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STEEL SPOTLIGHT: Structural Steel Design Awards 2018

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City headquarters meets

Bloomberg London is a finely crafted, highly sustainable building with open-plan floors and dramatic circulation routes

RUBY KITCHING

In a world where so much of what we do takes place in front of a screen, it's refreshing to see media and software firm Bloomberg consider staff interaction as one of the main design drivers for its new European HQ.

Located in the City of London, the building has also been awarded a BREEAM 'Outstanding' environmental rating, said to be the highest of any major office development in the UK. The 10-storey building is made up of a north and south block connected by high-level walkways. At street level, a new publicly accessible arcade separates them.

"At the heart of the building is open space, which helps people and information move more seamlessly," says Bloomberg chief executive officer Michael Bloomberg. Creating these open floorplates is a composite steel structure, which integrates with services to maximise ceiling heights.

Reinforced concrete stair and lift cores are unconventionally located on the building's perimeter, instead of occupying a central location, to enable clear views across floors.

And, rather than adopting a rectangular structural grid, the building adopts a repeating equilateral triangle of side length 13.85 m to maximise every inch of the angular site.

The project has required the team to think outside the box and, on one occasion, to think outside the fish tank. "As with any project of this scale and ambition, the brief was constantly evolving," says Sir Robert McAlpine building services engineer Chris Atkins. "An example is the inclusion of a 50-tonne fish tank on the sixth floor, which had to be installed after ceiling void closures had been completed on levels five and six."

He explains that the team's joint effort enabled a solution to develop that did not impact the programme. This involved strengthening steel at level six and finding space in an existing storeroom for extra plant and services.

"The use of steel within the design allowed for close co-ordination with other trades [...] which greatly de-risked and reduced the onsite programme," says William Hare's London operations director Curzon Graham.

Balancing the need for order and repetition on the main office floors is a twisting feature ramp in the north building.

The ramp playfully connects levels two to eight in a form that resembles the phases of a flower drawn using a 'Spirograph' drawing instrument, or a hypotrochoid, to give the shape its scientific name.

This 1.5 m-wide steel ramp, spanning a height of 30 m, passes through elliptical openings in the floorplate, which are rotated by an angle of 120 degrees between floors. The ramp provides another opportunity for staff to mingle.

"Having open floor plans throughout was a challenge," says Sir Robert McAlpine project manager Allan Cameron. "Every floorplate has a different design due to the large opening in the middle for the ramp, which changes position from floor to floor."

The 230 m-long ramp is the building's centerpiece, he continues. "It is only fixed to the building at two points to give it the appearance of floating.

"The extremely complex hypotrochoid shape meant we didn't know exactly how the structure was going to react once temporary propping was removed."

Temporary supports during its construction also provided access to install the ramp's bronze cladding panels. Close co-ordination with the panel supplier ensured that, after de-propping and when the ramp steelwork had settled, the space between adjacent panels compressed to create a seamless surface.

Located on a city centre site and surrounded by streets on all sides, design

INTRODUCTION

This year marks the 50th anniversary of the Structural Steel Design Awards (SSDA), which are jointly sponsored by the British Constructional Steelwork Association (BCSA) and Trimble Solutions (UK) Ltd.

The Awards celebrate UK excellence in steel fabrication, design and construction. This year's recipients reflect an industry that is focused on creating efficient, sustainable and cost-effective structures that look exceptional and function brilliantly.

