STRUCTURAL STEEL DESIGN AWARDS 2012

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INTRODUCTION

In a period of continuing recession it would have been reasonable to expect a reduction in entries for the Awards Scheme. Surprisingly, the quality and quantity of entry was extremely high; indeed, the Judges had great difficulty in selecting what they considered to be the best from a great number of highly competent entries.

Steel continues to be the most popular framing material and the entries reflect the increasingly high standards that are being achieved, not only in design and all aspects of fabrication, but also in the short programmes and accuracy on site. In varying proportions, the qualities of engineering excellence, innovation, attention to detail, economy and speed of construction have been brought together in each of these successful entries.

THE JUDGES

Chairman of the Panel
D W Lazenby CBE DIC FCGI FICE FIStructE
Representing the Institution of Civil Engineers

G F Hayter BSc (Hons) CEng MICE
Representing the Highways Agency

J Locke MBE FREng DEng MSc CEng FIStructE FWeldI
Representing the Steelwork Contracting Industry

M W Manning FREng CEng MIStructE MA(Cantab)
Representing the Institution of Structural Engineers

C A Nash BA (Hons) DipArch RIBA FRSA
Representing the Royal Institute of British Architects

W Taylor BA (Hons) DipArch MA RIBA FRSA
Representing the Royal Institute of British Architects

O Tyler BA (Hons) DipArch RIBA
Representing the Royal Institute of British Architects

OBJECTIVES OF THE SCHEME

"...to recognise the high standards of structural and architectural design attainable in the use of steel and its potential in terms of efficiency, cost effectiveness, aesthetics and innovation"

AWARD

OLYMPIC STADIUM, LONDON

ARCHITECT:	POPULOUS
STRUCTURAL ENGINEER:	BURO HAPPOLD
STEELWORK CONTRACTOR:	WATSON STEEL STRUCTURES LTD (SEVERFIELD-ROWEN PLC)
MAIN CONTRACTOR:	SIR ROBERT McALPINE
CLIENT:	OLYMPIC DELIVERY AUTHORITY

The brief was for a stadium of 80,000 capacity to host the London 2012 Olympic and Paralympic Games with the flexibility to transform into a smaller 25,000 capacity venue for the legacy. The requirement for a temporary 55,000 seat structure resulted in a lightweight demountable steelwork design consisting of trussed rakers on raking columns, which reduced the footprint and minimised the impact on the spectator circulation areas below the terracing.

To provide flexibility in both construction, dismantling and possible legacy uses the roof is structurally independent from the terrace structure. The roof consists of a 900m long ring truss supported on a series of inclined tubular columns. As the structure needs to be demountable, all site connections including those between the steel and precast concrete units are bolted.

The terrace superstructure consists of precast concrete units resting on large raking lattice girders, which are supported on concrete shear walls at the front and by raking steel columns along the span. The terrace girders were detailed as factory welded units and made as large as possible but within the easily transportable limits. The design was rationalised through the design development period to minimise the number of components and allow simple connections to be used.

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 900m long and 12m 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 which reduced the fabrication cost.

The inner cable tension ring consists of ten 60mm diameter cables connected by steel brackets at 6m centres which in turn support a continuous walkway. The ring truss is supported by 80mm diameter suspension cables from the top boom of the compression truss, and the whole system is tensioned by 70mm tie down cables connected to the bottom boom of the compression truss. Sitting on top of the inner cable ring are 14 large pyramidal lighting towers, each 30m high and weighing 34 tonnes, which are restrained to each other and back to the compression truss with a secondary cable system.

The terrace steel structure was erected on two fronts working from the south east corner using crawler cranes, followed closely by the installation of the precast terrace units using separate tower cranes. The precast units were installed by the steelwork contractor and, to minimise any site clashes, all the units were incorporated into the steelwork model during the detailing stage.

The ring truss was delivered to the central area as individual components and assembled in jigs into sections 30m long weighing approximately 100 tonnes each. The leading edge of the truss had to be supported by temporary works from the terrace structure until the ring truss was completed, at which point it became self stable.

The cable tension ring was assembled at low level on a temporary platform at terrace level. The suspension and tie down cables were fixed at high level to the compression truss and laid out across the terrace using temporary mats to prevent damage to either the precast units or the cables themselves. When the inner ring assembly was complete, temporary pulling cables were fixed to the ends of the suspension cables and attached to 32 separate strand jacks located on the top of the inner tension ring. The 32 strand jacks were then operated simultaneously which pulled the inner ring into tension and raised the ring truss of the temporary platform. The tie down cables were connected during the lifting process. Once the net was suspended at its final level, the permanent connections from the suspension cables to the inner ring were made and the pulling jacks and temporary cables removed.

Erection of the lighting towers was extremely challenging due to the weight and lifting radius, and the fact that they were not self-stable until the final high-level circumferential cable had been connected and pre-stressed. The 14 lighting towers were fully assembled and fitted out at ground level. The top ‘A’ frame assembly was lifted off the ground with a 600t capacity crawler crane. The pair of 18m long legs and a 40m long temporary strut were then lifted and fitted to the underside of the ‘A’ frame using a second crane. Each of the assemblies then weighed 43 tonnes and was lifted with a 600t crawler crane.

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. Before the temporary struts could be removed, verification that the cables had been pre-stressed to the required load, and that the stability of the lighting towers had been transferred to the cable net system, was required.

The final erected geometry of the roof and lighting towers was verified by using a full 3D laser scan of the entire stadium structure. The cable net pre-stress forces were also independently checked using cable vibration measurements to calculate the natural frequencies and forces in the cables.

The Olympic Stadium was completed within budget and handed over three months early.

JUDGES’ COMMENT

The requirement for a severe reduction in capacity after the Olympics has resulted in a lean design, with expressed exo-skeletal steel superstructure. This has been stripped of the usual layers of periphery accommodation.

There is clear definition between different structural systems, with white-painted tubular roof, and black steelwork for the seating bowl.

The architecture provides clarity to the structure, and its subsequent disassembly.

LONDON 2012 VELODROME, OLYMPIC PARK, LONDON

ARCHITECT:	HOPKINS ARCHITECTS
STRUCTURAL ENGINEER:	EXPEDITION ENGINEERING
STEELWORK CONTRACTOR:	WATSON STEEL STRUCTURES LTD (SEVERFIELD-ROWEN PLC)
MAIN CONTRACTOR:	ISG CONSTRUCTION
CLIENT:	OLYMPIC DELIVERY AUTHORITY

The 6,000 seat London 2012 Velodrome will serve as an Olympic and Paralympic stadium for track cycling during the Games. In legacy use, it will take its place as the centrepiece of the VeloPark, a unique community cycling venue that will provide pleasure and employment to generations of Londoners and visitors from all over the world.

The Velodrome is a world-class venue that intelligently answers questions of function, beauty, sustainability, buildability and value. It has been delivered by a truly integrated design and construction team who have pursued an agenda of form following function. Inspired by the dynamism and geometry of the track and the engineering rigour of high performance bikes, the team's design approach followed the desire for lean design throughout: putting the right material in the right places and removing unnecessary 'fat'. Structural steelwork fits perfectly with this agenda, providing an ultra light, ultra strong roof solution.

The external appearance of the Velodrome is the result of 'shrink wrapping' a skin onto a steel skeleton of accommodation within. This both minimises the internal volume that needs to be heated and reduces the surface area (and cost) of the cladding. The roof form is generated by tightly wrapping a steel cable net down onto the seating bowl leading to the distinctive double curved roof form. Similarly, the outer wall is inclined reflecting how the facade is fixed directly to the back of the upper bowl. This ensemble appears to float over a glazed band splitting the upper and lower tiers - flooding the stadium with natural light and providing dramatic views, connecting events inside with the rest of the Velopark.

On track for a BREEAM 'Excellent' rating, the Velodrome boasts a number of impressive statistics: 29% recycled content in the building, natural ventilation, exceeding Part L (2006) by 30% and extensive use of natural daylighting to name but a few. The structural system is so efficient that the steel cable net roof is about 35% lighter than the roof of the next best comparable venue in the world.

From the outset, a steel cable net structure was the preferred choice for the 13,000m^2 roof as it lends itself perfectly to the shape and span, providing a combination of strength and lightness.

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.

Both utilise CHS and Catalogue column and beam sections extensively. Unusually for a cable roof, the perimeter ring truss is integral with the steel supporting bowl in order to take advantage of the strength and stiffness of the whole structure. The key advantage of this was that the ring truss became substantially smaller than a self-contained truss member would have been, enabling the re-use of a CHS reclaimed from the Petroleum Institute to form the truss chords. This integrated approach generated embodied carbon savings of approximately 3,500 tonnes.

