TATA STEEL BCSA

Structural Steel DESIGN AWARDS 2013

Chairman of the Structural Steel Design Awards judges **David Lazenby CBE** is a Structural Engineer and a Past President of The Institution of Structural Engineers.

He started his career with Balfour Beatty before moving to Andrews Kent & Stone, where he became a Director.

He was Director of British Standards at BSI Group and helped to develop the Eurocodes. He was awarded the CBE in 2000.

Since 2003 he has operated his own consultancies in the fields of certification and company management.

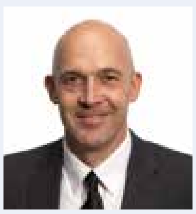
Richard Barrett was Managing Director of Barrett Steel Buildings for more than 20 years prior to its sale in 2007 and is currently a Director of steel stockholder Barrett Steel. He studied engineering at Cambridge University, graduating in 1978. At Barrett Steel Buildings he developed the business into a leading specialist in the design and build of steel framed buildings such as distribution warehouses, retail parks, schools, offices and hospitals. He was President of the BCSA from 2007 to 2009, and is currently Chair of the steelwork industry's Market Development Board.

Martin Manning is a Structural Engineer.

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

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

Roger Plank is a Structural Engineer and, having recently retired as Professor of Architecture and Structural Engineering at the University of Sheffield, is currently a Director of Vulcan Solutions, offering software and consultancy services in fire engineering. He has collaborated extensively with the steel construction sector in the fields of fire engineering and sustainability, and is a Past President of The Institution of Structural Engineers.



Oliver Tyler joined Wilkinson Eyre Architects (WEA) in 1991, becoming a Director in 1999. He has spent over 25 years in architectural practice with extensive experience in leading and coordinating the design and construction of many high profile buildings and infrastructure projects.

Oliver has led a number of prestigious projects at WEA including Stratford Regional Station in London for the Jubilee Line Extension, the Dyson Headquarters in Wiltshire, regional headquarters for Audi and the Arena and Convention Centre in Liverpool.

Oliver currently leads a number of major infrastructure and commercial office schemes.

Joe Locke retired in 2004 from his position at William Hare, where he was responsible for the engineering aspects of the company's activities and also Executive Director of subsidiary Westbury Tubular Structures; having previously retired in 1998 as Chief Executive Officer of Watson Steel. Joe was an apprentice with Watson and sat his associate membership of The Institution of Structural Engineers at only 23. Joe worked at home and overseas on a considerable number of high prestige contracts, including Sellafield nuclear power station's massive thermal oxide reprocessing plant and the terminal building of Kansai airport, Japan. Joe Locke was awarded an MBE in 1990 for his contribution to the structural steelwork industry. In 2007 he received a Gold Medal of The Institution of Structural Engineers.

Christopher Nash is a senior Consultant Architect. He graduated in 1978 from Bristol University School of Architecture, and was at Grimshaw Architects for 30 years and a Director/Partner from 1992 to 2012. While at Grimshaw Architects he was responsible for many of the practice's high profile buildings. These include - from his early years - the Financial Times Printing Works in London's Docklands and the British Pavilion for the Seville Expo 92, The Western Morning News headquarters in Plymouth, the RAC Regional Headquarters in Bristol and many other projects. Having spent ten years as Managing Partner, Chris returned to leading projects such as the Zurich Airport fifth expansion.

He continues to practise as a consultant in architectural practice management, architectural education and property development.

Bill Taylor is an architect in private practice and a Partner in TaylorSnell.

He joined architect Michael Hopkins straight from architecture school in Sheffield in 1982 and in 1988 became his partner. He was a pivotal figure in the development and success of the practice in the UK and overseas and was responsible for a large number of distinguished award winning projects, many of which received a Structural Steel Design Award. After completing the National Tennis Centre in Roehampton, Bill left Hopkins Architects in Spring 2010 to concentrate on his own projects.

He is a Senior Assessor for the RIBA Competitions programme and was a founding member of Tensinet, the pan-European organisation that researches lightweight structures and membrane architecture.

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Chairman's introduction

By Chairman of the Judges, David W. Lazenby CBE

"When the going gets tough, the tough get going!" This is well demonstrated by the structural steelwork industry in the current climate, and shown in the Awards scheme this year.

From a strong set of submissions the judges selected a shortlist of 16 projects, which were each visited and then carefully considered in the final judging. Over a wide geographical spread, the projects cover development of offices/commercial, transport, energy, education and sports facilities and a variety of bridges, together with a theatre and a major tourist attraction. We are delighted that there are large and small, practical and glamorous.

The judges are conscious of trends over the years. It remains clear that closer and cooperative relationships within project teams (including the client) have never been more important, nor the need for a thoroughly professional approach to the training and qualification of people, and proper tracking and certification of processes and materials.

This year we again see highly professional performance from the industry, with technical competence and careful management of the work. These are not achieved easily, but are key to satisfaction of the client.

We have enjoyed reviewing all the varied submissions, which have been of genuinely high quality, and particularly visiting the shortlisted projects and their teams.

The Awards continue to encourage and celebrate great performance in a tough environment.

David Lazenby

Steel awards showcase design excellence

AWARDS

Air W1
London

The Cutty Sark
Greenwich

Emirates Air Line
connecting Greenwich Peninsula and The Royal Docks

Twin Sails Bridge
Poole

COMMENDATIONS

Brent Civic Centre
Wembley

Marlowe Theatre
Canterbury

The Saints Stadium Bridge
St Helens

Four projects were Award winners at this year's Structural Steel Design Awards (SSDA), which were announced at a special presentation held at Madame Tussauds in London.

The winning projects were Air W1, London; Emirates Air Line connecting Greenwich Peninsula to The Royal Docks; The Cutty Sark, Greenwich; and the Twin Sails Bridge, Poole.

Television news presenter Emma Crosby presented the awards, now in their 45th year. The judges selected the Award winning projects from a short list of 16, with all entries scoring highly in efficiency, cost effectiveness, aesthetics, sustainability and innovation.

Chairman of the Judges David Lazenby CBE said: "We inspect all the short-listed projects at close quarters, and hear first-hand from the people who designed and constructed them and importantly we generally meet the clients, who we are all striving to satisfy (and usually successfully).

"We have so often been impressed by the professionalism of the industry and the particular teams. It has never been more important to deal with all aspects of the work in a thoroughly professional way which is the only route to success - indeed to survival."