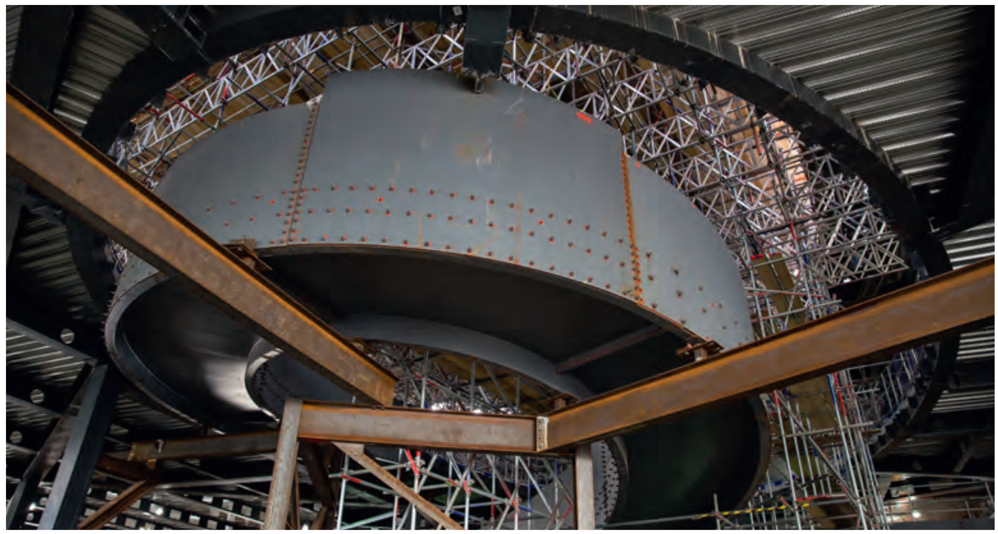
Always innovative, these project's teams use technology to refine and push boundaries. Key to the success of many of the 22 structures showcased here has been the use of BIM and collaborative working from the earliest opportunity.

Six Awards, eight Commendations and eight Merits were presented on 3 October at a ceremony held in Whitehall, London, where it was also announced that Jaguar Land Rover Engineering Manufacturing Centre was the 2018 SSDA Project of the Year.

The SSDA's cross-industry judging panel includes: chairman Chris Nash (Royal Institute of British Architects, RIBA), Richard Barrett (steelwork contracting industry), Paul Hulme (Institution of Civil Engineers), Sarah Pellereau (Institution of Structural Engineers, IStructE), Professor Roger Plank (IStructE), Julia Ratcliffe (IStructE), Bill Taylor (RIBA), and Oliver Tyler (RIBA).

AWARD Bloomberg London
Architect Foster + Partners
Structural Engineer AKT II
Steelwork Contractor William Hare
Main Contractor Sir Robert McAlpine
Client Bloomberg

exacting demands



and construction of this building was complicated by access issues and the impact it could have on nearby structures.

"Due to the close proximity of tube lines, a Victorian sewer running through the centre of the site and adjacent historic buildings, the structural steel frame is a complex mix of transfer beams – some pieces weighing 60 tonnes," says Sir Robert McAlpine project commercial director Michael O'Donnell. "Large trusses also support a section of the building which is hung from the roof."

The building's environmental wins come in the form of reusing foundations (with additional piles only introduced in the south-west corner), water recycling and efficiency measures, and low-energy features.

This all adds up to 73 per cent less water consumption and 35 per cent less energy use compared with a typical office building.

COMMENDATION
Two St Peter's Square, Manchester

Architect SimpsonHaugh

Structural Engineer BuroHappold

Steelwork Contractor William Hare

Main Contractor Laing O'Rourke

Client Mosley Street Ventures Ltd

© Daniel Hopkinson

This 12-storey double-basement office building in Manchester replaces four buildings that used to occupy the site. Its highly decorative precast concrete façade enables it to sit comfortably among the Grade I-listed Town Hall and Grade II-listed Central Library that occupy St Peter's Square.

Composite steel beams spanning 18 m create column-free floors, while double-height columns spaced 12 m apart at ground level give it a civic presence. "As a speculative office, designed and delivered during difficult market conditions, it was important to offer a flexible open-plan floorplate," says SimpsonHaugh associate partner Simon Critchley.

