Structural Steel Design Awards 2012

Produced in association with

TATA STEEL BCSA

Steel of Shakespearean proportions

The complex demands of renovating the Royal Shakespeare Theatre in Stratford-upon-Avon posed some significant steelwork challenges

INTRODUCTION

In the year of the London Olympics, it seems apt that the main stadium should feature as one of the winners of the 2012 Structural Steel Design Awards.

It is joined by the London 2012 Velodrome and four out-of-London projects, which include three bridges and a theatre.

This year, the judges presented six awards and 10 commendations from a shortlist of 29 finalists. Location, type of structure, size of project and budget remained as diverse as ever – taking in transport interchanges, housing, offices and power stations.

Nine bridges made it onto the shortlist, demonstrating perhaps a trend for sleek, long-spanning, lightweight structures which need to be built within tight programmes.

Presentations were also made to Queen's University Belfast and University of Bristol in the student award categories for Bridges and Structures steelwork design, respectively.

Daybreak's Helen Fospero presented the awards on 11 July at an evening ceremony at the Museum of London's Sackler Hall. Judges commented that despite the economic pressures faced by the industry, stunning landmark structures are still being built to serve as an inspiration for all.

The judging panel included chairman David Lazenby, representing the Institution of Civil Engineers; Gerry Hayter, representing the Highways Agency; Joe Locke, representing the steelwork contracting industry; Martin Manning, representing the Institution of Structural Engineers; and Christopher Nash, Bill Taylor and Oliver Tyler, representing the Royal Institute of British Architects.

SSDA
RUBY KITCHING

AWARD
ROYAL SHAKESPEARE THEATRE

Architect Bennetts Associates Architects

Structural engineer Buro Happold

Steelwork contractor Billington Structures (primary steelwork), CMF (auditorium steelwork)

Main contractor Mace Group

Client Royal Shakespeare Company

This £112.8 million renovation of the Royal Shakespeare Theatre has involved some extremely careful engineering design and construction – knitting the 1930s building with a new structure that meets modern theatre production needs and improved spectator and visitor experience.

The project involved retaining the existing façade and foyer on one side and fly tower (which houses hoists to lift scenery from the stage) on the other. Nestled in the middle is a new auditorium with increased capacity, which has been designed to allow all spectators to be within 15 m of the stage to ensure a more intimate theatre experience.

Two new main roof trusses measuring 24 m long by 3.5 m deep span the auditorium roof and are designed to support 25 tonnes of scenery.

They also support a hanging technical gallery, which will be used for lighting and sound equipment, plus two hung floors over the auditorium.

"Watching the 36-tonne roof trusses being lifted into place while everyone in the street outside the site stopped to watch was a project highlight," recalls Buro Happold associate director Andrew Wylie. "They all applauded when they fitted in place."

He says that the auditorium posed many design challenges for the team, including designing the auditorium roof structure for 25 tonnes of scenery that can be moved at up to 2.5 m/s, directly over the audience.

A fire engineering analysis removed the need for fire protection on the auditorium roof steelwork and balconies, which allowed winches carrying scenery to run on these structures without damaging protective coatings.

A lightweight frame was favoured for the new structure, so floors are made up of cross-laminated timber (CLT) planks fixed to the steel frame.

"CLT was considered lighter than the equivalent concrete floor system, allowing for lighter mini-piled foundations in some areas and a lighter load being transferred onto the retained Victorian walls, while also allowing an additional floor to be built without substantial masonry strengthening," explains Mr Wylie.

The rest of the project involved extending the existing building to create retail and circulation zones, as well as providing more space backstage.

Connecting to the existing building required coordination between the project team members to ensure the result met architectural, structural and building services aims, as well as cost and client expectations.

The most complex element of the steel erection process was to fix new walkways to the retained fly tower. Access was extremely limited and the steel had to be lifted through a 2 m by 2 m opening in the tower's roof.

"Using our 3D working models along with regular workshops ensured images from all angles could be interrogated, leading to swift approvals, which helped subsequent follow-on trades," says Billington Structures project manager Paul Hayes.

"Challenges on site included working around existing and retained sections of the building, connecting back to the existing structure and working on numerous fronts to an agreed sequence and programme."

But despite these complexities, the project was completed on time and to budget.

36
Weight in tonnes of the building's roof trusses

COMMENDATION: MCLAREN PRODUCTION CENTRE

Architect Foster + Partners

Structural engineer Buro Happold

Steelwork contractor Atlas Ward Structures (Severfield-Rowen)

Main contractor Sir Robert McAlpine

Client McLaren

This building is the manufacturing centre for the McLaren MP4-12C super sports car. Located in greenbelt land, the building had to be sunk into the ground to meet stringent height restrictions – set by a small grassy knoll located in the centre of the site.

Around 180,000 cu m of soil had to be excavated to accommodate the lower ground level for the building. While this level is concrete, the structure above ground is steel to facilitate long open spans.