He went on to say that he hoped that the winning projects will prove inspirational, and that the SSDA scheme itself will continue to stimulate the industry to deliver projects that in future years will show the same great flair.

Commendations were awarded to three further structures: Brent Civic Centre, Wembley; Marlowe Theatre, Canterbury and The Saints Stadium Bridge, St Helens.

Bimlendra Jha, Tata Steel Executive Director, Group Strategy and Supply Chain, stressed the importance of steel to the construction industry's supply chain. "Steelwork plays a crucial role, this is evident not just with the winning projects but across the board."

Ivor Roberts, British Constructional Steelwork Association President addressed the audience and also praised the quality of the winning projects as well as the entire shortlist. "Steel continues to be the material of choice for innovative, sustainable and aesthetically pleasing projects."

Emma Crosby Host

David Lazenby. Chairman of the Judges

Bimlendra Jha, Tata Steel

Ivor Roberts, BCSA

The award winning teams


Air W1, London


The Cutty Sark, Greenwich


Emirates Air Line, connecting Greenwich Peninsula with The Royal Docks


Twin Sails Bridge, Poole

Students exhibit innovations with steelwork design

Winners of the 2013 Student Design Awards were announced at the Structural Steel Design Awards presentation.

As always, the Student Awards were divided into three categories – Building Structures, Bridges and Architecture.

The brief for the Building Structures award was an outline design for a new air traffic control tower.

For the Bridges award students were required to design a new footbridge to improve access across a river for both pedestrians and cyclists.

Design of a coastal facility for the fabrication and testing of wind turbines, a building that also had to include a visitor's centre, was the brief for the Architecture award

The Building Structures award went to the University of Strathclyde, with London South Bank University coming second and the University of Nottingham collecting the third prize.

The University of Edinburgh won the Bridges award, ahead of Queen's University Belfast and the University of Southampton.

Salima Mitha from the Manchester School of Architecture was the winner of the Architecture award, with teams from the University of Nottingham coming second and third.


The winning team in the Building Structures category, the University of Strathclyde, receive their award


David Winning of the University of Edinburgh collects the Bridges category first prize


Architecture Category winner, Salima Mitha of the Manchester School of Architecture collects her prize

PROJECT TEAM

Architect: Dixon Jones
Structural Engineer: Waterman Group
Steelwork Contractor: William Hare Ltd
Main Contractor: Sir Robert McAlpine Ltd
Client: The Crown Estate

Air W1, London

Steel construction's flexibility came to the fore in creating a modern commercial and retail development within a retained historic façade in central London.

The site of Air W1 was formerly occupied by the Regent Place Hotel. Opened in 1915, it was considered to be one of London's finest hotels with an opulence and scale associated with Transatlantic liners.

Built for J Lyons and Co, it was also one of the capital's early examples of constructing a large building with a structural steel frame. It consisted of 1,100 rooms, making it the largest hotel in Europe at the time.

Unfortunately, by the end of the 20th Century the Regent Place Hotel was no longer fit for purpose as a modern hotel. The adjoining buildings were also in poor condition and contained a number of low quality users, while the size and mix of retail units was considered to be inappropriate for a modern central London retail destination.

The decision to redevelop the building to realise its full economic potential was taken in 2004. The original proposal was to demolish and replace the entire block with a new building, but this met with resistance from both Westminster City Council and conservationists.

The final scheme retained as much of the original façade as possible and kept the steel framed listed rooms in the basement while redeveloping the remainder of the site. The project forms part of The Crown Estate's £1bn redevelopment of Regent Street.

Wherever possible advanced works were completed on the existing steel structure prior to demolition. This approach was taken to minimise health and safety risks, as there was less working at height.

Each of the building's six atrium bridges were also delivered to site as prefabricated units with all edge protection, decking and reinforcement

fitted at ground level prior to installation.

Tim Hare, Sir Robert McAlpine Project Manager, says the project is a textbook example of recycling an old steel framed building.

"Wherever possible the existing structural elements were used, adapted and enhanced for use in the new structure. Where this was not possible the steelwork was removed and sent for recycling and replaced with new steel members.

"The end result is a melding of the old and the new that demonstrated both the adaptability and sustainability of steel construction."

Structural engineer Waterman Group arranged for test samples to be cut from the existing structure to verify the material properties. These results were then passed on to steelwork contractor William Hare for design of the connections.

Because of the confined footprint of the site the number of locations to put cranes was at a premium. This resulted in one of the site's tower cranes being built off the existing steel structure to protect the still partially intact Atlantic Bar while disassembly took place.

The 1930s art deco interiors of both the Atlantic Bar and Grill and the Titanic Bars (located in the basement) were dismantled and later reinstated.

The structural design of the building features larger floor plates than is usual for a building of this type. This was acheived using some large plate girder transfer structures installed at the lower levels. In total the job features about a dozen of these structures each weighing over 10t, with the largest being 3.2m deep.

"We have a large open plan grid for the office levels, but below ground floor the grid is much smaller because of the retained steel framed listed rooms," explains Grahame Andrews, Waterman Group Project Engineer.

In several cases the transfer structures were too heavy for the onsite tower cranes. Additional splices had to be introduced to break the beams down into smaller pieces, which were held in place by temporary props until the member was fully installed.

The roof structure presented an additional set of challenges to the team. The complex geometry of the mansard and atrium roof meant the fabrication accuracy and the management of the delivery and erection sequence was key to the entire build programme.

However, it was not possible to gain access to survey the roof connections until quite late in the project, so in some cases this meant completing the final connection design and fabrication on site.

The layout of the new floor slabs against the retained façades also placed constraints on the depth of the steel members that could be used, resulting in the use of stiff 200mm deep fabricated boxed sections.

