●	●	●	●	●	●	●	●	●		●		✓	Up to £6,000,000
Emmett Fabrications Ltd	01274 597484			●	●	●	●							●			Up to £1,400,000
EvadX Ltd	01745 336413			●	●	●	●	●	●	●	●	●				✓	Up to £3,000,000
F J Booth & Partners Ltd	01642 241581			●	●		●				●				●	✓	Up to £4,000,000
Fisher Engineering Ltd	028 6638 8521		●	●	●	●	●	●	●	●	●	●				✓	Above £6,000,000
Fox Bros Engineering Ltd	00 353 53 942 1677			●	●	●	●	●			●						Up to £3,000,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	Contract Value (1)

Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	Contract Value (1)
Gibbs Engineering Ltd	01278 455253				●		●	●		●	●				●	✓	Up to £800,000
GME Structures Ltd	01939 233023			●	●		●	●		●	●			●	●		Up to £800,000
Gorge Fabrications Ltd	0121 522 5770				●	●	●	●		●				●			Up to £1,400,000
Graham Wood Structural Ltd	01903 755991		●	●	●	●	●	●	●	●	●	●		●			Up to £6,000,000
Grays Engineering (Contracts) Ltd	01375 372411				●			●		●	●				●		Up to £100,000
Gregg & Patterson (Engineers) Ltd	028 9061 8131			●	●	●	●	●				●				✓	Up to £4,000,000
H Young Structures Ltd	01953 601881			●	●	●	●	●			●						Up to £2,000,000
Had Fab Ltd	01875 611711								●		●				●	✓	Up to £1,400,000
Hambleton Steel Ltd	01748 810598		●	●	●	●	●	●				●		●		✓	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 £6,000,000
Hescott Engineering Company Ltd	01324 556610			●	●	●	●			●				●	●		Up to £4,000,000
Hills of Shoeburyness Ltd	01702 296321									●	●				●		Up to £1,400,000
J Robertson & Co Ltd	01255 672855									●	●				●		Up to £200,000
James Bros (Hamworthy) Ltd	01202 673815			●	●		●			●	●	●			●	✓	Up to £2,000,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●					●		●			Up to £6,000,000*
Leach Structural Steelwork Ltd	01995 640133			●	●	●	●	●			●						Up to £1,400,000
Leonard Engineering (Ballybay) Ltd	00 353 42 974 1099			●	●	●	●				●						Up to £3,000,000
Lowe Engineering (Midland) Ltd	01889 563244									●	●			●	●	✓	Up to £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	●	●	●	●	●	●	●	●	●	●	●		●		✓	Above £6,000,000
Maldon Marine Ltd	01621 859000				●			●	●	●					●		Up to £1,400,000
Midland Steel Structures Ltd	024 7644 5584			●	●	●	●			●	●	●		●	●		Up to £2,000,000
Mifflin Construction Ltd	01568 613311		●	●	●	●	●				●						Up to £3,000,000
Milltown Engineering Ltd	00 353 59 972 7119			●	●	●	●	●									Up to £6,000,000
Newbridge Engineering Ltd	01429 866722			●	●	●	●								●	✓	Up to £1,400,000
Newton Fabrications Ltd	01292 269135			●	●	●				●	●	●			●	✓	Up to £4,000,000
Nusteel Structures Ltd	01303 268112						●	●	●	●						✓	Up to £4,000,000
On Site Services (Gravesend) Ltd	01474 321552				●		●	●		●	●				●		Up to £400,000
Overdale Construction Services Ltd	01656 729229			●	●		●	●			●				●		Up to £1,400,000
Paddy Wall & Sons	00 353 51 420 515			●	●	●	●	●	●	●	●					✓	Up to £6,000,000
Pencro Structural Engineering Ltd	028 9335 2886			●	●		●	●			●				●	✓	Up to £2,000,000
Peter Marshall (Fire Escapes) Ltd	0113 307 6730									●					●		Up to £1,400,000
PMS Fabrications Ltd	01228 599090			●	●	●	●		●	●	●			●	●		Up to £1,400,000
REIDsteel	01202 483333		●	●	●	●	●	●	●	●	●	●		●			Up to £6,000,000*
Remnant Engineering Ltd	01564 841160				●		●	●		●					●	✓	Up to £400,000*
Rippin Ltd	01383 518610			●	●	●	●	●									Up to £1,400,000
Robinson	01332 574711		●	●	●	●	●		●	●	●	●		●	●	✓	Above £6,000,000
Rowecord Engineering Ltd	01633 250511	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✓	Above £6,000,000
Rowen Structures Ltd	01773 860086		●	●	●	●	●	●	●	●	●	●		●			Above £6,000,000*
RSL (South West) Ltd	01460 67373			●	●		●				●						Up to £1,400,000
S H Structures Ltd	01977 681931						●	●	●	●							Up to £3,000,000
Severfield-Reeve Structures Ltd	01845 577896	●	●	●	●	●	●	●	●	●	●	●	●	●		✓	Above £6,000,000
Shipley Fabrications Ltd	01400 231115			●	●	●	●		●	●	●				●		Up to £200,000
SIAC Butlers Steel Ltd	00 353 57 862 3305		●	●	●	●	●	●	●		●	●				✓	Above £6,000,000
SIAC Tetbury Steel Ltd	01666 502792			●	●	●	●				●	●				✓	Up to £3,000,000
Snashall Steel Fabrications Co Ltd	01300 345588			●	●		●								●		Up to £2,000,000
South Durham Structures Ltd	01388 777350			●	●	●				●	●	●			●		Up to £800,000
Temple Mill Fabrications Ltd	01623 741720			●	●	●	●				●	●			●		Up to £400,000
Terence McCormack Ltd	028 3026 2261			●	●		●	●									Up to £800,000
The AA Group Ltd	01695 50123			●	●	●	●			●	●				●		Up to £4,000,000
Traditional Structures Ltd	01922 414172		●	●	●	●	●	●	●		●	●		●		✓	Up to £4,000,000*
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 £400,000
Walter Watson Ltd	028 4377 8711			●	●	●	●	●				●				✓	Up to £6,000,000
Watson Steel Structures Ltd	01204 699999	●	●	●	●	●	●	●	●	●	●	●		●		✓	Above £6,000,000
Westbury Park Engineering Ltd	01373 825500	●			●			●	●	●	●				●	✓	Up to £800,000
William Haley Engineering Ltd	01278 760591			●	●	●			●	●	●					✓	Up to £2,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●		●		✓	Above £6,000,000
Company name	Tel	C	D	E	F	G	H	J	K	L	M	N	Q	R	S	QM	Contract Value (1)