The air-handling units were integrated into the voids formed between the skeletal structure of the steel bowl, while the seating terraces were affixed directly to the inside of the bowl and the building cladding was fixed directly to the outside. This detailed coordination was achieved using 3D modelling software to precisely communicate the positioning of the services, architecture and steelwork in the limited space.

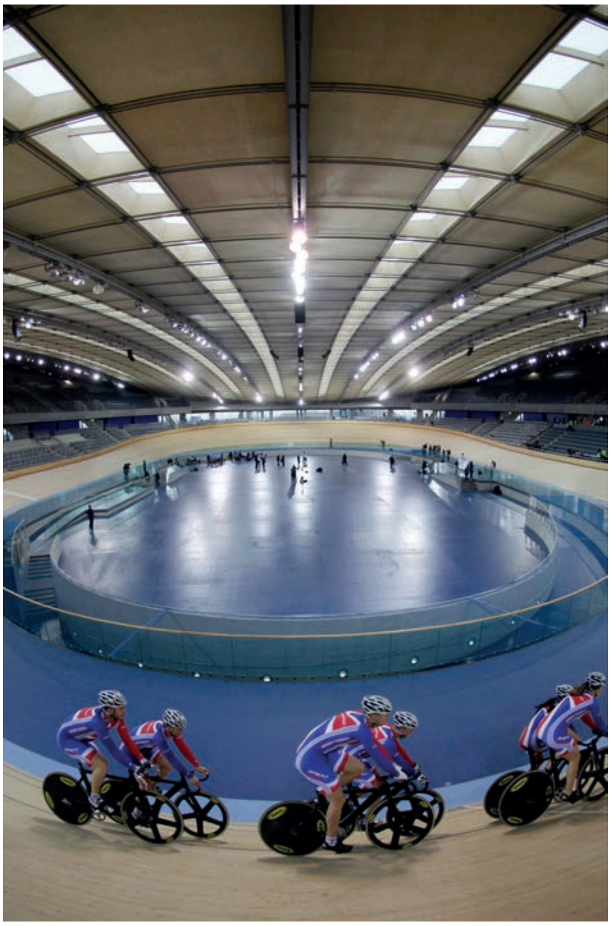
Construction issues included design for temporary construction load cases where the main bowl forces are reversed compared to the completed state. To successfully resolve this, structural steel columns and hollow sections were the best choice of material, and included the use of Macalloy post tensioning bars for the primary piers.

Due to the design of the cable net the steelwork was erected to a very tight tolerance (± 5mm) 20m up in the air. This required extensive use of 3D surveying tools and a significant use of prefabrication. The design of the steel bowl was developed around prefabrication to improve speed, cut down on waste, and improve quality. The success of using prefabrication is shown in that the only curved elements of the structure became the chord members of the steel ring truss.

The steel upper bowl was fabricated and erected as a series of 2D factory prefabricated trusses using off the shelf column sections and designed to be self stable on supporting piers following base bolt tightening. Permanent lateral bracing was used to tie the trusses together with no temporary steelwork required during the erection.

The desire to reduce working at height was a significant reason for opting for a cable net roof. The cables were laid out at ground level, clamped together and safety-netted. Only then were the cables jacked up into position: without any temporary works and completed in just three weeks.

The Velodrome's overriding strength is as an example of the benefits of good collaboration. The early design input of specialists such as the steelwork contractor was critical to the success of this innovative integrated building design. Collaboration ensured the right material was used in the right place, and the use of structural steelwork played a vital role in enabling the initial desire for ultra-lean design to be realised as an iconic sporting venue.



JUDGES' COMMENT

The capabilities and versatility of steelwork have been used well in this fine building. Using lean design, this exemplifies an integrated design/construction team mastering a complex brief to produce an exciting and sustainable result.

Truly an iconic world-class sporting venue which will endure in its legacy use in the VeloPark.

AWARD

M53 BIDSTON MOSS VIADUCT STRENGTHENING

STRUCTURAL ENGINEER:	AMEY
STEELWORK CONTRACTOR:	CLEVELAND BRIDGE UK LTD
MAIN CONTRACTOR:	COSTAIN
CLIENT:	HIGHWAYS AGENCY

The 730m multi-span box girder viaduct connects the M53 to the Kingsway Tunnel under the River Mersey and carries 63,000 vehicles daily on this strategic route to Liverpool. The viaduct was facing closure if not strengthened.

The complex project involved numerous innovative design solutions and 100km of new weld in extremely confined space conditions to strengthen and restore the viaduct to full network capacity, whilst maintaining live traffic at all peak times on the M53. The 100-week construction phase also included follow-on refurbishment activities including re-painting, drainage, lighting, cathodic protection and other highway works. To protect the road user, workforce and environment, 3.7km of box girder was housed within bespoke scaffold containment.

The main criterion for the design was to ensure strengthening work could be completed with minimal disruption to the road user. As such, most of the strengthening work was carried out inside the boxes and external faces of the box. A staged sequence was used minimising potential weakening of the structure due to drilling holes, cutting out large holes, applying heat to the structure and removing existing welds, which did not reduce the structural capacity of the structure significantly, allowing withstanding of the load effects from the interim loading.

The detailed structural surveys and analysis during the initial Phase A design period developed strengthening solutions bespoke to the project. With 604 unique boxes to be strengthened, the team developed specific solutions to suit requirements minimising the overuse of materials, maximising efficiency and steelwork techniques guaranteeing the 80-year design life.

It was recognised during the early stages that access through the structure was a serious health and safety concern due to the extreme confined spaces. A business case put forward demonstrated that by enlarging the 602 openings this would significantly reduce risk

to the programme and budget, giving greater certainty to the scheme outturn. This resulted in a £6.016m target cost being approved in advance of the main works, saving a proposed £1.9m with a two week programme saving; the actual saving was £6.1m and 12 weeks' early completion.

A full-time permit control and bespoke rescue team was maintained on site during all working periods who could respond and be at the scene of any incident within the extreme confined spaces in less than five minutes. Throughout the project, a full emergency and fire plan was maintained and several mock rescues and fire training events were held with the local fire department.

Working as an integrated team the number of solutions required was reduced to achieve the required strength. A number of value engineered solutions were completed - a good example of this was the strengthening of cross girder connections resulting in a saving of £700k.

Steel strengthening was utilised as it is compatible with the existing steel material. By strengthening the existing structure, this mitigated full replacement at a potential further cost of over £100m and reduced the embodied carbon by 85%, notwithstanding traffic disruption caused through taking a key strategic route into Liverpool offline. Steelwork allowed significant flexibility in design and construction, as well as reduced future maintenance costs when whole life cost is considered. Through the lightweight nature and unique installation methods utilised on the viaduct the project was able to limit the loading transmitting to the existing foundations.

The steelwork scope involved strengthening 3,900 linear metres of existing box corner welds both overhead and down hand, some 32,500 retrofit shear pin connectors enhanced the longitudinal shear transfer capacity of load from reinforced concrete slab to steel box. 140,000 holes required drilling in up to four plies worth of steel using close tolerance steel drilling which allowed the completion of holes at a diameter of 20mm within tolerance of -0.00mm + 0.15mm. To install over 565 tonnes of steel, 26,200m of finished weld was completed using highly specialised labour, varying between 1 and 14 runs, in excess of 100km.

Through utilising a bespoke containment system steelwork installation could progress seamlessly. The strictly controlled environment allowed first class application of corrosion protection paint utilising innovative equipment, currently the only project to be using such equipment.
A reduction of 99% of harmful fumes from painting operations delivered significant sustainable solutions.

With the entire site striving for continual improvement a true 'Lean Culture' was seen on the project which meant a drive to remove waste from processes and ensure smooth flow. Over 16 'Lean' improvements were delivered which represented a total saving of over £2.5m.

Through extensive engagement and flexibility of the steelwork installation significant savings were achieved. Of the original target cost of £25m through the installation of 387 tonnes of steel, a final 565 tonnes of steel was installed at a cost of £16.8m. This exceptional result was achieved through the extensive collaboration, integration and continual strive to optimise all solutions.

JUDGES' COMMENT

The original bridge structure was executed by a shipbuilder in the 1970s, and this is the third exercise to strengthen it to current standards. The work of the designer and steelwork contractor has been outstanding in investigating, analysing and executing the strengthening throughout the 3km length.

Successfully and safely undertaking the extensive heavy welding inside the very confined boxes presented extraordinary challenges.