"It is a very lean building, a bit like a Formula One car – nothing is wasted and many of the individual components perform several functions," explains Foster + Partners partner Iwan Jones.

The superstructure is designed using double primary beams and columns so that all the services, including air supply, power, data, lighting and sprinklers, are concealed within the structural steel frame.

Key aspects of the design are its simplicity and the high level of repetition. In addition, the building was designed in parallel with the development of the process equipment and so recesses and voids were left for items such as a double height paint booth and testing and washing booths.

"While the adjacent McLaren Technology Centre took six years to design and build, the fast-track programme on the McLaren Production Centre meant that it was completed in a third of the time," explains Foster + Partners design director Nigel Dancey. "The same design team worked on both buildings and this continuity helped meet this ambitious programme."

COMMENDATION: THE WALBROOK BUILDING

Architect Foster + Partners

Structural engineer Arup

Steelwork contractor William Hare

Main contractor Skanska UK

Client Minerva

This 10-storey London office block has been constructed using steelwork and composite steel floor slabs with two atria in the L-shaped floorplate to allow daylight to penetrate the building.

Cellular beams have been used to accommodate services and achieve spans of up to 21 m.

Arup associate Joanne Larmour says: "One of the most interesting aspects of the project focused on resolving the vibration issues created by long-span shallow beams.

"Through use of finite element analysis, we identified the key areas that needed to be improved to meet recommended response factors for office space.

"We developed a simple localised solution which was both technically effective and cost-efficient."

Strong showing secures award

The project to strengthen the overworked M53 Bidston Moss Viaduct in Liverpool impressed judges with its efforts to keep the busy overpass open to traffic while making both time and cost savings

SSDA
RUBY KITCHING

AWARD M53 BIDSTON MOSS VIADUCT STRENGTHENING
Structural engineer Amey
Steelwork contractor Cleveland Bridge UK
Main contractor Costain
Client Highways Agency

The M53 Bidston Moss Viaduct is a 730 m-long multi-span box girder structure that carries 63,000 vehicles into Liverpool daily. Having opened in 1970, heavier vehicles and higher use had left it facing closure unless it could be sufficiently strengthened.

"Within the structure there was a high risk of the unknown, therefore risk mitigation was critical," explains Amey project manager Darren Bearwish. "At design stage, great importance was given to ensure safety remained the number one priority during construction and for the future [maintenance] of the structure."

£6.1m Savings from the enlarged access openings

Since closing the viaduct to carry out repairs would have caused major traffic disruption, all strengthening had to be accessed from the sides, underneath or within the structure.

With the box girders posing confined space health and safety risks, a business case was put forward to enlarge 602 existing access openings in the 604 boxes.

Providing safer access would also facilitate more efficient working and an improved certainty on programme and budget. With this increased certainty, a £6.016 million target cost for the access hole enlarging contract was approved, saving a proposed £1.9m and two weeks on the overall programme.

In actual fact, £6.1m was shaved off the strengthening project's overall budget thanks to the enlarged holes making it easier and quicker to carry out the work – the project was also completed three months early, as a result.

The complex project involved numerous innovative design solutions and 100 km of new weld in extremely confined conditions to strengthen and restore the viaduct to full network capacity, while maintaining live traffic at all peak times on the M53.

The 100-week construction programme also included follow-on refurbishment activities including re-painting and new drainage, lighting, cathodic protection and other highway works. To protect the road user, workforce and environment, 3.7 km of box girder was contained within bespoke scaffolding.

The steelwork scope of the contract involved 3,900 linear metres of existing box corner welds and the retrofitting of some 32,500 shear pin connectors to enhance the longitudinal shear transfer capacity of load through the reinforced concrete slab to the steel box. Around 140,000 holes were drilled to tight tolerances, 565 tonnes of steel installed and nearly 26,200 m of finished weld completed using highly specialised labour.

"Heavy welding inside the confined boxes presented extraordinary challenges"
JUDGES' COMMENTS

On visiting the project, the judges commented: "Successfully and safely undertaking the extensive heavy welding inside the very confined boxes presented extraordinary challenges."

A staged construction sequence had to be specified to minimise potential weakening of the structure from drilling, cutting, heating from welding and extra stress from plant and temporary works. The judges added: "The work of the designer and steelwork contractor has been outstanding in investigating, analysing and executing the strengthening throughout the length of this project."

COMMENDATION: BOROUGH HIGH STREET BRIDGE

Architect Jestico + Whiles
Structural engineer Atkins
Steelwork contractor Watson Steel Structures (Severfield-Rowen)
Main contractor Skanska Civil Engineering
Client Network Rail

The new Borough High Street rail bridge will double the number of tracks coming out of the western end of London Bridge station, unlocking a major bottleneck in the Thameslink rail service.

This striking structure is located in one of the most congested sites in London – spanning a busy gourmet food market and close to railway lines and roads which feed the City. To build it within tight constructional tolerances and working restrictions required the highest calibre of engineering and innovation.