The façade is made up of 6 m-wide by 4 m-tall panels. Analysis of the steel frame's behaviour at different stages of the build determined the extent of pre-setting required so that it would settle in a controlled way as the panels were added, eventually resting at its final position when the building was complete.

Mr Critchley adds: "Point loads at structural columns, combined with pre-cambering of steelwork to accommodate the loading of the heavy façade panels and eventual cantilevering of the main office, required envelope and frame to work together."

More than just an engine

Jaguar Land Rover's new West Midlands facility has been designed and built with the same precision and care that goes into manufacturing its world-class car engines

AWARD and PROJECT OF THE YEAR
Jaguar Land Rover
Engine Manufacturing Centre

Architect Arup
Structural Engineer Arup
Steelwork Contractor Severfield
Main Contractor Interserve Construction
Client Jaguar Land Rover

RUBY KITCHING

Functionality, reliability and efficiency are some of the most important aspects of car engine design, but if this mindset alone were applied to the factories manufacturing them, the result would be soulless buildings and the people working in them made to feel like mere cogs.

Jaguar Land Rover's new facility in Wolverhampton is functional, reliable and efficient, but is also a place that connects people with other people and processes. It is not even described as a factory but an 'engine manufacturing centre' to emphasise that it does more than just house machinery.

The centre has been designed to encourage human interaction and for state-of-the-art machines to do their job, all while natural daylight floods in.

It breaks down the physical and psychological barriers between shop floor and administration through its open structure and large expanses of glazing.

Some 165,000 sq m of production space, offices, ancillary areas and a community education centre make up the development.

Arup architect Sean Macintosh is very proud of what has been achieved: "What could have felt like quite an oppressive series of volumes is transformed into airy volumes that are uplifting; a place where people like to work," he says.

Its robust, lightweight braced steel frame can also support a range of different machine layouts and be easily extended as necessary.

"The facility was designed for total flexibility in both the building and manufacturing facility to enable us to react quickly and efficiently to future business needs," explains Jaguar Land Rover's powertrain facility senior engineering manager John Vickers.

The processes and equipment of the machine and assembly halls, the two main areas of the centre, have dictated the structural grid of the building. The machine hall uses a structural grid of 30 m x 15 m while the assembly hall – where, according to Mr Macintosh, "you can eat your dinner off the floor" – a 30 m x 30 m grid.

Primary trusses spanning 30 m are arranged to create openings in the roof for northlights and column-free areas below. They also support primary services. "These lightweight systems allow easy maintenance and adaption in this complex that never sleeps," he adds.

Jaguar Land Rover's 3D production model was integrated with Arup's BIM model to create a single file for the entire facility, enabling effective co-ordination. When the project was on site, BIM helped Arup respond quickly to the client's decision to add an extra 30 m bay to the building.

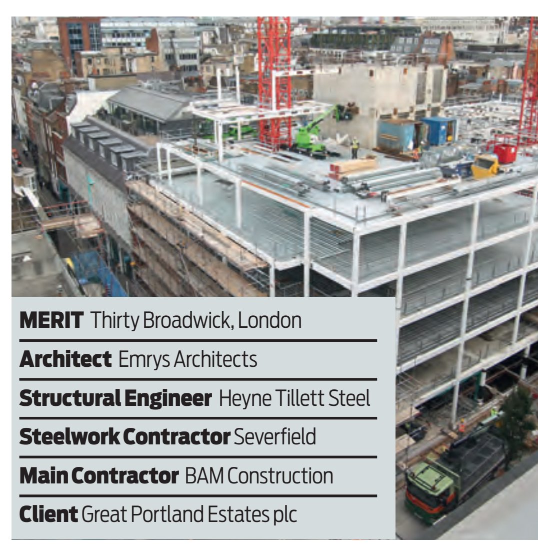
"Our automated workflow enabled design checks to be carried out quickly and for models to be updated to re-use already-manufactured steel in a different location and include a new penultimate bay," recalls Arup associate director Tim Snelson. The BIM model will also be used for ongoing management.