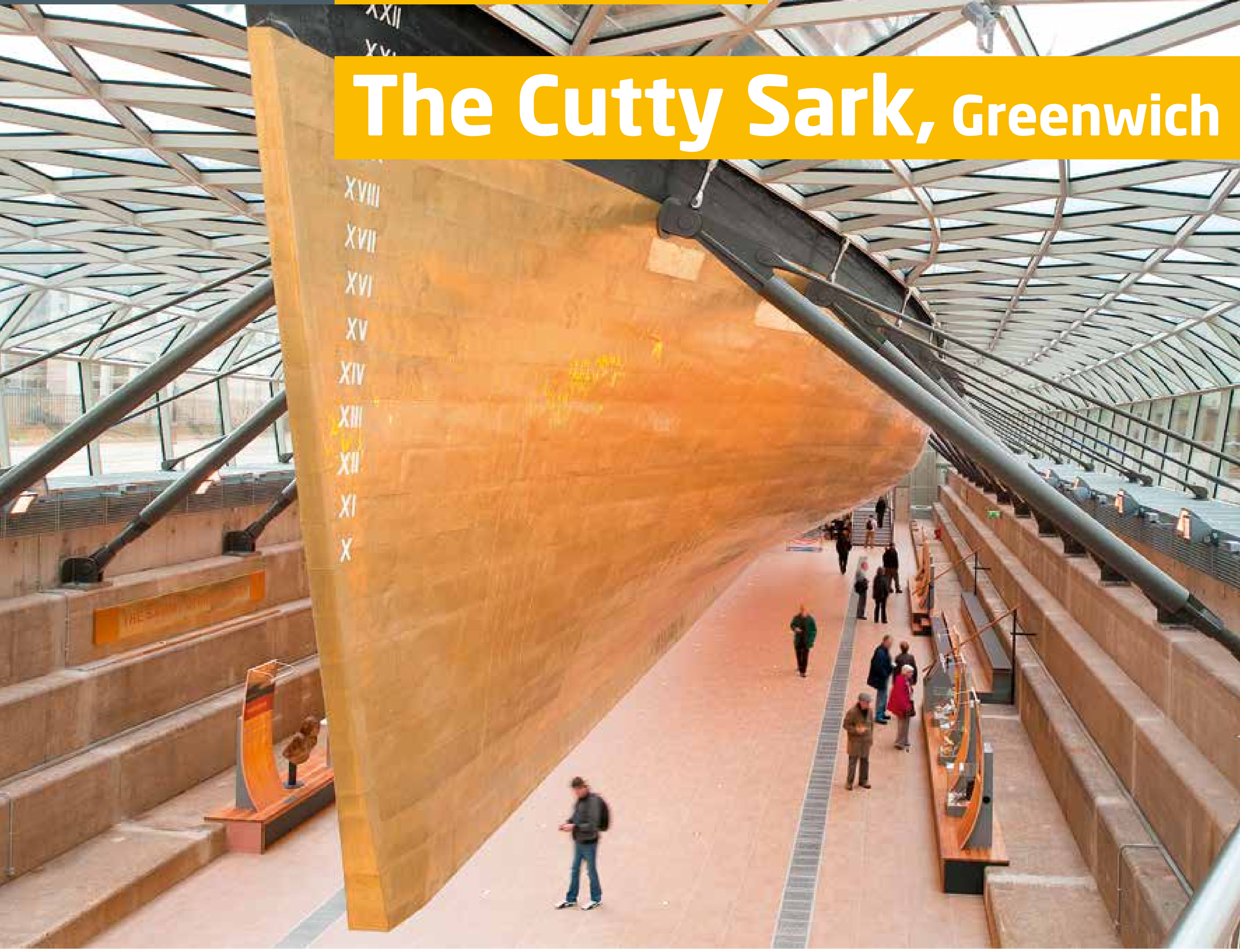
On completion the project was renamed Air W1, in reference to its postcode and the adjacent Air Street. The finished structure includes seven floors of offices, a ground floor with shops and restaurants located in a three level basement.

The refurbished building has been acclaimed for setting benchmarks in sustainable urban regeneration and the scheme has already attracted high quality global occupiers.

JUDGES' COMMENTS

"This is an exemplar for imaginative incorporation of existing steelwork in a striking modern office/retail/residential development."

The Cutty Sark, Greenwich



The fully restored Cutty Sark now rests in a steel cradle hung above the dock floor to allow, for the first time, views of its sleek and revolutionary hull.

PROJECT TEAM

Architect:
Grimshaw Architects
Structural Engineer:
Buro Happold
Steelwork Contractor:
S H Structures Ltd
Main Contractor:
Gardiner & Theobald
Ellmer Construction
Client:
The Cutty Sark Trust

The Cutty Sark is the world's last remaining tea clipper and holds a unique place in many people's hearts, especially the millions that have travelled to Greenwich down the years to visit the vessel.

Since 2006 the ship has been closed to the public and undergoing restoration work. Unfortunately a fire delayed the project in 2007, a conflagration that was luckily not as bad as it first appeared. Part of the ongoing conservation work included removing much of the historical contents of the vessel and putting it into storage. Thanks to this and some heroic fire fighting, there was little damage caused to the ship's original fabric.

Although the fire affected the progress of the conservation project, the original plans were still viable. Work restarted with the help of an additional £25M from the Heritage Lottery Fund and the culmination of six years hard work was rewarded when Her Majesty The Queen officially reopened The Cutty Sark in 2012.

The conservation and repair of historic vessels on this scale is a rare occurrence and it is hoped Cutty Sark's innovative design and triumph of engineering will set a new benchmark of how historic ships are preserved in the future.

All of the salt induced corrosion of the iron frame, which in the past has threatened to close the ship, has been painstakingly removed, and the original conserved ironwork is identified by the white painted vertical ribs, horizontal keelsons, deck beams and their supporting posts. In contrast, all new

strengthening steelwork is painted grey.

The Cutty Sark project features innovative use of structural steel for the conservation and interpretation of a unique Grade I listed ship.

A complex but elegant prestressed system hangs and stabilises the ship in its new position. This steel structure will preserve the shape of the ship's iconic hull and has enabled an additional public space to be created in the dry berth below, allowing visitors to walk underneath and admire the ship's form.

Diane Metcalfe, Grimshaw Architects' Associate Director, says: "The vessel had been sitting on wooden props and a concrete plinth on the bottom of the dry dock for 50 years. This wasn't good for the hull which was bulging and would not have lasted much longer."

The design plan was to replicate the vessel sitting in water and to restore the sleek and unique shape of the hull. This has been achieved by strengthening the original ironwork and installing a steel cradle, a structure that also has the added benefit of allowing visitors to walk beneath the ship and view the elegant lines of her hull.

In order to achieve this, precise three-dimensional surveys of the ship were carried out and every new detail was digitally modelled.

Work was carried out to tight tolerances and demanding geometries, at times twisted and curved. Every element of the new steelwork was modelled throughout the process.

S H Structures fabricated, supplied and erected around 200t of steelwork for the cradle which consists of 13 hanger frames that vary in shape and follow the geometry of the vessel.