The steelwork contract consisted of 128 m of approach viaduct to the west, the main 70 m Borough High Street Bridge span and a further 50 m of viaduct to the east.

The feature bridge is 9 m high in the centre and incorporates 850 tonnes of steel, with a further 400 tonnes of concrete in the deck. The deck is a trapezoidal girder constructed from large diameter tubes with tapering ends.

Atkins principal engineer Mike Richardson says the most innovative part of the project was the design and development of the tubular truss for a 120-year fatigue life. "This was achieved using advanced elastic critical buckling analysis to determine the buckling strength of the bridge, together with careful detailing, particularly of the tube connections."

The main tubes are up to 1,200 mm diameter with 50 mm-thick walls and, due to size and design requirements, many major joints had to be butt welded on site. To ensure a better fit, the entire girder was first assembled in the fabrication workshop before being dismantled and sent to site in sections of up to 65 tonnes each.

Building in such a confined site (within centimetres of adjacent buildings) was a major challenge. With careful coordination, the approach viaducts were built conventionally using cranes to place the girders and deck beams. But the main span had to be slid into position.

On a designated weekend road closure, the bridge was launched from the western viaduct and rolled across Borough High Street at the rate of a few centimetres per minute. The rear end of the bridge was supported on a slide track with Teflon pads, while the front end was supported on hydraulic towers that rested on multi-axle vehicles.

COMMENDATION: WEST BURTON POWER STATION

Architect EDF Energy
Structural engineer EDF Energy
Steelwork contractor Fisher Engineering (Severfield-Rowen)
Main contractor Kier Construction
Client EDF Energy

Three colossal portal frame structures make up the new turbine halls which dominate power company EDF's new 1300 MW combined cycle gas turbine power station on its existing West Burton site in Nottinghamshire. The new facility will supply energy to around 1.5 million homes.

Measuring 82 m by 35 m in plan with 32 m-high eaves, the structures consist of portal frames at 12.5 m centres and a 4.5 m-deep, 35 m-long roof truss supported off fabricated I section columns. SSDA judges commented that the project was a "good example of practical and economical use of heavy steelwork".

The fabricated columns have been designed to meet structural needs with minimum steel, so are a bigger section at the bottom than at the top. This means they are 1800 mm deep by 600 mm wide from ground to 15.75 m height, and then 450 mm deep up to 23.5 m height, where the supporting beam for a 100-tonne overhead crane is located.

Above this beam level, the final 8 m height of column is made from a 900 mm-deep by 450 mm-wide section. The changes in column section required fully welded splices, formed using full penetration butt welds and tapered flange sections to reduce local stresses.

"Steel-framed construction was essential for this project due to the speed of the project but also the need to create large, column-free spaces within the turbine halls," recalls Kier infrastructure and overseas construction manager John Jenkins.

Careful sequencing of the various site activities was required on this project: each turbine hall has two internal floors, which could only be installed following installation of the concrete slabs, plinths and pedestals required for the generating equipment. These internal floors in turn contribute to the overall frame stability and, as a result, the 40,000 sq m of external cladding to the buildings could not be fitted until erection of these floors.

At the very top of their Games

The London 2012 Olympic Stadium and Velodrome have been recognised for their exceptionally green and efficient use of steel

SSDA
RUBY KITCHING

AWARD OLYMPIC STADIUM, LONDON
Architect Populous
Structural engineer Buro Happold
Steelwork contractor Watson Steel Structures (Severfield-Rowen)
Main contractor Sir Robert McAlpine
Client Olympic Delivery Authority

Main stadiums for Olympic events are often designed to showcase the host nation's architectural and engineering talent and are readily interpreted by the rest of the world as an indication of that country's most highly regarded values.

The London 2012 Stadium scores highly as an interesting piece of architecture and efficient engineering structure, but what sets this structure apart from its recent predecessors is its leanness and emphasis on sustainability and buildability.

The London 2012 Stadium contains 10,700 tonnes of steel, which is about one-quarter of that used in the Beijing Olympic Stadium built for the last Games, and so has been designed to be as structurally efficient as possible.

> **"The structure has succeeded in providing a great deal of accommodation using a light and minimal structure"**
> CHRISTOPHER NASH, JUDGE

To add to this achievement, it has also used recycled material from gas pipelines in some of the structure's tubular elements and, where possible, the steel has been designed to be reused after it is dismantled.

"This is a very efficient structure, very compact and economical," says SSDA judge Christopher Nash. He adds that the lack of folly in the design is admirable: while the steel-framed pyramidal towers that punctuate the roof's perimeter offer the structure its identity, the towers are also doing a job – supporting the lighting.

"There's nothing spare in this design," says Mr Nash. "The structure has succeeded in providing a great deal of accommodation using a light and minimal structure."

10,700
Tonnes of steel used in the stadium

Legacy factor

The stadium's legacy is also a concern and one of its main features is that it is part-permanent and part-temporary, reflecting the venue's Olympic requirements as well as the reduced future capacity needs of a regional stadium.