Some 4,000 tonnes of steel was erected in just 18 weeks at the Wolverhampton facility, with up to eight mobile cranes working concurrently.

"A lot of hard work went into planning and designing the structure so that, although the erection programme was intense, execution was seamless," says Severfield operations manager Stephen Jay-Hanmer.

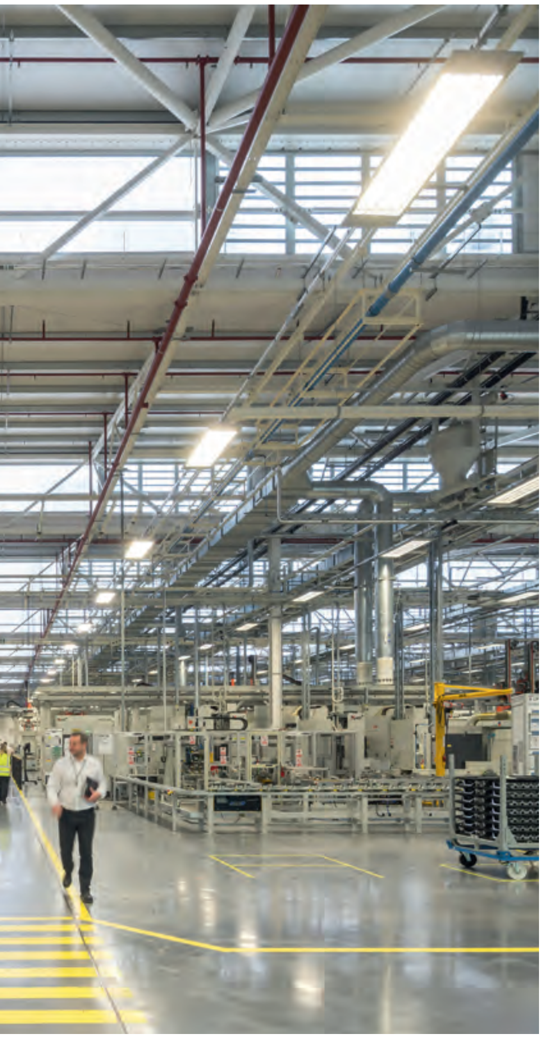
The building also has an impressive list of sustainable initiatives such as zero operational waste, naturally ventilated offices and a roof that supports one of the UK's largest installations of photovoltaics.

Some 21,000 panels deliver up to 5.8 MW of power, equivalent to 30 per cent of the centre's energy requirements, reducing the facility's carbon footprint by more than 2,400 tonnes per year.



MERIT Thirty Broadwick, London
Architect Emrys Architects
Structural Engineer Heyne Tillett Steel
Steelwork Contractor Severfield
Main Contractor BAM Construction
Client Great Portland Estates plc

factory



This new 11,000 sq m office and retail development in central London uses cellular beams to integrate services and structure to maximise ceiling height.

Clad in brick and stone, this steel frame and concrete core new-build structure was preferred over a refurbishment option, which involved retaining one of three existing buildings on the site and adding a steel frame extension.

Low carbon use was central to making the decision to demolish and build new at a late stage, between RIBA stages three and four.

"The new-build structural frame had to work within the confines of the original refurbishment scheme's building massing," says Heyne Tillett Steel senior engineer Chris Moore.

COMMENDATION Four Pancras Square, London

Architect Eric Parry Architects

Structural Engineer AKT II and BAM Design

Steelwork Contractor Severfield

Main Contractor BAM Construction

Client King's Cross Central Limited Partnership

© Dirk Lindner/Eric Parry Architects

Four Pancras Square is an office building made up of a central core, post-tensioned slabs and an external weathering steel frame. The success of its distinctive exoskeleton, a nod to the area's prominent gas-holder guide-frames, is the result of effective collaboration to resolve the project's unique set of challenges.