Internally each of the frames is connected by 64mm diameter ties to new keel strengthening plates. Running the length of the keel, these plates are 550mm deep and between 45mm and 55mm thick, depending on their location and are placed either side of the original timber keel.

The hull has been strengthened with two 500mm deep × 50mm thick twisting and curved steel strake plates that run along both sides of the ship. Twelve fabricated compression beams span across the ship, within the original deck beam and between the new strake plates.

The keel strengthening is supported from the compression beams via the tie bars which support the ship's structure beneath the new strakes, stabilising the keel position and transferring the wind loads from the masts into the new steelwork.

The majority of the ship's internal steelwork had to be completed prior to the lifting process. Raising a vessel, one that has not moved in half a century, 3.1m into the air was obviously a very challenging part of the project and a major undertaking for S H Structures.

"Using 24 climbing jacks, each with 100t capacity, the ship was raised 100mm at a time and lifted to its final height in three days," explains Tim Kelly, Buro Happold Associate. "The initial lift was a little tense as the ship tore away quite a large chunk of the concrete plinth, but from then on, apart from some creaking, the lifting proceeded smoothly."

S H Structures had to design and build a temporary cradle for the lifting procedure. This consisted of a cranked beam on either side of the ship, which was connected to the vessel at the points where the external struts and ties would eventually connect the ship back to the dry dock.

"After we'd lifted the ship the first 100mm we were able to weld a steel sole plate under the keel," explains Mark Randerson, S H Structures Technical Director. "This completed the keel strengthening by connecting the two plates which had previously been positioned either side of the original woodwork."

Once the Cutty Sark had been raised into position, temporary external steelwork was erected. On completion - with the new steelwork supporting the vessel - the temporary members were then lowered back down by jacks and dismantled.

Steelwork has also played an important role in other aspects of the ship's preservation, with new base plates for the restored masts, and 150 new steel members inserted to strengthen the corroded iron ribs.

JUDGES' COMMENTS

"The steelwork enables this famous ship to be preserved and, importantly, to be viewed internally and externally from below the hull. Ingenious steelwork is key to this remarkable visitor attraction."

Emirates Air Line
connecting Greenwich Peninsula and The Royal Docks

The UK's first urban cable car is an iconic addition to the capital's transportation network.

The Emirates Air Line spans the River Thames, providing a direct link between the Royal Victoria Docklands Light Railway (DLR) station on the north bank and the Jubilee Line station at North Greenwich on the south bank.

Three steel towers support the cable car, one on the south bank and two on the north shore, including an intermediate structure.

The intermediate tower was the first to be fully erected and although it is the smallest, it still stands at over 65m tall and weighs more than 290t. The other two towers top out at 90m and weigh in excess of 550t each.

Design of each of the towers comprises a shaft tapering towards a narrow neckline with a flared head supporting the cable car sheave assembly.

The overall geometry and form was aesthetically driven, as was the form of the shaft itself. This had been conceived as an interwoven assembly of two helically spiralling wide plates, known as ribbons and four narrower plates known as helices, spiralling in the opposite direction. Structurally the shaft works as a Vierendeel formed from the two interwoven differently pitched and spatially offset 'springs' of the ribbon and helix plates.

"The project was an outstanding success, not just because of the complexity and quality of the work, but also for the speed of the construction programme which helped us realise our aspiration to open in time for the Olympic Games," says Rory O'Neill, Head of Projects for the DLR.

The first tower was built within days of its steelwork being delivered to site. Severfield-Watson Structures fabricated the steel for the project in Bolton, with over half of its two hundred employees dedicated to the project.

The initial fabrication strategy involved approximating the double curved shape using 27 rolled conic sections, but this was limited by the maximum width of steel plate (3.3m) that could be rolled into a cylinder in the UK.

Severfield-Watson discovered that forming, a technique employed by the ship building industry, can curve much bigger continuous pieces of steel and this was explored as an alternative strategy. A detailed comparative analysis of the two methods revealed that the forming method would be more economical.

Initially, all plates were digitally unrolled as flat surfaces and nested in order to determine the most efficient steel plate sizes and minimise material waste. After CNC cutting, the plates were suspended with chains and formed by heavy presses. Each plate was then shaped to its exact final profile by applying the calculated pressure at the appropriate location.

The resulting geometry was checked using CNC cut templates which enabled tolerances of +/-5mm to be achieved.

"In order to simplify the design and fabrication of the towers the geometry of each was kept the same. Innovation was at the heart of the design and construction, with the latest methods and technologies used to create this unique addition to London's transport network.

"Our planners took the design for each of the towers and using cutting edge 3D modelling created the measurements for each piece. This intricate modelling saw designs for each part drawn to within a millimetre to ensure every piece fitted together like a jigsaw," explains Peter Miller, Director at Severfield-Watson Structures.

All of the tower sections were lifted

PROJECT TEAM

Concept Architect: Wilkinson Eyre Architects
Delivery Architect: Aedas
Structural Engineer: Buro Happold
Steelwork Contractor: Severfield-Watson Structures Ltd
Main Contractor: Mace Ltd
Client: Docklands Light Railway Ltd

into place by crane, a 300t capacity mobile crane was used for the north tower, while a 400t capacity crawler was used for the intermediate structure.

For the south tower, located approximately 70m offshore, a much larger crane was required. The lift radius further increased as the land immediately behind the river wall could not be proven to support the imposed load from the crane, so it had to be moved back to a lifting radius of approximately 90m. This meant that a large strut jib crane with a maximum capacity of over 1,000 tonnes had to be used.

The construction programme was based around limiting the amount of welding operations, wherever possible. Assembly areas were created adjacent to the north tower and on the bank adjacent to the south tower. The intermediate tower sections were delivered ready for erection and did not require any preassembly.

To assist with the erection a temporary steel base frame was provided under each section, which allowed the tower sections to be assembled in their vertical orientation.

Each ribbon section was lifted onto the temporary base and restrained in position with temporary bracing. A temporary lifting/aligning frame was fitted across the tops of the ribbons to tie them together and also act as a lifting frame during erection. The helical spiral members were then fitted between the ribbons and site welded into position.

One of the primary objectives was to reduce risk and simplify the erection process. This was achieved by developing an end plate bearing flange at each tower splice.

"This was a key area for this challenging project," says Fergus McCormick, Buro Happold Project Engineer. "The design had to work to extremely tight tolerances, which also meant steel was the only realistic option for the towers."