PEACE BRIDGE, DERRY-LONDONDERRY

ARCHITECT:	WILKINSON EYRE ARCHITECTS
STRUCTURAL ENGINEER:	AECOM
STEELWORK CONTRACTOR:	ROWECORD ENGINEERING LTD
MAIN CONTRACTOR:	GRAHAM CONSTRUCTION
CLIENT:	ILEX URBAN REGENERATION COMPANY

The Peace Bridge was conceived as a landmark structure across the River Foyle in Derry-Londonderry linking historically divided communities on the east and west banks.

The bridge is a self-anchored suspension bridge for the use of pedestrians and cyclists. The bridge deck is divided into two curved halves, each supported by the suspension system from a single inclined steel pylon. At the centre of the river, the structural systems overlap to form a 'structural handshake'. The 312m long bridge has six spans in total, three of which are supported from the cables. The main river span is 96m, with a minimum clearance of 4.3m for navigation.

The bridge deck is an orthotropic steel triangular box section, fabricated from painted weathering steel, and stiffened both longitudinally and transversely. The transverse cantilever girders are fabricated I-sections connected to the underside of the sloping box web. A perforated aluminium decking system spans longitudinally between the cantilever girders. The convex edge of the deck is provided with a longitudinal stringer beam that connects the ends of the deck cantilevers and provides support to the parapet system.

The deck width varies fluidly from 3.5m at the ends of the crossing to 4.5m at pier locations in the river to allow space for fixed seating. The zone of aluminium decking meanders sinuously over the river varying in width according to location as it undergoes a transition from being supported by one deck box to the other with the transition in the main span. The porosity of the decking system between the box girders in the main span region is used to enhance the aerodynamic stability of the bridge.

The sweeping alignment of the deck and catenaries is supported over the water from two oppositely inclined pylons. Each has an overall height of c38m and rakes away from the bridge deck. The pylons are formed from tapering hexagonal fabricated steel box sections which transform into a triangular based pyramid at the tip.

The bridge deck is suspended from one edge by a filigree array of hanger rods comprising helically spun spiral strands. These are spaced along the concave edge of the deck at approximately 4.5m centres. The main catenary cables comprise locked coil strands. The cable geometry has been determined to support the deck system

efficiently and ensure deck stability under wind and dynamic pedestrian loading.

The parapet is a bespoke stainless steel system with plate posts, tensioned wires and continuous welded top and hand rails. A feature at the pylons is the provision of bench seating with glazed back panels to provide a windbreak. Glazed panels are also provided in the span over the railway to provide the required level of protection over the line.

Particular care was taken in the selection of materials to minimise the whole-life cost; important due to the unique form of this bridge and its challenging environment. The internal surfaces of the deck boxes are unpainted weathering steel with sacrificial thickness to reduce the future maintenance costs, and minimise the risks associated with working in confined spaces. The main suspension cables are locked-coil strand with internal blocking compound and three outer layers of interlocking 'z' shaped galvanized wires which provide excellent protection against water ingress.

The bridge substructure generally consists of concrete pile caps on tubular steel piles. The pile caps were constructed using precast concrete shell sections to minimise wet working and reduce the environmental impact on the river.

Prior to fabrication, a comprehensive 3D computer model of the bridge pylons and deck was created which assisted the visualisation of the complex structure and simplified the checking process. Subsequently, the model was used to produce component, fabrication and assembly drawings.

The bridge deck sections were erected on temporary supports placed in the river using a large floating crane. The pylons were erected in a similar manner. The majority of work to install parapets, bridge lighting and aluminium deck systems was carried out in the Port assembly area minimising the extent of works required over water.

Following installation and welding of all deck units the suspension cable installation was undertaken in two stages. In the first stage the cables were anchored to the deck and pylon anchorages using a system of multiple winches and guides that hoisted the cable up from the deck. All of the hangers and clamps were attached to the cables as they were winched up to minimise working at height and over water. The hangers were all installed to their calculated final lengths.

In the second stage the suspension system was stressed by an innovative system of jacking the main catenary cables only. As a suspension bridge, the combination of unstressed lengths of suspension cables and hangers, deck weight and tower stiffness define the unique deck and cable profiles. The catenaries were stressed simultaneously using synchronised jacks to activate the whole suspension system in a single operation. The loads and geometry were comprehensively monitored and, as predicted, when the cable loads reached 98% of design values the deck was lifted off the temporary supports and was supported fully by the cable system.

From the overall arrangement of forms to the visual resolution of small details, the engineering and architecture of the bridge are seamlessly integrated. The structure is deliberately highly visible as it crosses the open water of the River Foyle and symbolic of its intended aim of uniting historically divided communities.

JUDGES' COMMENT

This bridge is symbolic of recent political and physical developments.

S-shaped on plan, and sloping from the city walls to a development area to the East, the triangular box girder deck is supported from cables over two masts within the river. This robust construction is a fine example of careful detailing and complex fabrication.

This excellent bridge is much loved within the city and across Northern Ireland.

AWARD

THE ROYAL SHAKESPEARE THEATRE, STRATFORD-UPON-AVON

ARCHITECT:	BENNETTS ASSOCIATES ARCHITECTS
STRUCTURAL ENGINEER:	BURO HAPPOLD
STEELWORK CONTRACTORS:	BILLINGTON STRUCTURES LTD (PRIMARY STEELWORK) CMF LTD (AUDITORIUM STEELWORK)
MAIN CONTRACTOR:	MACE GROUP LTD
CLIENT:	ROYAL SHAKESPEARE COMPANY

© Peter Cook

The Royal Shakespeare Theatre opened its doors in November 2010 following a £112.8M renovation. The theatre is one of the most iconic theatrical sites, and the Royal Shakespeare Company (RSC) wanted to create the best theatre in the world to perform and pay homage to Shakespeare plays.

The 'Transformation' project called for the retention of the existing theatre facade and foyer and the rebuilding of a larger theatre. This included the creation of a new 1,040+ seat thrust stage auditorium bringing the actors and audiences closer together based on courtyard theatres of the Middle Ages, with the distance of the furthest seat from the stage being reduced from 27m to 15m.

Several elements were involved in the overall transformation, including the refurbishment of the existing building and the demolition of the 'picture frame' auditorium which was originally built in the 1930s. Improvements to the Swan Theatre created an array of new public spaces, including a Riverside Cafe and Rooftop Restaurant, a 36m observation tower and improved backstage conditions. The new theatre was also made more accessible to people with disabilities.

The main part of the transformation involved structural steelwork extensions to three areas on the existing building, including the new auditorium and two new wings. This work required the seamless supply and installation of 580 tonnes of structural steelwork, as well as having to be sensitive to the needs of the area and fit comfortably alongside the remaining historic building.

The new auditorium sits in between the retained theatre fly tower and the 1930s Grade II listed Scott Foyer. The two main roof trusses span the length of the new auditorium at 24m long x 2.5m deep and weighing 36 tonnes. The trusses needed to be solid and were designed to support 25 tonnes of scenery which is to be suspended from them. They will also support a hanging technical gallery which will be used for lighting and sound equipment, plus two hung floors over the auditorium.

The complexity of the theatre brought with it many challenges during the erection phase. The biggest was making the improvements to the existing theatre building where the steel had to be erected in and around the building, with consideration given to the surrounding area and infrastructure. The most challenging element was working around temporary supports which were in place and could not be removed until the solid structure had been connected. Erection of the fabricated new fly tower behind the new stage area,

took place on site within a very tight space. While erection of the columns was relatively straightforward, the internal trusses required splicing and lifting into the tower in small sections. This was a time-consuming task that required extra care during erection due to the Grade II listed building classification the theatre has.

The building's architectural excellence involved the construction of a new 'thrust stage' main auditorium and remodelling of public and back-of-house spaces, whilst retaining the art deco interiors of the existing foyers. A public square and viewing tower were to be added as part of a master plan to enhance the visitor experience. The 32m high 'lantern' platform, giving visitors panoramic views across Stratford, has been positioned at the top of the theatre's new tower.

Steel's lightweight advantage suited the complexity of the project. The efficient design, fabrication and erection allowed the steelwork to connect back to the existing building's retained facade. Overall around 36 tonnes of trusses were erected which were brought to site in three sections and assembled on site before being lifted into place with some complex lifts and manoeuvres.

The steel wing structure includes a 10m long Vierendeel truss which connects up the rooftop cafe's canopy. This section weighed 10 tonnes and was brought to site in one piece prior to lifting into position.

Another complex part of the erection process was to erect new steelwork walkways to the retained fly tower. Access was very limited and the steel had to be lifted through a 2m x 2m opening in the tower's roof.