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

Company name	Tel	1	2	3	4	5	6	7	8	9
AceCad Software Ltd	01332 545800		●							
Advanced Steel Services Ltd	01772 259822								●	
Albion Sections Ltd	0121 553 1877	●								
Andrews Fasteners Ltd	0113 246 9992									●
ArcelorMittal Distribution – Bristol	01454 311442								●	
ArcelorMittal Distribution – Mid Glamorgan	01443 812181								●	
ArcelorMittal Distribution – Birkenhead	0151 647 4221								●	
ArcelorMittal Distribution – Scunthorpe	01724 810810								●	
Arro-Cad Ltd	01283 558206			●						
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								●	
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 Services Ltd	01274 682281								●	
Bentley Systems (UK) Ltd	0141 353 5168		●							
Cellbeam Ltd	01937 840600	●								
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									●
Corus	01724 404040				●					
Corus Ireland Service Centre	028 9266 0747								●	
Corus Panels & Profiles	01684 856600	●								
Corus Service Centre Dublin	00 353 1 405 0300								●	
Corus Tubes	01536 402121				●					
Corus Wednesfield	01902 484100								●	
Daver Steels Ltd	0114 261 1999	●								
Development Design Detailing Services Ltd	01204 396606			●						
Company name	**Tel**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Company name	Tel	1	2	3	4	5	6	7	8	9
Easi-edge Ltd	01777 870901							●		
Fabsec Ltd	0845 094 2530	●								
Ficep (UK) Ltd	01924 223530					●				
FLI Structures	01452 722200	●								
Forward Protective Coatings Ltd	01623 748323						●			
GWS Engineering & Industrial Supplies Ltd	00 353 21 4875 878									●
Hadley Rolled Products Ltd	0121 555 1342	●								
Hempel UK Ltd	01633 874024						●			
Hi-Span Ltd	01953 603081	●								
Hilti (GB) Ltd	0800 886100									●
International Paint Ltd	0191 469 6111						●			
Interpipe UK Ltd	0845 226 7007								●	
Jack Tighe Ltd	01302 880360						●			
Kaltenbach Ltd	01234 213201					●				
Kingspan Structural Products	01944 712000	●								
LaserTUBE Cutting	0121 601 5000								●	
Leighs Paints	01204 521771						●			
Lindapter International	01274 521444									●
Metsec plc	0121 601 6000	●								
MSW Structural Floor Systems	0115 946 2316	●								
National Tube Stockholders Ltd	01845 577440								●	
Northern Steel Decking Ltd	01909 550054	●								
Northern Steel Decking Scotland Ltd	01505 328830	●								
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	●								
Profast (Group) Ltd	00 353 1 456 6666									●
Rainham Steel Co Ltd	01708 522311								●	
Richard Lees Steel Decking Ltd	01335 300999	●								
Rösler UK	0151 482 0444					●				
Schöck Ltd	0845 241 3390	●								
Site Coat Services Ltd	01476 577473						●			
Steel Projects UK Ltd	0113 253 2171		●							
Steelstock (Burton-on-Trent) Ltd	01283 226161								●	
Structural Metal Decks Ltd	01202 718898	●								
Studwelders Ltd	01291 626048	●								
Tekla (UK) Ltd	0113 307 1200		●							
Tension Control Bolts Ltd	01948 667700									●
Voortman UK Ltd	01827 63300					●				
Wedge Group Galvanizing Ltd	01909 486384						●			
Company name	**Tel**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