Another key consideration was the access required for the steelwork erectors to each splice location. The permanent access ladders and rest platforms were designed where possible to align with the splice positions so that the use of temporary access platforms was minimised.

"Another key challenge was the interface at the tops of the towers where the yokes and the cable support heads and wheel assemblies had to align to ensure that the cables run in a perfectly straight line across all five towers," sums up Matt Randall, Mace Project Director. "This precision engineering and site control was achieved by Severfield-Watson in the final erection sequence of each tower under extremely tight timescales."

JUDGES' COMMENTS

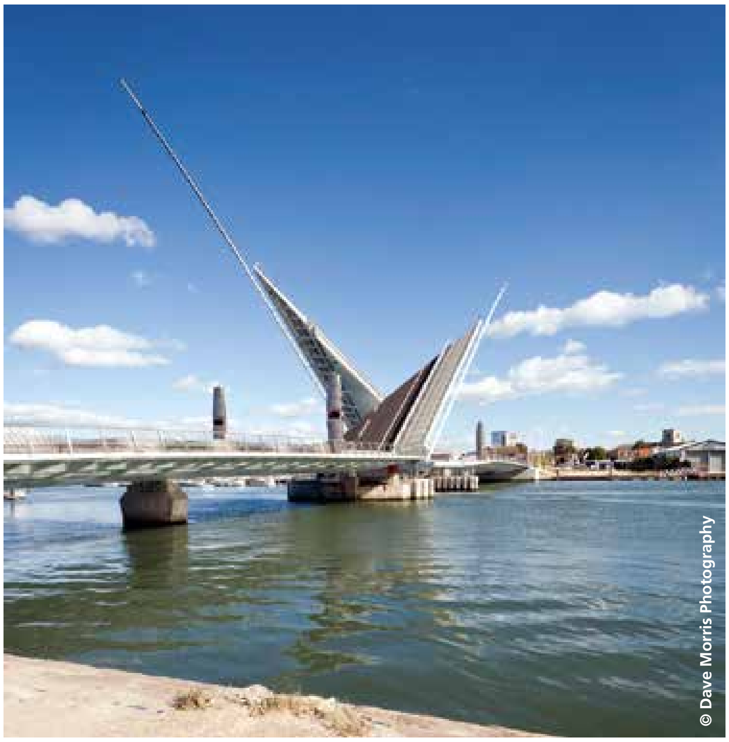
"This was a structural steelwork success story contributing to London's outstanding year 2012 and an elegant legacy for ongoing regeneration."

Twin Sails Bridge, Poole

A boost for future regeneration, Poole's Twin Sails Bridge is also an iconic landmark structure.

PROJECT TEAM

Architect:
Wilkinson Eyre Architects
Structural Engineer:
Ramboll
Steelwork Contractor:
Cleveland Bridge UK Ltd
Main Contractor:
Hochtief (UK) Construction Ltd
Client:
Borough of Poole



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Connecting Poole Old Town to Lower Hamworthy, the five span Twin Sails Bridge provides a much needed second crossing for the Dorset town's busy harbour, as well as being an important component for future regeneration.

The low level bridge, with its soaring landmark carbon fibre masts, high standard of finishing and sophisticated lighting ensures that each operation of the structure is a spectacle.

"There are no other structures in the vicinity, so being a low level bridge it blends into the landscape," explains Steve Thompson, Design Project Manager for Ramboll. "However, drama unfolds when it opens at mid-span to reveal its elegant yet simple maritime shape."

Structurally the lifting span is designed and configured as a simple bascule, with two hydraulically

operated lifting sections.

Normally the joint between lifting sections is transverse, but here it is skewed across the deck creating two triangular leaf-like segments. It is these triangular moveable parts, mirroring the shape of yachts when in their open upright position, that make the bridge unique and are the reason for its 'Twin Sails' name.

Materials were selected to maximise durability and minimise maintenance requirements throughout the life of the structure. The lift span deck utilises weathering steel to remove the need for maintenance painting of the internal surfaces within the box.

According to Mr Thompson steel was the only option for this project as the bridge needed to be a lightweight structure that could open at least 15 times a day. A low level bridge that mirrored the height of the quayside was another important design criteria best achieved with steel.

The adaptability of steel allowed the project team to fabricate and create robust yet lightweight sculpted forms. It was therefore the ideal material for fabricating the triangular sails of the lifting span. In addition, the use of steelwork acting compositely with a concrete deck for the approach spans also was an ideal solution to produce the desired shallow deck profile.

The bridge features two distinct structural forms; the triangular lifting spans comprising fabricated steel boxes, with orthotropic deck plates and curved soffits, and the approach spans constructed as composite steel boxes, again with curved soffits. The deck and sails were made up of 41 sections of steel.

The abutments and piers sit on top of 53 foundation piles, mostly 1.2m in diameter and sunk 31m into the channel bed.

The construction process itself was inventive, with much of the steel superstructure fabricated offsite. Modular sections were brought to the site, assembled to form individual deck spans and welded together on the quayside adjacent to the Channel.

The steel sections for the bridge were all fabricated at Cleveland Bridge's Darlington facility and transported by road to Poole. The company initially assembled and positioned three spans of the bridge.

"We had to keep the harbour open to maritime traffic at all times," says Ben Binden, Cleveland Bridge Project Manager. "So working from the western bank we first erected three spans, which included the two lifting segments for the central span. Once the hydraulic lifting gear was installed and commissioned we were able to erect the final two spans, as boats were then able to access and exit the harbour via the new bridge's lifting channel."

Although the spans vary in length they were all, with the exception of the central span, assembled on site from four large box sections and four walkway sections. Each half of the central span was assembled from two large box sections and two outer walkway sections to form a triangle with an overall length of 25m.

Once each span had been fully welded and painted they were ready to be positioned. The on-shore fabrication process significantly reduced the amount of work which needed to be undertaken over the water. Only one welded splice was needed for each span following installation.

Each completed span was loaded onto a self-propelled mobile transporter (SPMT) which then carried it the short distance down to the water's edge and onto a flat deck barge.

The spans were all driven onto a barge with the deck positioned perpendicular to its final position.

Once the barge was in the bay, tugs helped nudge it into position so the span could be aligned on its final bearings.

However, before the final positioning could take place the construction team had to wait for the correct tide. "Each span was taken onto a barge via an access ramp from our assembly point," explains Mr Binden. "The barge then had to wait for high tide before moving the span into a position above and between its supports."