Throughout the project there was a high degree of communication between the project team to value engineer and accurately produce prototype 3D models that not only drove the seamless installation of steelwork but helped achieve the most exacting of site programmes. The models produced for all areas of the structure in erection sequence helped give project managers and all site operatives a better understanding of the complexities of the steel structure and its integration into and around the existing building.

Fire engineering on the building was achieved through a combination of shop applied corrosion primer protection, and intumescent coating to the exposed beams in the foyer.

JUDGES' COMMENT

The complete remodelling of this iconic theatre and varied ancillary areas has been exceptionally challenging. The design team, main contractor and steelwork contractors have responded well to the evolving demands of the scheme. The steelwork has been key to dealing with the varied major areas, with interesting interactions of structural materials.

The breadth and popularity of the theatre's activities illustrate the success of this complex project.

THE FOOTBRIDGE, MEDIACITYUK

ARCHITECT:	WILKINSON EYRE ARCHITECTS
STRUCTURAL ENGINEER:	RAMBOLL
STEELWORK CONTRACTOR:	ROWECORD ENGINEERING LTD
MAIN CONTRACTOR:	BALFOUR BEATTY REGIONAL CIVIL ENGINEERING
CLIENT:	THE PEEL GROUP

The Footbridge at MediaCityUK spans the Manchester Ship Canal and is a signature element within the redevelopment of the region; former industrial docks located along the canal and now a new home for the BBC. Symbolising regeneration and allowing for future expansion the steel swing bridge was constructed from modular sections, while the deck was launched into position via an innovative sliding procedure. It links the MediaCityUK site with South Quay, adjacent to the Imperial War Museum North.

The bridge is a cable-stayed steel structure aligned roughly north to south that features a pair of asymmetric spans; on its northern side is the main span, approximately 65m long, which crosses the canal, while at the southern end is an approximately 18m long concrete-filled back span that serves as a counterweight. A fan-shaped array of masts supports the high-tensile, spiral-strand steel cables. Varying in height up to 30m, the masts converge at their base in a steel pedestal that is centred on the 9m diameter reinforced-concrete pier on which the bridge deck pivots. The pier is located in the canal and founded on bedrock, constructed in the dry via the use of a steel cofferdam system, the lower portion of which was left in place around the concrete shaft.

In order to meet the client's desire for a 'unique and memorable' structure the asymmetrical profile of the bridge, along with the masts and cables, intentionally mimics the shape of the industrial cranes that once lined the docks. The existing public right of navigation continues - thus the bridge was designed as a movable structure, swinging to the west. Its closed clearance over the 10m wide navigation channel was set at 4.77m.

The design is far from being run-of-the-mill; this asymmetric cable-stayed structure's main span pivots through 71 degrees to allow vessels to pass along the canal. Choosing a swing bridge design over a fixed crossing was one of the main design issues and the choice was made because of the public right of navigation. Although ships do not enter the Port of Manchester on such a regular basis as they once did, the bridge design had to accommodate any possible ship movements and usage could potentially increase as the redevelopment of the area progresses.

Structurally the bridge comprises two spans; the main pivoting span crossing the canal is 65m long, with a short back span of 18m. The latter was constructed as a hollow steel box and then filled with concrete to form the bridge's counterweight for balancing the main span during opening.

The main span's deck is fabricated as a shaped internally stiffened orthotropic steel box, with pedestrians walking on an epoxy aggregate applied coating. A fully welded structure, the deck box is sealed against the ingress of moisture making the internal areas maintenance free. Supporting the deck at 6m centres are steel cables, all anchored at their upper and lower ends using fork connectors onto steel outstand lugs aligned in the plane of the stays at the mast tip and deck connections.

The most economical method of constructing this bridge was to fabricate much of the structure off-site. To achieve this, the steelwork contractor fabricated the majority of the structure in modular sections, which were then brought to site to be welded together and assembled adjacent to the bridge's final position.

With a width that fans out from 6m to 18m, the main span was fabricated in three sections, while the shorter back span was fabricated as one section. All steel sections had two coats of paint applied at the factory - a further two were applied once the welding had been completed.

Prior to the spans being assembled the steelwork contractor first had to install the steelwork for the pivot bearing. The pivot for the bridge comprises a large steel casting welded into the pivot zone of the steelwork deck and mounted on a slewing bearing, which in turn is supported on a fabricated steel structure. This arrangement provides vertical support, resists the overturning moment generated about the horizontal axes and also provides horizontal restraint during bridge rotation.

Both spans were then slid into position; the main span first and then the back span. Once these were in position temporary works were assembled to allow the masts and cables to be erected and installed. With temporary works supporting the spans, as well as beam and column steelworks supporting the masts, the cables were attached and correctly tensioned. Only when all of the cables were in position were the temporary works removed.

This was a unique project from start to finish; both in design and execution. Not only was the slide procedure and construction method slightly unusual, but the bridge's design is also unique as the deck is curved in plan and elevation.

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JUDGES' COMMENT

This elegant cable-stayed swing bridge completes the pedestrian links at Salford Quays.

The tapering triangular box deck is curved on plan and elevation, and is supported by multiple masts at the bridge pivot points. The details of the structure and attachments are well-considered and executed.

This is analytically courageous and technically accomplished.

COMMENDATION

THE WALBROOK BUILDING, LONDON

ARCHITECT:	FOSTER + PARTNERS
STRUCTURAL ENGINEER:	ARUP
STEELWORK CONTRACTOR:	WILLIAM HARE LTD
MAIN CONTRACTOR:	SKANSKA UK PLC
CLIENT:	MINERVA LTD

The Walbrook Building, developed on the previous Walbrook House, St Swithin's House and Granite House site, directly opposite Cannon Street Station, is a 10-storey steel-framed structure comprising 6,313 tonnes of structural steelwork.

The building falls within the height limitation band imposed by St Paul's Cathedral, close to the remains of where the Roman Temple of Mithras was discovered in the 1950s. Its L-shaped floor plate is based on a 9m grid with only 10 internal columns on a typical floor plate, providing around 3,693 sq m of retail space, plus 35,283 sq m of high quality office space, as well as two basement areas.

The superstructure generally consists of structural steel columns and beams with composite floor slabs cast in-situ on metal decking with cellular beams used extensively to facilitate services distribution. Two atria from third to ninth floor allow increased daylight penetration into the office space.

The frame is designed for a target maximum vibration Response Factor of six, while still maximising the areas of column free space and minimising construction depth.

The extensive use of Fibre-Reinforced Polymer (FRP) solar shading is the first time that FRP has been used so extensively for a building, and will keep the building cool in summer.

The floor plate design and long open spans create space suitable for the broadest possible range of occupiers and were designed to suit a financial sector tenant with provision for trading floors made on both the first and second floors.

The most complex aspect of the job was the raking columns, which rake in mansard style up the height of the building. The columns change in inclination resulted in high axial forces in the beams which had to be considered as part of the connection design.

Below the sixth floor the frame is based on a relatively simple beam and column layout, above floor six the members crank in multiple locations resulting in some complex nodes with members clustered at awkward angles. Where floor beams intersect the underside of the mansard cranks, the ends of the beams had to be double cut so as to match the different skews of the columns. Therefore, fabrication accuracy was key to ensuring a good fit up on site.

The unconventional framing pattern meant that careful consideration was required to temporary stability above the sixth floor.

The roof level design was further complicated by the provision of a Building Maintenance Unit track (BMU), which had to cantilever over the curved face of the building resulting in large uplift forces and complex connections.

The environmental impact of the building was a key consideration from initial design stage, with many features that allowed it to achieve a BREEAM 'Excellent' rating, with 38% less CO_2 emissions than Building Regulations and a 4% improvement over the GLA target on CO_2 reductions from renewable energy.

This impressive building is a first-class example of steel providing the creation of a dramatic, yet functional, commercial building.

JUDGES' COMMENT

With large open trading floors and clear spans of 21m, this marks the latest in the design development of office buildings for the City of London. Progress has been evolutionary rather than revolutionary, but with ingenious construction methodology and refinements in fire engineering, this structure is impressively light, economical and efficient for the users.

Further developing steelwork's capabilities for offices.

COMMENDATION

McLAREN PRODUCTION CENTRE, WOKING

ARCHITECT:	FOSTER + PARTNERS
STRUCTURAL ENGINEER:	BURO HAPPOLD
STEELWORK CONTRACTOR:	ATLAS WARD STRUCTURES LTD (SEVERFIELD-ROWEN PLC)
MAIN CONTRACTOR:	SIR ROBERT McALPINE
CLIENT:	McLAREN

Nigel Young/Foster + Partners

McLaren's new Production Centre in Woking is the manufacturing facility for the McLaren MP4-12C super sports car, providing 34,500m^2 of internal area.