Accordingly, for the Games the stadium will have a capacity of 80,000, which can be reduced to 25,000 afterwards. This is achieved through 55,000 temporary seats in a lightweight demountable steelwork structure, which consists of trussed rakers on raking columns, which sit above the permanent seating.

The roof was designed to be simple to build – having repetitive and prefabricated components – and for future legacy use, as it is also simple to dismantle. It is also structurally independent from the terrace structure. The roof consists of a 900 m-long ring truss supported on a series of inclined tubular columns.

"The building features different supporting structures with differentiating roles," says SSDA judge Oliver Tyler.

"The white circular sections support the roof, and black I and plate sections support the seating." He says that designing a structure which has to reduce in capacity made it suitable for a steel-framed solution so that it would be easily demountable. "It feels very efficient, stripped back and well put together, but still has a strong visual identity," he adds.

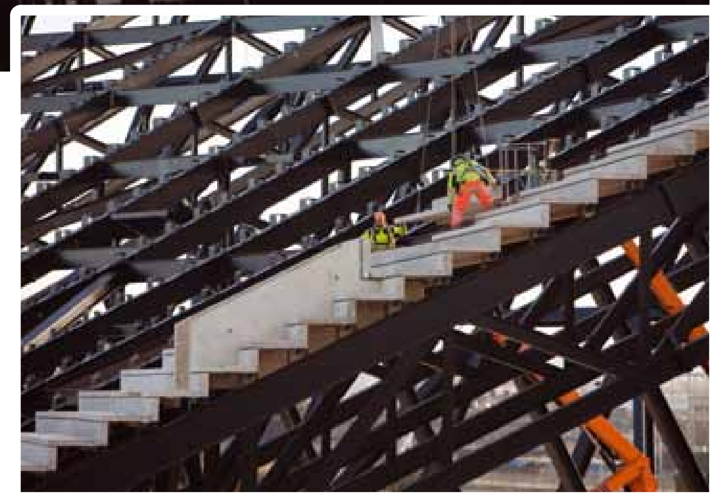
The permanent terrace superstructure consists of precast concrete units resting on large

> **"It feels very efficient, stripped back and well put together, but still has a strong visual identity"**
> OLIVER TYLER, JUDGE

raking lattice girders. As the structure needs to be demountable, all site connections, including those between the steel and precast concrete units, are bolted.

The roof covering consists of a PVC fabric supported on a cable net with an inner tension cable ring and an outer steel compression truss.

The outer ring truss is approximately 900 m long and 12 m deep and is supported at 32 positions by inclined raking tubular columns down to ground



level. The ring truss was designed to be fully bolted with simple flange connections for ease of erection and dismantling, and the individual sections are faceted rather than curved, reducing the fabrication cost.

Sitting on top of the inner cable ring are 14 large pyramidal lighting towers, each 30 m high and weighing 34 tonnes, which are restrained by each other and back to the compression truss with a secondary cable system.

Following installation of all 14 towers on their temporary supports, the upper high level circumferential stability cables and the rear stability cables were fixed and pre-stressed. Only then could the temporary struts be removed and the stability of the lighting towers transferred to the cable net system.

AWARD: LONDON 2012 VELODROME, OLYMPIC PARK

Architect Hopkins Architects
Structural engineer Expedition Engineering
Steelwork contractor Watson Steel Structures (Severfield-Rowen)
Main contractor ISG Construction
Client Olympic Delivery Authority

This 6,000-seater Velodrome is a world-class venue that intelligently answers questions of function, beauty, sustainability, buildability and value. On track for a BREEAM Excellent rating, the venue boasts some impressive statistics, with 29 per cent recycled content, natural ventilation, exceeding Part L (2006) by 30 per cent and extensive use of natural daylight to reduce the reliance on artificial lighting.

The structural system is so efficient that the steel cable net roof is about 35 per cent lighter than the roof of the next best comparable venue in the world, according to the project team. "What's really amazing about this structure is the efficiency of the design," explains SSDA judge Christopher Nash. "Compared to other velodromes I've visited, what stands out is that the volume of this building is so small – so it is very efficient in terms of resources, material cost and impact."

Inspired by the geometry of the cycling track and the engineering of high-performance bikes, the team's design approach followed the desire for lean design throughout: putting the right material in the right place and removing unnecessary fat.

"You can see the structural solution has influenced the architecture of this building," says SSDA judge Oliver Tyler. "This is how we should be designing buildings – with efficiency of materials and structure in mind."

The 13,000 sq m roof is supported by a steel cable net structure, which gives the venue its sculptured identity while accommodating the span very efficiently. Mr Nash says: "The net is a very fine structure, laid on the ground [during construction] and just pinned into place at the edges – you'd have expected that some form of adjustment would have been required, but it wasn't. It was fabricated to exact details – the result is the whole thing is beautiful because of its simple form."