The team developed a durable connection detail between the weathering steel and floor slab so that the steel could develop its protective coating. It also produced a performance-based approach for fire engineering that enabled the weathering steel to be left exposed. "Seeing the steelwork coming together on site after a long period of collaboration was a project highlight," says BAM Design associate Stuart Hinde.

A 5.5 m-tall Vierendeel truss wraps around the building at first floor and supports a regular 4.5 m column grid above and spans of up to 27 m below. Design, manufacture and delivery of this system required precise co-ordination, and some 10,000 bolts to connect the truss together. "For the three sections to achieve the 27 m span, welding was required due to the high forces involved," says Eric Parry Architects associate director Robert Dawson. "This has delivered a continuous appearance on this impressive structure."

Erection of this south entrance truss was also a defining moment for AKT II design director David Illingworth. "The beauty of that structural and architectural statement was proof that all the hard work had been worth it."

COMMENDATION The Greenwich Peninsula Low Carbon Energy Centre

Architect C.F. Møller

Artist Conrad Shawcross RA

Structural Engineer Price & Myers

Steelwork Contractor Billington Structures Ltd

Main Contractor Kier Group

Client Knight Dragon

© Billington Structures

The new 61 ha Greenwich Peninsula development in south-east London will create 15,700 homes and will be serviced by one of the largest residential heat networks in Europe. Using advanced technology, its boilers save more than 20,000 tonnes of carbon a year.

Celebrating this development's commitment to low-carbon energy is a highly sculptural 49 m-tall lattice tower that shrouds its flues. Some 345 tonnes of steel was erected for the tower, made up of five ladder frames spaced 4.5 m apart and clad using triangular perforated aluminium panels. Each frame is made up of three 16 m x 3.15 m sections.

"The ability to accurately fabricate steel offsite in large sections allowed a fast installation of four months, which reduced the time working at height," says C.F. Møller Architects project architect Sam Whatman.

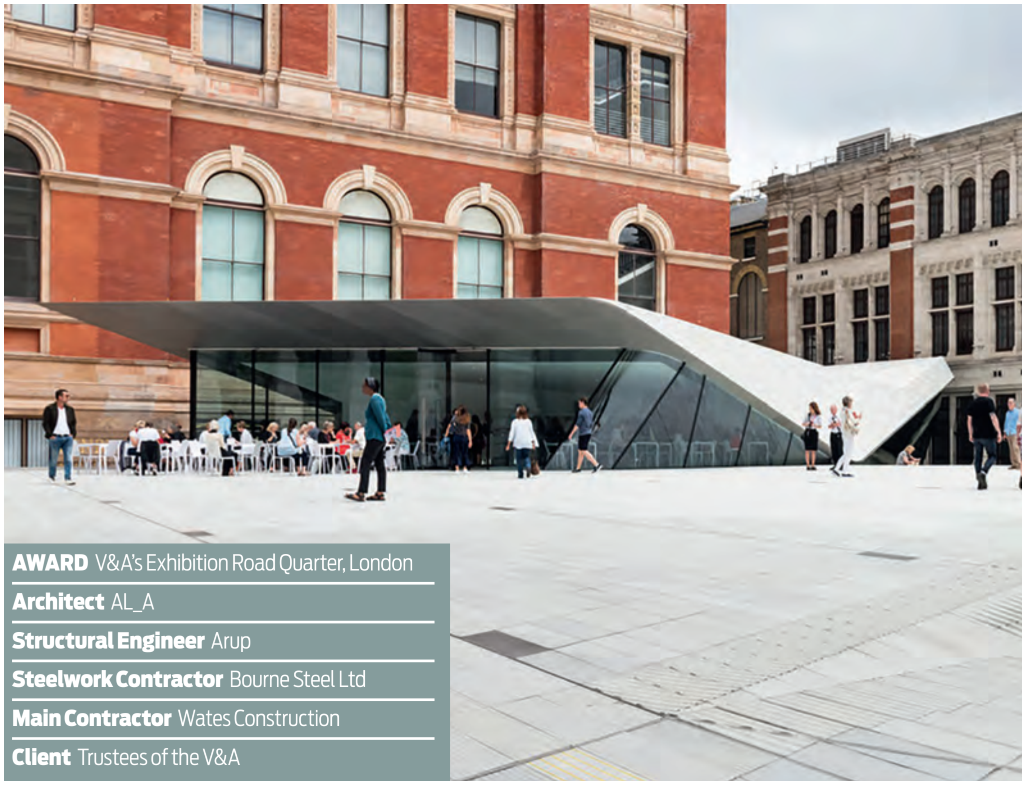
Diagonal secondary members brace these frames, with up to eight of them connecting into a vertical column at node points. "These [connections] were designed for both ultimate and fatigue design situations, to be cost-effective and easy to manufacture and erect, and not be detrimental to the aesthetic appearance of the tower," says Billington Structures principle engineer Craig Clayton.