As the site was located in greenbelt, the design had to comply with very tight planning restrictions on building height that was set by the small grassy knoll located in the centre of the site. This necessitated sinking the building within the landscape that involved the excavation of 180,000m^3 of soil that was retained and used to re-landscape the site.

The resulting building is two-storey, with the buried portion being concrete and the above ground elements being steel. Steelwork was the obvious choice for the Production Centre as:

- Steelwork was a cost-effective solution
- Pre-fabrication and rapid site erection worked within the compressed programme
- Steelwork allowed for the large spans the brief demanded
- The majority of steelwork required no fire protection and the steel was left exposed
- The high level of finish obtainable with steel eliminated the need for architectural cladding

The super-structure is designed using double primary beams and columns such that all the servicing is concealed within the structural steel frame. The air is supplied at low level within the double columns to provide ventilation via displacement providing improved environmental conditions for less energy. Beneath the air supply is a slot for panels installed during the fit-out to provide data, single and three phase power and compressed air required for the assembly process.

Key aspects to the design are its simplicity and the high level of repetition. A cross grid 18m, 21m, 21m, 21m and 18m was selected to optimise the working aisle widths beneath. These were then repeated on an 18m grid for 12 bays along the length of the building. Primary, secondary and tertiary beams were then optimised for these spans and repeated throughout the building. The detailing of the key interfaces was carefully considered and a prototype of a typical bay was fabricated and installed. On approval of the prototype, fabrication commenced and the steel was erected on site as the concrete box progressed.

Although the bulk of the internal steel elements are standardised, the perimeter of the building and the entrance drums are expressed to match the visual appearance of the Technology Centre. Elegantly detailed spiral stairs and viewing galleries were added to enhance the visitor's experience when entering from the Technology Centre.

In the majority of locations the steelwork is left exposed. These areas received a high quality painted finish that matched the paint quality of any architectural finishes to give a very clean and consistent aesthetic to the space. Ceilings are used to conceal the services along the main distribution spines that run the length of the building that incorporated acoustic absorbency to control the reverberation of the space. Detailing avoids ledges and recesses to help maintain a pristine environment.

The building was designed in parallel with the development of the process equipment and recesses and voids were left for these items, including double height paint booths, testing and washing booths. The inherent flexibility of steel allowed for minor modifications to be made on site to account for the final detailed interface, which gave confidence to proceed with the production of the steel frame before the detailed fit-out requirements were known.

JUDGES' COMMENT

An automotive production building which is almost surreal in its clinical precision. Following the ethos of previous development on the site, the steel framed structure is closely coordinated with the integrated building services within double beams and columns. The clarity of purpose, careful repetition and tight tolerances are exceptional.

This shows what can be achieved if sufficient care is taken over all aspects of a project.

COMMENDATION

JARROLD BRIDGE, NORWICH

ARCHITECT:	RAMBOLL
STRUCTURAL ENGINEER:	RAMBOLL
STEELWORK CONTRACTOR:	S H STRUCTURES LTD
MAIN CONTRACTOR:	R G CARTER LTD
CLIENT:	JARROLD (ST JAMES) LTD

Jarrold Bridge, at just over 80m in length, is a dynamic and unique bridge form that appears to float over the site with little visible means of support.

The two landing points - the boulevard to the north and a raised platform protected by the river wall to the south - were determined at an early stage. The curvilinear 3D geometry follows the most efficient path between these two points that simultaneously accommodates clearances for both river traffic and the riverside's cycleway without ever being steeper than 1 in 20, thus allowing access for all over the bridge.

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.

The main structure is fabricated from weathering steel chosen for its aesthetic and long term maintenance benefits. It also develops a deep-brown oxidized coating over time, sealing the structure and protecting it against further corrosion.

The deck surface is untreated renewable hardwood selected for its density, strength and durability. A unique hidden clamp system fixes the strips to bearers which are then bolted invisibly to the steel structure. Inset fibreglass strips ensure slip-resistance in all weathers. Stainless steel top rails accentuate the curved form and a lightweight stainless steel mesh encloses the deck, allowing full visibility along the river. There are no applied finishes anywhere on the bridge reducing maintenance requirements, and lifetime costs, to a minimum.

At each abutment there are two bearings: one fixed uplift bearing below the box girder and one sliding guided bearing under the balustrade end of each bearing beam which provide a vertical, lateral and torsional restraint at the abutments.

A closed steel box beam represents the optimum form to resist the bending and torsion experienced by the deck, and allows manipulation of the cross-sectional shape to achieve the optimum aesthetic and structural form.

This trapezoidal beam is the spine of the bridge; all load from the deck and balustrade is transferred to the cross-beams which cantilever from the box girder. This applies torsion and bending to the girders, the torsion in one arm of the bridge being resisted by the bending capacity of the other.

Thermal expansion is realised as bending in the corresponding perpendicular 'arm'. Thermal stresses are thereby locked-in and the structure is designed to accommodate this. The pin-jointed columns provide vertical support but allow rotation and lateral movement as the beam flexes.

The bridge resists horizontal loading by acting as an arch supported by the bracing which ties the box girder, the edge beam and the cross beams together.

A tuned mass damper located inside the spine box girder at mid-span dampens vertical accelerations induced by resonant pedestrian loading.

The primary beam incorporates a detail where adjacent weathering steel plates oversail each other.
Off-site manufacture delivered significant benefits such as:

- Site welds were minimised to control welding and dimensional requirements in workshop conditions
- Bridge component size and weight were controlled to minimise transport and lifting operations
- A bolted splice connection was developed at mid-span to remove any need for temporary works within the river during installation
- Perfect fit of complex interface details was ensured by matching elements in the Works

Successful installation of the whole bridge was completed in a matter of hours over two days in November 2011.

JUDGES' COMMENT

An elegant architectural solution, the bridge is sensitive to its setting and the topography.

Curving vertically and on plan, the simple palette of self-finished materials, particularly the weathering steel and hardwood, enables the bridge to integrate with its mature surroundings and should minimise maintenance.

This beautifully crafted structure gives an impression of already being well established in its setting.

COMMENDATION

WEST BURTON POWER STATION

ARCHITECT:	EDF ENERGY
STRUCTURAL ENGINEER:	EDF ENERGY
STEELWORK CONTRACTOR:	FISHER ENGINEERING LTD (SEVERFIELD-ROWEN PLC)
MAIN CONTRACTOR:	KIER CONSTRUCTION LTD
CLIENT:	EDF ENERGY

The new EDF Energy Power Station is a 1300 MW Combined Cycle Gas Turbine (CCGT) unit which supplies enough energy for 1.5 million homes. The three turbine halls dominate the new CCGT facility. They are identical steel portal frames with 32m eaves height and an 82m x 35m footprint and are founded on CFA piles.

Typically the steel portal frames are at 12.5m centres and consist of 35m span roof trusses supported off stepped plate girder columns to the elevations. The turbine halls also contain a number of access platform levels, together with a 100 tonne overhead travelling crane located at 23.5m above finished floor level.

The columns are substantial fabricated plate girder sections with fully fixed moment bases. At their base, the fabricated I sections are 1800mm deep by 600mm wide with 60mm flanges and a 15mm web. At a height of 15.75m the flange width of the 1800 deep section is reduced to 450mm to save on column weight and there is also a step in the column at the crane beam level (23.5m). The top 8m of the column shaft is formed from a 900mm deep by 450mm wide plate girder section fabricated from 30mm flanges and a 12mm web. The changes in column section required fully welded splices which were formed using full penetration butt welds and tapered flange sections to reduce local stresses.

To limit the overall section weights for transport a bolted splice was also provided within the lower shaft.

The roof trusses have a maximum depth of 4.5m with 280mm deep top and bottom booms. The internal truss members vary in section type with a combination of I sections, channels and angles adopted according to load requirements.

The crane beams are also fabricated plate girder sections with a maximum span of 15m and an overall depth of 1500mm. They are designed as single spanning off rocker bearings and are formed from 40mm flanges and a 15mm web.

Full moment connections are provided for the main portal columns. These are substantial fabrications requiring 1.5m long M64 holding down bolts, together with 50mm thick base plates with stiffeners and heavy washer plates to locate the bolts.

As the columns were too large to transport they were delivered to site as 24 tonne and 9 tonne pieces. The full column was then assembled on the ground before being erected as a single piece. Similarly, the roof trusses were delivered as three equal sections, with two parts bolted together on site before being joined with the third section in the air as part of a tandem lift involving two mobile cranes.