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
Roger Pope Associates	01752 263636
Highways Agency	08457 504030

Steelwork contractors for bridgework

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

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

- **FG** Footbridge and sign gantries
- **PG** Bridges made principally from plate girders
- **TW** Bridges made principally from trusswork
- **BA** Bridges with stiffened complex platework (eg in decks, box girders or arch boxes)
- **CM** Cable-supported bridges (eg cable-stayed or suspension) and other major structures (eg 100 metre span)
- **MB** Moving bridges
- **RF** Bridge refurbishment
- **QM** Quality management certification to ISO 9001

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	FG	PG	TW	BA	CM	MB	RF	QM	Contract Value [(1)]
'N' Class Fabrication & Installation	01733 558989	●	●	●	●			●	✓	Up to £800,000
Andrew Mannion Structural Engineers Ltd*	00 353 90 644 8300	●	●	●	●				✓	Up to £3,000,000
Briton Fabricators Ltd*	0115 963 2901	●	●	●	●	●	●	●	✓	Up to £3,000,000
Cimolai Spa	01223 350876	●	●	●	●	●	●		✓	Above £6,000,000
Cleveland Bridge UK Ltd*	01325 502277	●	●	●	●	●	●	●	✓	Above £6,000,000*
Concrete & Timber Services Ltd	01484 606416	●	●	●		●	●		✓	Up to £800,000
Harland & Wolff Heavy Industries Ltd	028 9045 8456	●	●	●	●	●		●	✓	Up to £6,000,000
Interserve Project Services Ltd	0121 344 4888							●	✓	Above £6,000,000
Interserve Project Services Ltd	020 8311 5500	●	●	●	●		●	●	✓	Up to £400,000*
Mabey Bridge Ltd*	01291 623801	●	●	●	●	●	●	●	✓	Above £6,000,000
Millar Callaghan Engineering Services Ltd	01294 217711	●						●	✓	Up to £800,000
Nusteel Structures Ltd*	01303 268112	●	●	●	●	●		●	✓	Up to £4,000,000
P C Richardson & Co (Middlesbrough) Ltd	01642 714791	●						●	✓	Up to £3,000,000*
Remnant Engineering Ltd*	01564 841160	●							✓	Up to £400,000*
Rowecord Engineering Ltd*	01633 250511	●	●	●	●	●	●	●	✓	Above £6,000,000
SIAC Butlers Steel Ltd*	00 353 57 862 3305	●	●	●	●	●		●	✓	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	●	●	●	●	●	●	●	✓	Above £6,000,000

* Denotes membership of the BCSA