The lattice steelwork arrangement was developed in response to artist Conrad Shawcross' design. Since the perforated cladding panels do not offer weather protection, each sub-frame had to be galvanized prior to erection. The process of galvanizing – dipping twice into a zinc bath – limited the size of sub-frame.

Team digs deep for V&A ba

The V&A's new basement gallery provides one of the largest temporary exhibition spaces in the UK as well as a new public courtyard on its roof to cater for outdoor installations and events

RUBY KITCHING



AWARD V&A's Exhibition Road Quarter, London
Architect AL_A
Structural Engineer Arup
Steelwork Contractor Bourne Steel Ltd
Main Contractor Wates Construction
Client Trustees of the V&A

The Victoria & Albert museum's heroic underground extension has involved the engineering superpowers of triangular steel trusses to span 38 m, while also resisting significant ground forces from a newly excavated 15 m-deep basement.

These trusses, of which the most substantial is a 3.3 m-deep 'spine' truss weighing 38 tonnes, form the roof structure of the new Sainsbury Gallery, which also supports the new Sackler Courtyard.

Together, they connect the museum of art and design with South Kensington's Exhibition Road, the London street that is home to other visitor attractions and centres of learning such as the Science Museum, Natural History Museum and Imperial College. Plant rooms previously occupied this plot of land, and the new development required the ground beneath it to be excavated for the first time.

The extension maximises the full extent of land available, so its site boundary follows the line of piles supporting the V&A's three existing wings and Exhibition Road itself. Working so close to the V&A's Grade I-listed facades while visitors used the museum beyond undisturbed, while also having to co-ordinate deliveries from a busy and largely pedestrianised street, added complexities to every activity.

The roof structure of the new 1,100 sq m gallery accommodates a mezzanine level and frames around glazed openings and skylights to allow natural light to enter the underground space. As well as the spine truss, there are 13 'Toblerone'-shaped trusses making up the roof's framework. These are up to 25 m long and weigh up to 14 tonnes.

"The roof, with its consistent modular width and varying height, was key to unlocking the potential of the site, increasing headroom in the gallery where we could (in response to the changing ground levels) without increasing the depth of excavation of the basement," says Arup associate director Carolina Bartram.

To simplify fabrication and erection, the design team worked together to optimise both the overall geometry of the roof and the individual members making up the trusses. This resulted in 40 per cent savings in steel tonnage compared with the concept design.

Though simplified, a typical truss connection still involved three chord members and up to four internal members intersecting at a point, says Bourne Steel engineering director Alan Pillinger, "with none of them in a common plane".

Input from Arup, Bourne Steel and the wider industry at an early stage also influenced design development so that temporary supports were not required to support the trusses during erection.

Fabricating and delivering large steel sections to site, and positioning them

Refurbishment of this 1980s office building has involved adding two extra storeys and a four-storey extension, offering 25 per cent more floor area than the original building.