Floating each span was a tricky procedure but they were all successfully completed. "The spans were positioned above their final bearings, using a combination of the SPMTs jacks and tidal range between high and low tides," sums up Mr Binden.

JUDGES' COMMENTS

"This ingenious design for an opening traffic bridge combines elegance and functional efficiency. The client and the public are delighted with this iconic and vital bridge."

PROJECT TEAM

Architect: Hopkins Architects
Structural Engineer: URS
Steelwork Contractor: Bourne Construction Engineering Ltd
Main Contractor: Skanska
Client: Brent Council

Brent Civic Centre, Wembley

The UK's greenest public office building includes a number of architecturally impressive steel elements.

The new Brent Civic Centre is a multi purpose development that allows the Council to consolidate many of its staff into one unified facility.

Located opposite the world famous Wembley Stadium, the project has scored an impressive BREEAM 'Outstanding' rating and has incorporated an array of sustainable features. These include a 33% reduction in carbon emissions, thanks to a combination of solar shading, natural ventilation, high performance façade, and combined cooling, heating and power which utilises waste fish oil.

Overall, the project is a hybrid structure that incorporates a number of high quality and complex steel elements.

"All of the steel parts are isolated and provide the building with a lot of visual interest through the detailing," says Robert Barker, URS Project Engineer.

The project also features a number of large open areas utilising long span steel beams to create their roofs.

"We fabricated a series of 30m long beams for the atrium roof," comments Chris Barnfather, Bourne Construction Engineering Project Designer. "These were bespoke members with a 1m wide gutter welded to the top."

Central to the project is a steel framed circular area known as the drum. Clad in timber fins, it houses a multi purpose community hall, library, one stop shop and civic chamber. It is topped with a steel structure known as the lantern, a roofing feature that spans the 15m wide void.

Below the civic chamber there is a large open plan two-storey high community hall. "This is another steel framed area," says Mr Barker. "Steel pin jointed struts form the hall and give it visual expression."

In order to reduce costs, accurate scheduling of steel components during the design process also kept wastage down and saved valuable time, and importantly helped achieve the main contractor's green initiative.

The project presented a number of engineering challenges, which included the different tolerances posed by the structural steelwork and concrete elements of the building. This was resolved through the erection of the external columns with temporary cross bracing prior to the casting of the edge beams and post tensioning of the floors.

BIM also played an important role in this job and was used to track components, including scheduling, sequencing, deliveries and erection progress. The 3D model was discussed weekly, aiding coordination of interface details between steel, concrete, timber and cladding.

"The innovative methods used on this project allowed Bourne Construction Engineering to deliver to the client a fully integrated design solution for the steelwork," says Mr Barnfather.

JUDGES' COMMENTS

"The new civic facilities comprise an office building and a voluminous steel framed entrance atrium. The steelwork throughout the atrium, supporting the ETFE roof, glazed walls, exposed glass lifts and connecting bridges, is very light, elegant and immaculately detailed. Steel is key to this impressive civic space.

Marlowe Theatre,
Canterbury

The construction of the Marlowe Theatre faced challenges from archaeology, flooding and incorporating the original fly tower, all within the demanding town planning environment of historic Canterbury.

This complex steel structure is said to bring drama to the site, with cantilevering and hung structures defining different spaces and creating exciting open public areas.

The site identified for the Marlowe Theatre was originally the location of a 1930s Odeon Cinema, and had undergone several transformations, including the addition of a fly tower during the mid 1980s conversion to a theatre.

A decision was made to retain the fly tower steelwork as an integral part of the new theatre complex. This helped to reduce the development's environmental impact through the re-cladding and reuse of existing steelwork.

"Connecting old steel to new steelwork gave the project continuity," explains Ryan Thurston, DGT Structures Project Manager. "We also added a galvanized steel spired roof to the tower, making it a feature element."

Overall, the flexibility of steel construction allowed the design team to develop a challenging structure with frequently varying floor levels in a cost-effective way.

An innovative steel solution was developed to achieve this and create a highly flexible and spacious front of house area. The first and second floor foyer spaces are hung from trusses in the roof. The hung foyer steelwork forms the backspan of the auditorium balcony cantilevers.

"Steel is the ideal material for this kind of project which has long column free spans and cantilevering balconies," says Richard Brown of Keith Williams Architects. "Steel is integral to the structure's design, although most of it is hidden within the completed building."

Andrew Wylie, Buro Happold Project Engineer, continues: "Steel was important as it gave us the desired lightweight solution as well as effectively and efficiently framing the project's complex geometry."

The area with the longest spans is the new auditorium and here a closer relationship between the audience and performers has been created as no seat is further than 25m from the stage. Services are integrated throughout the steel structure, with low velocity air distributed into the auditorium at floor level.

A major benefit of the project has been the creation of the 150 seat Marlowe Studio. The smaller of the site's two venues, the Marlowe Studio cantilevers out above the café towards the river, adding further opportunities for performances.

The floor of this space has been designed to carry a collapsible seating system, creating a highly adaptable space. The structure has acoustic isolation from the café below and auditorium plant room above, and this prevents any noise or vibration from spoiling the performance.

"The sense of grandeur in the new auditorium is coupled with a feeling of intimacy. Everything's so much closer to the stage than the old theatre could ever be. It's a great sense of shared experience and that's what live theatre is all about," says Mark Everett, Theatre Director of the New Marlowe Theatre.

PROJECT TEAM

Architect: Keith Williams Architects
Structural Engineer: Buro Happold
Steelwork Contractor: DGT Structures Ltd
Main Contractor: ISG Jackson
Client: Canterbury City Council

JUDGES' COMMENTS

"Good teamwork produced a thoroughly competent and effective project which delights the client and theatre goers."

© Moxon Architects

The Saints Stadium Bridge, St Helens

A landmark structure, the Saints Stadium Bridge set an example for inter team cooperation to deliver a high quality, cost-effective project.

Crossing the busy A58, the Saints Stadium Bridge allows easier access between the new rugby league stadium and St Helens town centre.

In order to give the structure symbolic status, viewed from above, the steel arches on the bridge are shaped like a rugby ball, which is more than apt for a town synonymous with the sport of rugby league.

"We wanted an iconic bridge," says St Helens Council Project Engineer Les Fairclough. "One which would stand out and become a landmark."