The three turbine halls were erected sequentially from one end of the site. Initially, three mobile cranes were required to allow the erection of two portal frames and associated bracing to ensure a stable core for subsequent erection.

Careful sequencing of the various site activities was required. 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 consequence, the 40,000m^2 of external cladding to the buildings could not be fitted until these floors were erected.

JUDGES' COMMENT

Three large identical portal frames provide the turbine halls for this new 1300 MW facility. Designed, fabricated and erected very fast, this is one of the first major projects to conform to the Eurocodes.

A good example of practical and economical use of heavy steelwork.

COMMENDATION

NEO BANKSIDE, LONDON

ARCHITECT:	ROGERS STIRK HARBOUR + PARTNERS
STRUCTURAL ENGINEER:	WATERMAN STRUCTURES LTD
STEELWORK CONTRACTOR:	WATSON STEEL STRUCTURES LTD (SEVERFIELD-ROWEN PLC)
MAIN CONTRACTOR:	CARILLION
CLIENT:	GC BANKSIDE LLP

Following NEO Bankside's successful planning application, investigations began into the possibility of relocating the bracing outside of the cladding plane allowing it to be expressed as the distinct and legible system.

Although the primary structure of the four residential pavilions comprises traditional in-situ reinforced concrete frames, the perimeter bracing serves three key purposes: provides lateral stability under wind load contributing up to 75% of the overall stability; reduces the requirement for shear walls allowing greater flexibility of internal planning and servicing arrangements; and provides support for the winter-garden elements at the prows of the building.

Building stability forces are transferred into the external perimeter bracing system via nodes arranged on a six-storey interval vertically and three-storey interval horizontally, and connected back to the primary concrete columns and slabs by steel 'spindles' that project through the cladding. The nodes transfer the lateral stability forces that act on the structural frame into the bracing system, and allow for the transfer of bracing forces between OHS members in the plane of the framework. Lateral loads from the intermediate floors are transferred to the nodal floors by reinforced concrete walls arranged around the core which act as vertical beams.

The spindles and node fin-plate assemblies were delivered to site prefabricated onto 4.5m long steel stanchions that were embedded within the primary concrete columns and locked into the floor-plates by high-strength large-diameter anchor bars. This meant that both fabrication and site erection tolerances had to be very tightly controlled to ensure that the bracings would fit between the node fin-plates. The bracings taper at their ends and attach to the node fin-plates via cast fork-ends, with close-tolerance pins of up to 100mm in diameter. This pin tolerance is an essential factor in controlling overall building sway by limiting the free movement within the pin-holes under load-reversal conditions.

The colour of the external perimeter bracing was an important factor affecting the structural design, with implications to the range of thermal stresses and movements to which the system would be subjected.

The external diagrid bracing system provides gravity load support to the promontory winter-gardens at each end of the pavilions by utilising a system of external hangers or struts at their apexes.

The offset of the bracing from the facade means that a fire inside the apartment never reaches sufficient temperatures at the bracing members to require intumescent treatment; also the system has been designed to remain stable even if, due to a catastrophic fire in one apartment, up to three nodes failed. At ground level the OHS elements are concrete filled to protect against impact.

Glazed lift towers are expressed separately to the pavilions on each of their east elevations. The lift enclosures are supported by elegant gallows frames arranged on a three-storey interval to bring all of the gravity loads back to just four columns that sit in pairs to either side of each of the lift doors. Lateral stability is provided by cantilevering the lobby slabs and steel-edge beams horizontally from the primary concrete frames.

The exposed tubular braces and exposed stair and lift structures required a highly architectural finish.

Site installation of the nodes was particularly challenging because of the extremely tight tolerances that were required. The accurate positioning was achieved by adapting a two-stage concrete pour strategy which allowed the nodes to be fixed and held back securely to the partially complete concrete structure with temporary supports while the second pour was carried out which then locked them finally in position.

The dramatic appearance of the nodes has become a selling point, with buyers requesting nodal apartments.

JUDGES' COMMENT

This project is outstanding in its rigour and attention to detail.

Intelligently conceived, designed and beautifully built, it is clear that the whole team was immersed in every aspect.
The prominent elliptical external structural bracing has a refined architectural quality.
The elegant stair/lift cores are a delight.

Impressive quality achieved on a design-and-build project.

COMMENDATION

RISE, BELFAST

SCULPTOR:	WOLFGANG BUTTRESS
STRUCTURAL ENGINEER:	PRICE & MYERS
STEELWORK CONTRACTOR:	M HASSON & SONS LTD
MAIN CONTRACTOR:	WOLFGANG BUTTRESS
CLIENT:	BELFAST CITY COUNCIL

RISE is a large scale piece of public art, visible to thousands of pedestrians, motorists and air passengers travelling via George Best Belfast City Airport.

The structural design of RISE itself was carried out by structural engineers specialising in the design of geometrically challenging structures. RISE is a unique manifestation of the form, with its pair of concentric spheres supported on tangential and normal columns. However, through efficiency of design and selection of a favourable geodesic scheme, the structural fabric of the sculpture was optimised to consist of a relatively small number of fundamental components. Over 4,000 components, connected with c10,000 bolts, were distilled down to less than 60 individual types. This standardisation allowed the steelwork contractor to focus on delivering the level of accuracy required to ensure that every member would adopt its correct position on the surface of each 'sphere'.

To ensure continuity from the sculptor's design models right through to the finished structure, StruCad's import features were used to take in centreline geometry from the structural engineer's master model. This geometry formed the basis of numerous subsequent models used to fabricate the structural fabric of RISE itself, as well as a complex array of temporary works, lifting frames and installation aids deployed on site to enable safe and accurate erection of the work.

A number of prototype assemblies, up to and including one complete geodesic panel, were prepared which allowed the erection team to start planning for a most complex steelwork erection task. From an engineering standpoint, the trial assemblies provided invaluable insight into the actual, often non-linear, behaviour of the geodesic frameworks during lifting and up-ending operations.

As detailing of the structure progressed, 3D geometric modelling techniques were brought to bear on some particularly challenging aspects, such as the optimal degree of dishing to be applied to the circular node plates which hold the spheres together. The interaction of the two spheres, the supporting columns and surrounding bed of steel 'reeds', all coated in brilliant white, has created varied and dramatic views.

From the outset it was recognised that the erection of RISE would be extremely challenging due to the nature of the site centred on a major roundabout, which compounded the challenges associated with complex and sometimes prolonged lifting operations. Whilst the geodesic form of each sphere is highly stiff and stable once complete, great care was required to ensure stability during erection before final strength was achieved. A series of bespoke temporary works, lifting appliances and associated accessories to minimise erection risks were designed to ensure intermediate and final stability and accuracy of the sculpture.

Maximising the number of connections made at or near ground level, catering for the highly non-linear nature of the partly completed structure, and ensuring safety during removal of temporary steel were essential aspects of the design and execution of the temporary works. The final operation of transferring the weight of the inner sphere off the temporary stability mast through the 72 steel suspension cables and onto the outer sphere brought a welcome conclusion to a series of increasingly complex lifting operations.

The creation of RISE owes a great deal to the quality, versatility and efficiency of structural steel.

JUDGES' COMMENT

Inspired by a summer sunrise seen through rushes, this large sculpture is impressive for its geometric form and precision. Intelligent analysis, precision fabrication and safe assembly on a road-locked site have produced steelwork of fine quality.

Linking two distinct Belfast communities, this is a stunning and popular landmark.

COMMENDATION

BOROUGH HIGH STREET BRIDGE, LONDON

ARCHITECT:	JESTICO + WHILES
STRUCTURAL ENGINEER:	ATKINS
STEELWORK CONTRACTOR:	WATSON STEEL STRUCTURES LTD (SEVERFIELD-ROWEN PLC)
MAIN CONTRACTOR:	SKANSKA CIVIL ENGINEERING LTD
CLIENT:	NETWORK RAIL

The bridge is located within a conservation area and the busy Borough Market. The steelwork contract consists of 128m of approach viaduct to the west, the main 70m span Borough High Street Bridge and a further 50m of viaduct to the east.

The approach viaducts are a standard through-deck plate girder design with deck beams spanning 7.6m between the 2.0m deep edge girders, which in turn are supported on concrete piers at approximately 25m centres. The permanent formwork soffit is formed with precast concrete panels incorporating white cement and a coffered profile.

The iconic feature bridge is 70m long, 9m high in the centre and incorporates 850 tonnes of steel with a further 400 tonnes of concrete in the deck.

The main span has a unique trapezoidal girder constructed from large diameter tubes with tapering ends. The north elevation of the bridge is close to an existing railway bridge and is not visible and therefore the girder along this elevation is a simple and economic plate girder.