The new lightweight steelwork is painted a distinctive red colour, creating "an engaging and dynamic interior", astudio director Richard Hyams says. Extensive investigation, testing and analysis of the existing structural frame proved it could carry the extra storeys, so that no strengthening was required. Existing piled foundations could also be reused with only four new minipiles needed to support the extension.

"From early on the design focused on working with the existing structure to minimise unnecessary work, reduce build costs and embodied carbon," says Heyne Tillett Steel director Tom Steel. The modern warehouse office achieved a BREEAM 'Excellent' rating.

MERIT Seventy Wilson, London
Architect astudio
Structural Engineer Heyne Tillett Steel
Steelwork Contractor TSI Structures Ltd
Main Contractor Willmott Dixon
Client Stanhope

sement


© Paul Carstairs/Arup

correctly for the build, required careful co-ordination, Ms Bartram continues: "Use of 3D modelling and BIM was absolutely essential to ensure clash-free installation."

Wates Construction project director Neil Lock agrees. "It's not a simple structure – there are no straight lines on the job – everything traverses out upwards to a curve. Without a 3D model and the levels interpreting it, we would never have been able to dig and prop and rebuild."


© Tony McAteer

COMMENDATION Brooklands Museum Aircraft Factory and Racetrack Revival

Architect Thomas Ford & Partners

Structural Engineer Alan Baxter Ltd

Steelwork Contractor Ainscough Industrial

Main Contractor Brymor Construction Ltd

Client Brooklands Museum


© David Lankester

Brooklands Museum is built on motorsport and aviation history. Located on the site of the world's first purpose-built motor racing track and where parts of Concorde were designed and manufactured, the museum wanted to reinstate parts of the original racetrack, which had been obscured by a dilapidated aircraft hangar.

Though originally built in 1940 as a temporary structure, the hangar was also of historical significance and so would need to be carefully dismantled, refurbished and relocated.

The 'Bellman' hangar, named after its designer, is an example of steel modular construction where angle sections are welded to create trusses of standard length, that are then bolted together to form portal frames.

Structural engineer Alan Baxter analysed the hangar at Brooklands and others like it to understand how the structure was designed and the best way to dismantle and rebuild it.

The research discovered that the hangars had an inherent weakness at their haunches, which could become overstressed in high winds when the hangar doors were open. The Brooklands hangar, therefore, had to be sensitively strengthened before being rebuilt.

Alan Baxter senior engineer Gabriele Burelli says: "Steel was the obvious option for the construction of light, modular, temporary structures during WWII. Almost 90 years later, steel is still the preferred option both for strengthening works to the original fabric of the hangar and for the new structures needed to provide additional space to exhibit the museum's aircraft collection."

Brooklands Museum trust vice-president Allan Winn adds: "We have taken a hugely important building in terrible condition and moved it in the way it was originally designed and restored it. We have achieved all that while preserving almost all of the original structure."

COMMENDATION Belfast Waterfront Conference & Exhibition Centre

Architect Todd Architects

Structural Engineer Doran Consulting Ltd

Steelwork Contractor Walter Watson Ltd

Main Contractor McLaughlin & Harvey Ltd

Client Belfast City Council

This steel-framed extension to Belfast Waterfront conference centre includes two additional halls and meeting rooms, adding 7,000 sq m of extra floor space.

Designed to host concerts and exhibitions, internal partitions suspended from the structural steelwork can sub-divide halls to create spaces of different capacity. Cellular beams that integrate services and structure were used for the hall's roof.

The structurally independent extension connects with the original building on multiple levels and extends out to the banks of the River Lagan.

Since there was limited land available to develop on, intermediate levels have been added to increase floor area. 'Slimflor' construction techniques were used on these levels to maximise ceiling height.

Due to a tight construction programme and site constraints, steelwork was erected concurrently at both ends of the site.