Galliford Try won a £1.2M design and build contract for the project and appointed Moxon Architects and structural engineer Flint & Neill to come up with a unique design. The scheme has delivered a sleek 4m wide x 54.6m long bridge, which has a deck suspended via flat plate hangers from two parabolic arches formed from 610mm diameter CHS sections.

Before any steelwork arrived on site, Galliford Try had to liaise with all of the project team members to address the main risks to the project associated with the installation of the bridge. Its unique shape presented challenges both from potential settlement and the difficulty of installing fixed length hangers between the deck and arches.

"Given the large numbers of spectators passing across the bridge on match days, one of the key design issues was ensuring that adequate damping was provided to suppress pedestrian induced excitation. The main concern was vertical accelerations of the bridge deck and also achieving comfort criteria under crowd loading. This has been done by providing tuned mass dampers inside the bridge deck which absorb the vibration energy," explains Paul Sanders, Flint & Neill Project Engineer.

Erection of the steelwork began with the deck brought to site in three pieces, each complete with parapet panels. Using a 250t capacity mobile crane, the team lifted in the central 27m-long central section followed by the two outer sections. They were all landed on temporary trestles and then bolted together through the end diaphragms which acted as a backing strip for the welds between the sections.

With the deck in place and still resting on trestles, the arches, which are positioned either side of the bridge, were installed. These tubular sections were brought to site in six pieces; two end U-shaped sections with temporary bolted connections at the ends and two further sections for each of the two arches with matching bolted connections.

The final piece of the erection process involved connecting the arches to the deck via a series of hangers. There are 14 of these bespoke hangers for each arch, fabricated from 50mm thick × 200mm wide plate. They range in length from 2.5m to 6.5m.

PROJECT TEAM

Architect: Moxon Architects Ltd
Structural Engineer: Flint & Neill Ltd
Main Contractor: Galliford Try
Client: St Helens Council

JUDGES' COMMENTS

"This elegant bridge is a key part of the development of the stadium, providing most of the pedestrian access. The plan form reflects the shape of a rugby ball, producing tough fabrication challenges as the elements are non-planar. The result is a fine steel landmark structure."

10 Brock Street, London

Accommodating the commercial and retail portions of a large development in central London, 10 Brock Street is an architecturally impressive steel framed structure, overlooking the scheme's main plaza. It consists of three interconnected fingers, featuring floor to ceiling glazed external cladding and linked by two atria.

The central finger is 15 storeys and it is flanked by ten-storey and eight-storey finger structures. Visually the front elevation of the 15-storey portion offers the most impressive element as it has a leaning façade, which is skewed to the rest of the building.

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

Commenting on the steelwork, Adrian Richards, Lend Lease Project Manager, says: "The steel frame was designed in early 2011 and within four months it was being fabricated and delivered to site."

PROJECT TEAM

Architect: Wilkinson Eyre Architects
Structural Engineer: Halcrow Yolles (CH2M)
Steelwork Contractor: William Hare Ltd
Main Contractor: Lend Lease
Client: British Land

A406 Wilmer Way Footbridge, London

Replacing a nearby older structure, the A406 Wilmer Way Footbridge provides a new connection across London's North Circular Road.

The 48m long bridge is a steel structure formed of three pairs of bow arch trusses spanning at a skew of 51 degrees across the road. The main piers support pairs of 12m long inverted Vierendeel bow arch trusses that are fixed in the centre with a stiff steel plate box support 'tree'.

"The bridge has a very specific shape and steel was the only way to achieve it," explains Tim Belcher, Hyder Consulting Project Engineer. "We wanted a slender long span structure, something with minimal massing in keeping with the environs."

The design also includes trusses with main chords that are continuous along the length of the bridge. The deck chord is a gently curved parabola, which allows the deck above to drain naturally.

The support spans of the bridge are anchored with inclined braced pairs of circular hollow sections. These ties provide a crucial adjustment to the harmonic frequency of the bridge to mitigate against pedestrian vibration.

"Steel was absolutely the ideal material for the project. It enabled the creation of a structure which was architecturally expressive and allowed us to use a prefabricated system which could be craned into place overnight," says Grimshaw Architects Project Partner Ewan Jones.

PROJECT TEAM

Architect: Grimshaw Architects
Structural Engineer: Hyder Consulting
Steelwork Contractor: McGrath Group
Main Contractor: Skanska Infrastructure Services
Client: Transport for London

Sky Wind Turbine, Isleworth

Standing 60m tall Sky's Wind Turbine makes a very visual statement for renewable energy in west London and puts renewable infrastructure firmly onto the architectural stage.

"It had to be this height to be taller than the surrounding buildings in order to catch sufficient wind," says Tim Snelson, Arup Associates Project Engineer.

Steel is the material of choice for wind turbines, due to the strength to weight ratio (thereby minimising craneage requirements) and its ability to be shaped into trussed elements and resist fluctuating tensile and compression forces from dynamic loads.

The design of the wind turbine uses curved trusses to make most effective use of the structural geometry to both minimise and resist the applied forces.

The three tower sections were assembled and clad at ground level, then lifted fully assembled in a single day. To minimise site works, the top section of the tower was fully welded in the fabrication yard. A specialist erection team then added the nacelle and blades the following day. This strategy also minimised the amount of lifting adjacent to Sky's TV studios which were in constant use.

"Sky always insisted the wind turbine make a real contribution in energy terms. After all the hard work of the team, it was great to see it go up." says Steve Holford, Head of Engineering, Sky.

PROJECT TEAM

Architect: Arup Associates
Structural Engineer: Arup Associates
Steelwork Contractor: William Hare Ltd
Main Contractor: Mitie
Client: BSkyB

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National Football Centre, St George's Park, Burton-upon-Trent

PROJECT TEAM

Architect: redboxdesigngroup
Structural Engineer: Arup
Steelwork Contractor: Billington Structures Ltd
Main Contractor: Bowmer and Kirkland Ltd
Client: The Football Association

English Football has a new home at St George's Park, a 330 acre site near Burton-upon-Trent. The facility provides The Football Association with a teaching and development centre as well as a training home for all 24 England representative teams.

Steelwork has been used to construct most of the large buildings, including two hotels which have more than 200 rooms, conference and banqueting facilities, restaurants and an 18m swimming pool.

Adjacent to these facilities are the indoor sports areas, housed in three large steel framed structures, all interconnected but divided by movement joints. The largest of these, measuring over 100m in length, houses a full sized synthetic football pitch and required more than 700t of structural steelwork.