The main tubes are up to 1200mm diameter with 50mm wall thick thickness and, due to the overall size and the design requirements, many of the major joints had to be butt welded on site. The bottom chords have significant torsional stiffness ensuring continuity between the cross girders and the internal tubular steel members of the truss. Fine grained steels Grade S355 NL were required to provide the required notch ductility.

The entire girder was first assembled in the fabrication workshop to ensure fit up before being dismantled and sent to site in large sections of up to 65 tonnes each.

The major challenge was how to construct the bridge within the extremely confined site. It was just possible to construct the approach viaducts conventionally using a crane operating within the footprint of the site to place the girders and deck beams.

The main span over Borough High Street however had to be installed during a weekend road closure which, because of the requirement to site weld the major tubular connections, meant that the bridge would need to be assembled off site and somehow moved into position.

An innovative installation solution was developed which was to first build the western approach viaduct, install the precast deck units and provide temporary bracing to the top flanges. Then using this deck as a working platform and the edge plate girders as supports, the main span was assembled at an elevated position on top. Extensive temporary supports were required to make this feasible because the main span was up to 3m wider than the viaduct on which it was assembled.

When the bridge steelwork was complete and the concrete deck units installed the bridge was prepared for installation. The rear end of the bridge was supported on a slide track with Teflon pads. The front end of the bridge was supported on hydraulic towers which in turn rested on multi-axle vehicles.

On the designated weekend, the bridge was rolled across Borough High Street at the rate of a few centimetres per minute and was then lowered down onto the bearings on the new concrete supports. Great care was required during this operation as the launch path of the bridge passed within a few centimetres of existing buildings.

This iconic structure, located in what must be one of the most congested locations in London, required the highest calibre of engineering and innovation in order to achieve the successful installation which was completed within the designated time period.

JUDGES' COMMENT

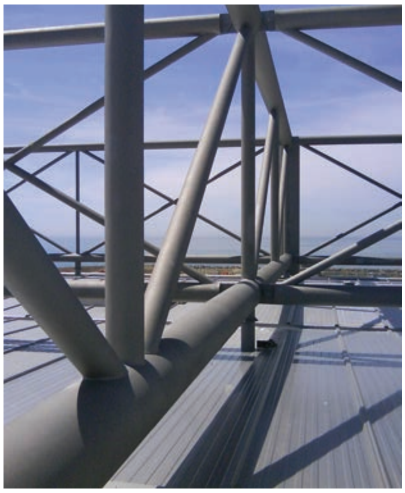
Substantial additional rail capacity is threaded through the busy historic Borough Market area by means of this new viaduct and bridge. To achieve this on a key commuter route tested the ingenuity of the team.

The technique of launching the main span from the viaduct itself was inspired. The bridge is both attractive and practical – another railway success by steelwork.

COMMENDATION

ENERGY FROM WASTE FACILITY, LA COLLETTE, JERSEY

CONCEPT ARCHITECT:	HOPKINS ARCHITECTS
EXECUTIVE ARCHITECT:	EPR ARCHITECTS
STRUCTURAL ENGINEER:	CAMPBELL REITH HILL LLP
STEELWORK CONTRACTOR:	BOURNE STEEL LTD
MAIN CONTRACTOR:	CSBC
CLIENT:	STATES OF JERSEY TRANSPORT AND TECHNICAL SERVICES DEPARTMENT



The Jersey Government's new Energy from Waste (EfW) facility at La Collette replaces the ageing Bellozanne incinerator on the island. Two new buildings were to be constructed:

- EfW Building - containing waste bunker, incinerators, boiler hall, electricity turbines and gas treatment area.
- Bulky Waste Facility (BWF) Building - a single storey portal frame structure adjacent to the main EfW building.

The site is located adjacent to the existing Jersey power station enabling the EfW plant to share the chimney, cooling water and other auxiliary services, minimising the environmental impact of the development.

To achieve a high architectural building, the structure was expressed externally beyond the building envelope and set to a 16m grid allowing the rhythm of the internal process to be reflected in the external structural arrangement, and also for the scale of the building in height and span to be represented in the column and truss engineering.

With regard to the geometry of the building, steel was the obvious solution due to the long span opportunities provided with steel. The exposed steel frame comprises six 36m long roof trusses together with four lines of 16m long secondary trusses, all supported on 37m high large diameter CHS columns at 16m intervals.

The roof steelwork supports a flat standing seam composite steel panel roof which in turn hangs from the external trusses. The end walls are glazed to reveal the structure's bracing and the clarity of the single clear span over the process within. The profiled metal cladding to the long elevations is supported by seven lines of bespoke cladding/wind rails over the height of the building. These rails have feature openings and remain exposed beyond the line of the cladding to create patterns in light and shadow. Two vertical Macalloy bars restrain the rails at mid-span and connect back to the main roof structure.

To make the steelwork as light and efficient as possible adopting 864mm x 12mm CHS sections worked both structurally and aesthetically. The CHS tubes forming the trusses were varied in thickness to suit loadings, ensuring the structures are as light and efficient as possible.

A 3m deep, 40m long sunken plant roofwell containing M&E equipment was required. Suspending the plant area from the roof structure ensured the equipment did not foul the appearance of the feature roof trusses.

The 1,000 tonnes of fabricated trusses and columns were ferried to the island in two and three sections respectively, then welded together prior to erection in a site workshop allowing for rapid construction of the frame and cladding. The size and complexity of the process engineering equipment resulted in the majority of it being assembled in advance of the steel frame. This added challenges in erecting the envelope steel frame above and around the equipment already installed.

The steelwork was protected against the hostile marine environment by applying a C5 high build epoxy protective paint coating to all members providing a cost-effective method of minimising future maintenance expenditure. A sprinkler system within the building also removed the need for any additional fire protection to the steelwork or cladding.

Full operation commenced in May 2011, with the new facility providing up to 7% of the island's electricity.

JUDGES' COMMENT

Prominently sited on a coastal headland, this required a clever solution to assimilate the disparate shapes and volumes of an EfW plant into a large cubical pavilion. The columns and roof trusses boldly articulate the building, as part of a cost-effective steel structure.

Visually reducing the impact of this plant has been an important structural success.

COMMENDATION

GARSINGTON OPERA PAVILION, WORMSLEY

ARCHITECT:	SNELL ASSOCIATES
STRUCTURAL ENGINEER:	MOMENTUM
STEELWORK CONTRACTOR:	SHEETFABS (NOTTM) LTD
MAIN CONTRACTOR:	UNUSUAL RIGGING LTD
CLIENT:	GARSINGTON OPERA


Dennis Gilbert


Dennis Gilbert

The new auditorium, which provides 600 seats and six wheelchair positions, occupies a commanding yet intimate and sheltered position within the Park at Wormsley. It is conceived as an elegant lightweight pavilion set within its parkland setting, elevated above the ground giving the appearance of 'floating' above the landscape.

The auditorium design takes its cue from a traditional Japanese pavilion in its relationship to its landscape setting and its use of sliding screens and verandas to link it to the landscape, both visually and physically.

The site allows the division of areas between front of house gardens and back of house technical spaces, which remain screened from view. The ha-ha follows the contours of the land and naturally creates the orchestra pit and under-stage trap room.

The layout of the new structure is planned to allow the auditorium, verandas and terraces to face towards the landscape views. The stage, side stages and backstage store rooms are discretely located to the rear of the theatre next to the surrounding woodland, screening the areas from public view and allowing easy access for sets and performers.

The auditorium is made from timber, fabric and steel. Hardwood timber features for the decked areas of the verandas, terraces and stage walls. The enclosing walls of the auditorium use stressed fabric sails shaped to enhance the room acoustic and a double layer fabric roof absorbs rain noise like the flysheet of a tent. The sides of the auditorium are enclosed with transparent PVC fabric sails to minimise draughts within the auditorium whilst retaining views out over the adjacent gardens. The feeling of space has been retained and the auditorium ceiling and walls have been specially designed to improve the room acoustics.

The new opera pavilion was constructed using pre-fabricated techniques which minimised material waste, reduced the construction time spent on site and allow the building to be assembled/disassembled as quickly and economically as possible.

The requirement for the structure to be demountable led to an entirely bespoke structure being preferred to allow the roof and column trusses to be divisible into the minimum number of modular pre-fabricated elements that can be lifted by crane, minimising construction time and cost. The whole steel structure was pre-fabricated in the factory and galvanized, providing a maintenance-free, durable and corrosion resistant protective finish.

As the building is modular and entirely demountable, it is an extremely flexible structure which can be adjusted as required to suit the changing opera performances. The sliding screens' track allows the outer line of the building envelope to be adjusted in a matter of minutes to reflect climatic conditions, and the design of the tracks allows for additional screens to be installed as required.