A curved steel-framed bowl supports the upper seating tiers and is topped by an undulating steel perimeter ring truss, which is used to restrain the roof cables. Unusually for a cable roof, the perimeter ring truss is integral with the steel-supporting bowl to take advantage of the strength of the whole structure.

As a result, the ring truss is much smaller compared with a traditional self-contained truss member, which has enabled the use of reclaimed steel tubes to form the truss chords. This approach gave embodied carbon savings of about 3,500 tonnes.

To keep the building compact, equipment such as air-handling units fit under and between the steel-framed bowl. Co-ordinating services, architecture and steelwork in the limited space was modelled using 3D software to ensure no clashes.

MAIN IMAGE COURTESY OF POPULOUS ARCHITECTS

Footbridges cross the divide

These two winners, an innovative self-anchored suspension bridge and a cable-stayed swing bridge, both have the wow factor, impressing the judges with their sleek designs dependent on steel

SSDA
RUBY KITCHING

AWARD PEACE BRIDGE, DERRY-LONDONDERRY
Architect Wilkinson Eyre Architects
Structural engineer AECOM
Steelwork contractor Rowecord Engineering
Main contractor Graham Construction
Client Ilex Urban Regeneration Company

If ever there were the perfect physical symbol for bringing together two communities, it would be the simple bridge. So at Derry-Londonderry, the new Peace Bridge aptly takes on the symbolic and physical role unifying the city and connecting the historically divided east and west banks of the River Foyle.

This 312 m-long sinuous structure is a self-anchored suspension bridge which is the centrepiece of a wider regeneration plan.

Two inclined steel pylons support the deck via a system of suspension cables with one pylon serving each curved half of the S-shaped deck. At the centre of the river, the structural systems overlap to form a "structural handshake".

"As far as we are aware, this is the only pedestrian self-anchored suspension bridge in the UK," says Graham Construction chief engineer Philip Brown. "The structure is highly innovative, with its fluid curves linking in with the main thoroughfares on both sides of the river."

The sweeping alignment of the deck and catenaries are supported by two oppositely inclined 38 m tall pylons, which are formed from tapering hexagonal cross-section fabricated steel box sections. The pylons morph into a triangular cross section with height, finishing with a pyramidal tip. The bridge deck is a steel triangular box section fabricated from painted weathering steel, and stiffened both longitudinally and transversely.

"The bridge deck and pylons are fabricated from weathering steel so that no maintenance will be necessary on the inside of the sealed boxes," says Mr Brown.

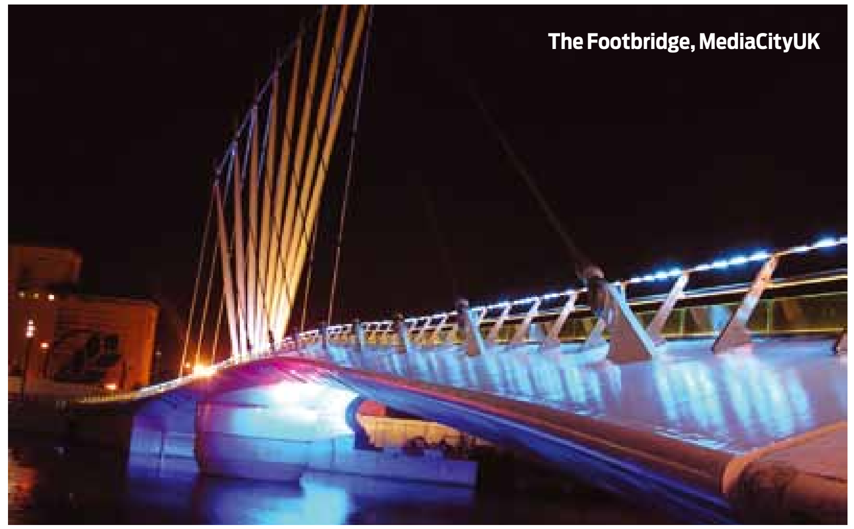
Both pylons and the deck were built using floating cranes.

The deck width varies from 3.5 m at the ends of the crossing to 4.5 m at pylon locations in the river to allow space for fixed seating.

Cable installation involved initially lifting the catenary and hangers using a system of multiple winches and guides and then stressing the suspension system by jacking the main catenary cables only.

For Rowecord Engineering contract manager Peter Samworth, this was the most interesting part of the project. "The loads in the cables, hangers and temporary and permanent supports were continuously monitored and the bridge lifted off its temporary supports at 98 per cent of the calculated loads."

Peace Bridge, Derry-Londonderry



The Footbridge, MediaCityUK

AWARD THE FOOTBRIDGE, MEDIACITYUK
Architect Wilkinson Eyre Architects
Structural engineer Ramboll
Steelwork contractor Rowecord Engineering
Main contractor Balfour Beatty Regional Civil Engineering
Client The Peel Group

Linking the BBC's MediaCityUK site with South Quay across the Manchester Ship Canal, this cable-stayed footbridge has been designed to be a showstopper - with its fan-shaped array of masts supporting high-tensile, spiral-strand steel cables. It is also a swing bridge, where the structure's main span pivots about a pier through 71 degrees to allow vessels to pass along the canal.