"There are some long spans in these areas and steel was the obvious choice for the framing material," adds David Bloomfield, Arup Project Engineer, "the same reasoning why steel was used in the sports structures."

To create the 80m wide spans of this large column free space, steelwork contractor Billington Structures has erected a series of large 4.5m deep trusses, fabricated from UKC and CHS sections.

"This was a very complex procedure, but all of the trusses and their supporting columns were erected in just six weeks, with three trusses lifted into place every week," sums up Neil Brook, Bowmer and Kirkland Project Director.

Manchester Road Bridge, Bradford

PROJECT TEAM

Architect: City of Bradford Metropolitan District Council
Structural Engineer: City of Bradford Metropolitan District Council
Steelwork Contractor: Briton Fabricators Ltd
Main Contractor: Eric Wright Civil Engineering Ltd
Client: City of Bradford Metropolitan District Council

This replacement foot/cycle bridge spanning Manchester Road is a crucial element of Bradford's Living Street, a collaborative project between Bradford Council, Sustrans and Trident (a community led regeneration company) creating a new gateway into the city centre.

Endorsed by public consultation, the design of the bridge is based on a series of deck plates supported by cross beams at 2m centres, spanning onto continuous curved steel members.

"Steel gave us the strength, beauty and the visual presence required by this landmark project," comments Ziad Younis, Bradford Metropolitan District Council's Project Engineer.

All of the columns are pin-ended at both ends to allow them to tilt in response to the thermal movement of the bridge.

Due to the complexity of the project, and to assist with the many parts and spiralling decks/ramp sections, the steelwork contractor decided to prepare detailed fabrication drawings utilising 3D modelling software. With 7,400 component parts to trace it was important that a system was employed to keep control of every component and track its way through the fabrication.

Overall the bridge including the ramps is 210m long, with the typical spans measuring 14m and rising up to 23.5m over Manchester Road.

Two Snowhill, Queensway, Birmingham

PROJECT TEAM

Concept Architect: Sidell Gibson Architects
Architect: Weedon Architects
Structural Engineer: Curtins
Steelwork Contractor: Caunton Engineering Ltd
Main Contractor: Balfour Beatty Construction Northern Ltd
Client: Hines

The 17-storey high steel framed Two Snowhill office block is the second of three landmark office schemes in the Snow Hill area of Birmingham.

"Every steel connection to the core is bespoke on this building, requiring us to measure the exact geometry and then fabricating elements to exact dimensions," explains Dave Tighe, Balfour Beatty Project Manager.

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

A steel framed solution was an obvious choice for the building explains Yvonne Aust Curtins Consulting Project Engineer, since it could connect back to the existing cores and construction could proceed quickly. With offices occupying the majority of the floors, clear spans and a flexible structure were also very important for the client.

An atrium occupies the centre of the building from ground floor. The curved roof for this structure is supported by a system of steel "trees" which spring from level 14 and 15. The tallest double storey tree sits at level 14 and is made from a 406mm diameter circular hollow section "trunk" with four "branches" supporting steel beams in the atrium roof.

Bow string trusses which support glazing for the building's scenic lift also offered some of the most technical challenges for the design and build team on this project.

South Wolverhampton & Bilston Academy

South Wolverhampton & Bilston Academy forms part of Wolverhampton City Council's £270M Building Schools for the Future Programme and is a new build school on a site adjacent to the former premises.

Previously occupied by the school's playing fields, the site had coal seams and mine shafts beneath it, all of which had been grouted up prior to the construction programme.

"Because of these ground conditions we needed a lightweight framing solution as piling was out of the question," says Andrew James, Capita Symonds Lead Engineer.

"Steel offered the best solution for this challenge and to achieve the desired architectural form within a constrained site."

The new school is a four-storey structure featuring numerous cantilevers and two triple height atria, architectural forms which again swayed the design team to choose a steelwork solution.

"Steel allowed us to easily create the long span areas of the school as well as the architectural cantilevers," confirms Neil Farquhar, Capita Symonds Architect.

PROJECT TEAM

Architect: Capita Symonds
Structural Engineer: Capita Symonds
Steelwork Contractor: Mifflin Construction Ltd
Main Contractor: Carillion Building
Client: SWB Academy Trust & Wolverhampton City Council

The Crystal, Royal Victoria Docks, London

© Edmund Sumner

Located in London's Docklands, the world's first Siemens' sustainability centre is a flagship development built to present new technologies and host exhibitions highlighting ways of living and working in a more environmentally friendly manner.

The design of the 7,000m² building is unique and based on two interlinked rock crystals bursting forth from the ground. As well as nature, the design draws inspiration from its waterside location and curvature of the nearby O_2 arena.

"Steel not only allowed us to create the building's shape, but also much of it has been left exposed as it looks aesthetically interesting," sums up Chris Carroll, Arup Project Engineer.

Within the two crystalline shapes there are offices, a 300 seat auditorium, meeting rooms, an exhibition area, along with a shop and classrooms.

Structurally the design creates the internal spaces in each half or crystal with a series of portal frames in one direction and cantilevers in the other.

"The design concept led to the decision to use structural steelwork," says ISG Senior Project Manager Mike Jenner. "To achieve the project's slenderness and get the detailing correct would have been extremely difficult with any other framing material."

PROJECT TEAM

Architect: Wilkinson Eyre Architects
Structural Engineer: Arup
Main Contractor: ISG
Client: Siemens

The Shoal, Stratford

The Shoal is a large art project introduced to improve the frontage to the Stratford shopping centre in east London.

It consists of a trellis of steel trees, which support an array of giant moveable leaf shapes, which reflect the varying light conditions throughout the day.

There are plans for the shopping centre to be developed and a new public realm created to the rear of the Shoal. "This meant we had to think about the views of the project from all directions," says Ron Packman of structural engineer Packman Lucas. "The Shoal consequently rewards the eye from all angles."

The Shoal consists of three separate linear installations or 'runs', each of which has an array of titanium clad leaves that are free to pivot about their upper supports in response to the prevailing winds.

The supporting frames are designed in one of two ways. The first of these are 'A' frames, which have two trunks rising separately from the ground and coming together at high level to form a braced arrangement. The second are cantilever, or 'C' frames, which project from a single point as a robust assembly of up to five tubes.

PROJECT TEAM

Architect: Studio Egret West
Structural Engineer: Packman Lucas
Steelwork Contractor: S H Structures Ltd
Main Contractor: Ringway Jacobs
Client: London Borough of Newham

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