The integration of services requirements was carefully considered at the design stage to coordinate both the theatrical and house lighting positions and integrate them into the structure. Radiant heating panels are also used to heat the audience on cold evenings and these are suspended from purlins running between the roof trusses.

The whole structure is conceived as a 'Rig for Opera'.

JUDGES' COMMENT

The brief was for a theatre with full facilities, yet to be demountable annually. Techniques used in 'instant' open-air concert staging have been used and developed, with lightweight superstructure and heavier floor and terraces, all with ingenious membrane cladding.

The result is a delightful and cost-effective pavilion which sits lightly on the wooded hillside so successfully that it has now been agreed that it may remain in place.

COMMENDATION

DEPTFORD LOUNGE, LONDON

ARCHITECT:	POLLARD THOMAS EDWARDS ARCHITECTS
STRUCTURAL ENGINEER:	ATKINS
STEELWORK CONTRACTOR:	CONDER ALLSLADE LTD
MAIN CONTRACTOR:	GALLIFORD TRY
CLIENT:	LONDON BOROUGH OF LEWISHAM

The brief was for the Giffin Street Redevelopment to form a focal point for the local community. The Deptford Lounge, serving the community, will hold something for everyone, regardless of age, income, cultural and ethnic background.

The visionary concept combines a replacement primary school, Tidemill School, with the Lounge - a new state-of-the-art district library offering community facilities, and Resolution Studios – providing new homes, studios and exhibition space for local artists. The upper floors of the Lounge are designed for shared school and community use thus maximising the resources available to both the school and the wider community.

The Lounge is a three-storey steel framed building with reinforced concrete stair and lift cores providing the stability to the primary frame. The key structural challenges have been the buildability issues associated with the busy city centre site and the location of the four main buildings to maximise all available space, including the positioning of the ball court on the roof of the Lounge Building and the external play area on the roof of the South school building.

The requirement for flexible open spaces resulted in large structural spans over the ground floor library with 15.5m clear spans. The twin 2.1m diameter Victorian masonry sewers running beneath the Lounge building needed to be protected and the loads imposed onto them limited to below 60kPa. As a result it was essential for the superstructure above to be a lightweight construction.

Structurally the provision for services required careful co-ordination to position openings through the webs of the deep long span beams. Sustainability considerations included natural ventilation to the classrooms and offices and the integration of the bio mass boiler within the basement and duct routes for pellet deliveries.

The external cladding to the Lounge building comprises 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 system is a bespoke system designed to provide a striking appearance, whilst controlling light and shading. The degree of perforation varies across the facade to create interest in the aesthetics and to control the degree of light perforation for the classrooms, sustaining a high quality of natural light without the need for additional shading.

To the south facade the external perforated cladding system is offset from the primary steelwork frame by up to 2.5m. A series of secondary steelwork trusses span between compression struts which are braced back to the primary steel columns at the top and base of the cladding system.

There were a number of technical complexities in the structural design of the ball court which was designed to be structurally isolated from the adjacent offices. This was achieved through the use of double beams on the edges of the ball court, a structurally separated floor slab from the adjacent office spaces and high-load rotational pot bearings. A detailed analysis on the ball court floor structure was undertaken to ascertain the natural frequency and prevent excessive vibrations due to synchronised activity.

Careful consideration was made of the required one-hour fire protection (typical between floors). This was achieved primarily through the use of fire-boarding to the main frame. An intumescent coating was applied to exposed steelwork with a cosmetic top coat to fit in with aesthetic requirements.

JUDGES' COMMENT

The requirement for 15m clear span at ground level against a fast programme and tight budget meant that steelwork was the material of choice.

Careful design and attention to detail, with acoustic and thermal isolations between many different space uses, have led to a genuinely flexible, vibrant and striking hub for Deptford.

Steelwork is key to this remarkably successful building.

OTHER FINALISTS

MEDIACITYUK

ARCHITECT:	THE FAIRHURSTS DESIGN GROUP
STRUCTURAL ENGINEER:	JACOBS ENGINEERING
STEELWORK CONTRACTOR:	WILLIAM HARE LTD
MAIN CONTRACTOR:	LEND LEASE CONSTRUCTION (EAMA) LTD
CLIENT:	THE PEEL GROUP

THE THIRD WAY BRIDGE, TAUNTON

ARCHITECT:	MOXON ARCHITECTS LTD
STRUCTURAL ENGINEER:	FLINT & NEILL LTD
STEELWORK CONTRACTOR:	MABEY BRIDGE LTD
MAIN CONTRACTOR:	GALLIFORD TRY INFRASTRUCTURE LTD
CLIENT:	SOMERSET COUNTY COUNCIL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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 & DRAMA

MAGGIE'S CANCER CARING CENTRE, NOTTINGHAM CITY HOSPITAL

ARCHITECT:	CZWG ARCHITECTS LLP
STRUCTURAL ENGINEER:	AKTII
STEELWORK CONTRACTOR:	SHIPLEY FABRICATIONS LTD
MAIN CONTRACTOR:	B&K BUILDING SERVICES LTD
CLIENT:	MAGGIE KESWICK JENCKS CANCER CARING CENTRES TRUST

COMMONWEALTH SPORTS ARENA AND SIR CHRIS HOY VELODROME, GLASGOW

ARCHITECT:	3D REID
STRUCTURAL ENGINEER:	HALCROW YOLLES
STEELWORK CONTRACTOR:	WATSON STEEL STRUCTURES LTD (SEVERFIELD-ROWEN PLC)
MAIN CONTRACTOR:	SIR ROBERT McALPINE
CLIENT:	GLASGOW CITY COUNCIL

IQ WINNERSH FOOTBRIDGE

STRUCTURAL ENGINEER:	RAMBOLL
STEELWORK CONTRACTOR:	LITTLEHAMPTON WELDING LTD
MAIN CONTRACTOR:	LITTLEHAMPTON WELDING LTD
CLIENT:	SEGRO

OTHER FINALISTS

BUS STATION, SLOUGH

ARCHITECT:	BBLUR ARCHITECTURE
STRUCTURAL ENGINEER:	BURO HAPPOLD
STEELWORK CONTRACTOR:	S H STRUCTURES LTD
MAIN CONTRACTOR:	McLAREN CONSTRUCTION LTD
CLIENT:	SLOUGH BOROUGH COUNCIL

ARNSIDE VIADUCT, MORECAMBE BAY

STRUCTURAL ENGINEER:	RAMBOLL
STEELWORK CONTRACTOR:	MABEY BRIDGE LTD
MAIN CONTRACTOR:	MAY GURNEY LTD
CLIENT:	NETWORK RAIL

THE GRAND PIER, WESTON-SUPER-MARE

ARCHITECT:	ANGUS MEEK ARCHITECTS
STRUCTURAL ENGINEER:	FAIRHURST
STEELWORK CONTRACTOR:	WILLIAM HALEY ENGINEERING LTD
MAIN CONTRACTOR:	JOHN SISK & SON LTD
CLIENT:	KERRY AND MICHELLE MICHAEL

TICKET HALL, FARRINGDON STATION, LONDON

ARCHITECT:	ATKINS
STRUCTURAL ENGINEER:	ATKINS
STEELWORK CONTRACTOR:	BOURNE CONSTRUCTION ENGINEERING LTD
MAIN CONTRACTOR:	CoLOR JV
CLIENT:	NETWORK RAIL

PORTH TEIGR BRIDGE OUTER LOCK CROSSING, CARDIFF BAY

ARCHITECT:	STUDIO BEDNARSKI LTD
STRUCTURAL ENGINEER:	FLINT & NEILL LTD
STEELWORK CONTRACTOR:	ROWECORD ENGINEERING LTD
MAIN CONTRACTOR:	VINCI CONSTRUCTION UK LTD
CLIENT:	IGLOO REGENERATION LTD

THE BALANCING BARN, THORINGTON

ARCHITECTS:	MDRV MOLE ARCHITECTS
STRUCTURAL ENGINEER:	JANE WERNICK ASSOCIATES LTD
MAIN CONTRACTOR:	SEAMANS BUILDING LTD
CLIENT:	LIVING ARCHITECTURE

ST GEORGE'S GROVE, LONDON

ARCHITECT:	HUNTERS
STRUCTURAL ENGINEER:	EOS LTD
STEELWORK CONTRACTOR:	EOS LTD
MAIN CONTRACTOR:	WILLMOTT DIXON HOUSING
CLIENT:	THAMES VALLEY HOUSING ASSOCIATION

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