"Steel was most suitable for the bridge as it allowed the designers to create a sleek and slender structure with incredible wow factor," says Peel construction director David Glover. The bridge is made up of two spans: a 65 m long main span which crosses the canal and an 18 m long concrete-filled back span that serves as a counterweight.

Varying in height up to 30 m, the masts converge at their base at a steel pedestal which sits on a 9 m diameter reinforced-concrete pier.

Offsite fabrication of the structure by Rowecord Engineering kept costs down allowing deck modules to be welded together and assembled adjacent to the bridge's final position. After the pivot bearing and steelwork had been installed, the bridge was then jacked up and slid over the canal.

Ramboll UK design project manager Steve Thompson explains the process which removed the risk of working over water: "The slide procedure for the main span was carried out over 36 hours and involved jacking up the structure approximately 500 mm off its temporary supports onto a skid track system that incorporated a pair of 40 m long beams. Finally, the structure was jacked down onto its slew ring bearings where it pivots [with the aid of] six hydraulically operated drive motors to rotate the bridge between its open and closed positions."

COMMENDATION: NEO BANKSIDE, LONDON

Architect Rogers Stirk Harbour + Partners
Structural engineer Waterman Structures
Steelwork contractor Watson Steel Structures (Severfield-Rowen)
Main contractor Carillion
Client GC Bankside

Located next to the Tate Modern art gallery in London and overlooking the Thames, this group of residential buildings is said to be the first in the UK to be externally braced at this scale. While the primary structure is of reinforced concrete, the perimeter steel bracing does most of the work in terms of providing lateral stability and allowing the internal spaces to be more open-plan.

Internal forces from the building are transferred into the external perimeter bracing system via nodes. The nodes are spaced evenly around the buildings' perimeter and are themselves connected to the primary concrete columns and slabs by steel spindles that project through the cladding. They required careful installation, says Carillion project director Chris Wallace.

"The massive steel nodes that connect the external bracing to the concrete frame had to be accurately located on all three axes and held in position while the column supporting each node was concreted," he says. "The challenge was to position and suspend in place a piece of steel weighing up to half a tonne without massive temporary works that would impede the concrete frame construction."

While the views and location are what attract people to live in these buildings, purchasers are reportedly favouring apartments with a view of these nodes. "Perhaps wishing to celebrate their personal connection with the buildings?" suggests Waterman Structures director Steve Fuller. "For an engineer, that is a real high."

COMMENDATION: RISE, BELFAST

Sculptor Wolfgang Buttress
Structural engineer Price & Myers
Steelwork contractor M Hasson & Sons
Main contractor Wolfgang Buttress
Client Belfast City Council

Inspired by the sunrise on a cold, crisp winter's day, RISE is a large-scale public sculpture which has landed in the centre of Belfast city's busy Broadway Roundabout.

The 37.5 m-high and 30 m-wide sculpture takes the form of a small sphere inside a larger one, both of which are supported by a cradle of inclined columns.

M Hasson & Sons draughtsman Terry Hasson explains that there was initial scepticism from passers-by as the unorthodox web-like globes took shape: "From a dish, to a bowl, then the central globe being swallowed up and the bowl becoming a globe – with its own leg being added – and the wire ropes tensioned up to support the structure as a whole, we have created a landmark for future generations to enjoy."

More than 4,000 components made up of 60 different sizes make up the two concentric spheres of the structure. In fact, the spheres are faceted surfaces created by projection from an internal icosahedron (imagine a 20-sided cube, where each face is an equilateral triangle).

Sculptor Wolfgang Buttress explains his design: "I wanted to create something that had both a strong presence but was delicate and ethereal at the same time. The spheres do seem to float; to create magic at this scale is a wonderful feeling."

Inspiring designs

The commended entries and finalists in the 2012 Structural Steel Design Awards prove that stunning landmark structures are still being built that, according to the judges, serve as an "inspiration for all"

COMMENDATION
ENERGY-FROM-WASTE FACILITY, LA COLLETTE, JERSEY

Concept architect Hopkins Architects
Executive architect EPR Architects
Structural engineer Campbell Reith Hill
Steelwork contractor Bourne Steel
Main contractor CSBC
Client States of Jersey Transport and Technical Services Department

This development comprises an energy-from-waste (EFW) building and a single-storey portal-frame bulky waste facility (BWF). The main EFW building is 80 m long, 36 m wide and 32 m tall and contains a waste bunker, incinerators, boiler hall, electricity turbines and gas treatment area.

The process engineering equipment is supported on a reinforced concrete frame and enclosed by a steel frame structure which supports side cladding panels with glazed gable ends.

The building's structural frame is expressed externally beyond the building's envelope and comprises six 36 m long roof trusses together with four lines of 16 m long secondary trusses, all supported on 37 m tall large diameter circular hollow section columns at 16 m intervals.

Campbell Reith partner Steve Calder says: "The building achieves its primary function as an energy-from-waste facility while maintaining an interesting and elegant appearance which is often lost in industrial buildings."

COMMENDATION
DEPTFORD LOUNGE, LONDON

Architect Pollard Thomas Edwards architects
Structural engineer Atkins
Steelwork contractor Conder Allslade
Main contractor Galliford Try
Client London Borough of Lewisham

The three-storey Deptford Lounge will be the focus of redevelopment in that part of south London, providing a new school, library, artists' studios and gallery spaces. It is a steel-framed building with reinforced concrete stair and lift cores. The steel frame enabled long spans to be achieved while keeping the building weight low, which was of particular concern since a Victorian masonry sewer below the structure could not be overloaded.

The building is clad using a twin layered system; the internal layer is a rendered external wall insulation system on blockwork, with the external layer consisting of tensioned cables supporting perforated copper sheets.

The perforated cladding is a striking addition, but also meets technical requirements for controlled light and shading.

"At the right angle, the perforations in the cladding also allow you to see behind the façade and appreciate how the building works," says Atkins structural engineer Jon Bennett.

COMMENDATION GARSINGTON OPERA PAVILION, WORMSLEY

Architect Snell Associates
Structural engineer Momentum
Steelwork contractor Sheetfabs (Nottm)
Main contractor Unusual Rigging
Client Garsington Opera

This 600-seat steel and fabric auditorium has received critical acclaim for its appearance and acoustic excellence. Located in parkland, the temporary building is elevated above the ground, giving the appearance of floating above the landscape.

The structure comprises a steel frame, hardwood timber stage walls and verandas enclosed by a stressed fabric sail-like roof and walls.

Architect Robin Snell explains how the structure sets a benchmark in opera-venue design: "Traditionally, an auditorium is made with outer envelopes of more heavy-weight construction such as concrete or brickwork or even timber for acoustic reasons. This auditorium is not only see-through to view the surrounding countryside and also demountable, but has used materials [structural steelwork with PVC fabric] not normally associated with auditorium construction – and all capable of being erected or dismantled within three to four weeks." Excellent acoustic response is achieved by the shape of the fabric sail walls and the double layer fabric roof.

Since the structure had to be demountable, a bespoke system allowed the roof and column trusses to be divisible into the minimum number of modular prefabricated elements which could be lifted by crane. This also minimised construction time and cost. "Finding an economic way to make bespoke assemblies to construct the building in large pallets by crane – which also met the architect's brief – was a challenge and could not have been achieved using proprietary systems," says Unusual Rigging project manager Mark Priestley.

From concept to project completion took just seven months.

Garsington Opera general director Anthony Whitworth-Jones adds: "We undertook the challenge of the funding designing and constructing the pavilion, and staging three world-class opera productions, all in under 12 months."

COMMENDATION
JARROLD BRIDGE, NORWICH

Architect Ramboll
Structural engineer Ramboll
Steelwork contractor S H Structures
Main contractor R G Carter
Client Jarrold (St James)

This 80 m-long elegant pedestrian and cycle bridge spans the River Wensum, linking the centre of Norwich with a new development. Fixed by concrete abutments at each end and propped by two slender, pin-jointed stainless steel columns, the bridge acts as two mutually stabilising propped cantilevers. Ramboll associate Stephen James says: "Our challenge was not to design a landmark structure that imposed itself on the site, but to develop one that was appropriate and sympathetic to its immediate riverside environment.

The main structure is fabricated using weathering steel for its corrosion protection qualities and aesthetic appeal. Over time, the surface develops a deep-brown oxidized coating, sealing the structure and protecting it against further corrosion.

With its curved profile, timber deck, stainless steel balustrade, and mirrored-finish in-water supports, the structure appears to float over the river. "It would have been impossible to create a bridge of this elegance with its curved span and slender deck with any material other than steel," says S H Structures sales and marketing manager Tim Burton.

The judges said: "The simple palette of self-finished materials gives the bridge an impression of already being well established in its setting."

OTHER FINALISTS

■ **MediaCityUK**
Architect The Fairhursts Design Group
Structural engineer Jacobs Engineering
Steelwork contractor William Hare
Main contractor Lend Lease Construction (EMEA)
Client The Peel Group

■ **The Royal Welsh College of Music and Drama, Cardiff**
Architect BFLS
Structural engineer Mott MacDonald
Steelwork contractor Morgans of Usk
Main contractor Willmott Dixon
Client Royal Welsh College of Music and Drama

■ **Maggie's Cancer Caring Centre, Nottingham City Hospital**
Architect CZWG Architects
Structural engineer AKTII
Steelwork contractor Shipley Fabrications
Main contractor B&K Building Services
Client Maggie Keswick Jencks Cancer Caring Centres Trust

■ **IQ Winnersh Footbridge**
Structural engineer Ramboll
Steelwork contractor Littlehampton Welding
Main contractor Littlehampton Welding
Client Segro

■ **The Third Way Bridge, Taunton**
Architect Moxon Architects
Structural engineer Flint & Neill
Steelwork contractor Mabey Bridge
Main contractor Galliford Try Infrastructure
Client Somerset County Council

■ **Commonwealth Sports Arena and Sir Chris Hoy Velodrome, Glasgow**
Architect 3D Reid
Structural engineer Halcrow Yolles
Steelwork contractor Watson Steel Structures (Severfield-Rowen)
Main contractor Sir Robert McAlpine
Client Glasgow City Council

■ **Bus Station, Slough**
Architect Bblur Architecture
Structural engineer Buro Happold
Steelwork contractor S H Structures
Main contractor McLaren Construction
Client Slough Borough Council

■ **Arnside Viaduct, Morecambe Bay**
Structural engineer Ramboll
Steelwork contractor Mabey Bridge
Main contractor May Gurney
Client Network Rail

■ **Grand Pier, Weston-super-Mare**
Architect Angus Meek Architects
Structural engineer Fairhurst
Steelwork contractor William Haley Engineering
Main contractor John Sisk & Son
Client Kerry and Michelle Michael

■ **Ticket Hall, Farringdon Station, London**
Architect Atkins
Structural engineer Atkins
Steelwork contractor Bourne Construction Engineering
Main contractor CoLOR JV
Client Network Rail

■ **Porth Teigr Bridge Outer Lock Crossing, Cardiff Bay**
Architect Studio Bednarski
Structural engineer Flint & Neill
Steelwork contractor Rowecord Engineering
Main contractor Vinci Construction UK
Client Igloo Regeneration

■ **The Balancing Barn, Thorington**
Architects MDRV: Mole Architects
Structural engineer Jane Wernick Associates
Main contractor Seamans Building
Client Living Architecture

■ **St George's Grove, London**
Architect Hunters
Structural engineer EOS
Steelwork contractor EOS
Main contractor Willmott Dixon Housing
Client Thames Valley Housing Association

Students show steel promise

The UK's undergraduates have shown their potential as student awards for steel bridges and structures have been presented to teams from Queen's University Belfast and University of Bristol

STUDENT AWARDS

RUBY KITCHING

The annual British Constructional Steelwork Association/Tata Steel Student Design Awards has inspired yet another set of undergraduates to put theory into practice for the structural design of a railway bridge for the Bridges Award, and a golf range for the Structures Award.

Organised by the Steel Construction Institute, the competition aims to encourage excellence in steel design among undergraduates where the structural, economic and aesthetic advantages offered by open and tubular profiles are realised.

Both competitions also required entrants to produce a construction programme and costs for the proposed solution.


Queen's winning bridge design

168
Span in metres of Queen's winning bridge design


Cardiff


Manchester

RAILWAY BRIDGE

This year saw a team from Queen's University Belfast named winners of the Bridge Design competition, with Cardiff University coming second and the University of Manchester third.

The brief called for a cost-effective yet elegant structure to carry a new twin-track high-speed railway over an existing motorway and rail line.

The new railway connects two major cities in the UK, although the bridge sits in a countryside location.

Queen's University Belfast's design was for a tied arch bridge to span 168 m. The submission demonstrated it to be the most structurally efficient option with lowest initial cost when compared with cable-stayed, simple girder and arched truss alternatives.

The team members were Ronan Sweeney, Conor Casey, Conor Woods and Niall Mellon.

GOLF RANGE

A team from The University of Bristol received first prize for designing a golf range in the Structures category. The University of Nottingham was placed second and Queen's University Belfast came in third.

A Gulf state desert location was cited for the golf range, which also had to be enclosed to protect the "wealthy golfing enthusiast client" from intense heat and high winds.

The brief for the design also required initial proposals for a structure in the form of a giant golf ball with internal usable space over several storeys.

The University of Bristol's scheme was inspired by an oyster shell for the range, and a pearl for the golf ball building.

A robust array of arched trusses supported a lightweight space frame roof to achieve the 400 m clear span of the range, which also included undulations to mimic a seashell's texture.

A 50 m-tall geodesic frame achieved the spherical pearl structure.

The University of Bristol team members included Oliver Teall, Sam Watson, Jos Van Der Boom and Jonathan Stokes.

50
Height in metres of the geodesic frame used in Bristol's entry


Nottingham


Queen's


Bristol's first-placed golf range design

THE 2013 AWARDS

Entries for next year's Structural Steel Design Awards can now be submitted – until the closing date of 7 December – for projects completed and ready for occupation or use during 2011/12. Previous entries are not eligible. The awards celebrate excellence in steel construction and its potential for cost effectiveness, aesthetics and innovation. For more information visit www.steelconstruction.org.