The absence of a back span for cantilevering trusses closer to the riverside end was overcome by temporarily propping the free end. This was Belfast City Council's first major project using BIM. A digital survey of the original building provided accurate data that could be integrated into the extension's 3D model.

Iconic steel viaduct honou

The Ordsall Chord project has delivered a new landmark for the north of England

RUBY KITCHING

Sweeping across an innocuous stretch of river and dual carriageway, the Ordsall Chord viaduct's trademark 'ribbon' of steel flamboyantly connects Salford and Manchester to continue the area's rich industrial heritage.

It has been built to carry a new stretch of track that will reduce congestion on the rail network, allow new passenger services to run, and boost the local and regional economy.

Built within touching distance of the world's first intercity railway – the Liverpool to Manchester route masterminded by engineer George Stephenson, which opened in 1830 – the viaduct continues the area's reputation for ground-breaking engineering.

Its network arch bridge is the first ever built in the UK and the first asymmetric network arch anywhere in the world. As such, this project demands closer attention than your ordinary railway bridge.

A network arch solution was chosen for the 89 m span across the River Irwell. Its 'network' of cables and steel 'arch' design combine strength and stiffness with a relatively low profile. By spanning the river at an angle and incorporating two inclined and tapering arches, the design goes beyond the standard network arch design by also being asymmetric.

The network arch connects with a 100 m-long twin girder bridge over Trinity Way dual carriageway via a connecting structure known as the 'cascades'. Limiting the arch's height was important so that its relationship with these structures was fluid and in keeping with the architect's design.

A line on the arch ribs expressed by the side angle of its trapezium-shaped box-section, and continued in the shape of the stiffening plates on the I-girders of the cascades and girder bridge, leads the eye along the viaduct. Fabricated using weathering steel, the rust-coloured viaduct stands out in the landscape.

"From the early stages of design, weathering steel was considered to be the ideal surface finish for the structures," says BDP director Peter Jenkins.

"It provides an honest expression of the material in terms of its function, colour and texture, echoing the historic masonry structures that it sits alongside."

Box girders had originally been envisaged for the entire viaduct, but this was value-engineered on the spans over the dual carriageway to be stiffened plate I-girders.

The solution reduced construction cost and simplified future maintenance. The 'cascades' are the most geometrically complex pieces of steelwork on the project, curving in two planes and appearing to twist to create the transition from the box-section arch ribs to I-girders on the Trinity Way bridge. The arrangement of stiffening plates on the cascades also varies in angle and spacing along its length.

Successful design and fabrication of all three parts of the viaduct required architects, engineers and the steelwork contractor to work closely together.

"Steel allowed us to build the complex structural geometry without compromising the architectural vision," says Aecom Mott MacDonald JV engineering manager Brian Duguid. "It was also ideally suited for offsite manufacture on a constrained site, allowing installation using a variety of cranes and modular transporter methods. The extensive use of weathering steel will reduce maintenance and minimise the need for future disruption to both roads and railway."

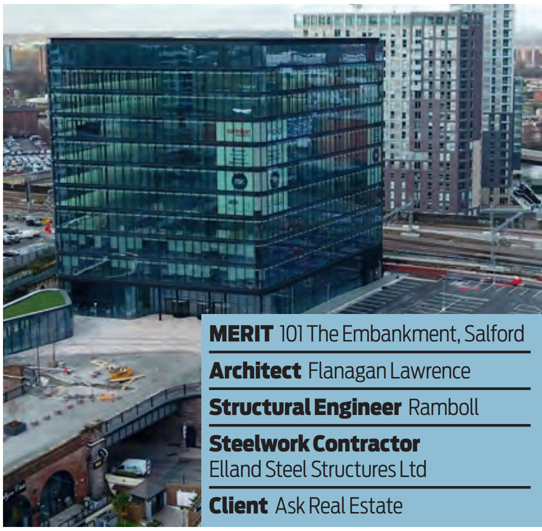
Two cranes working in tandem were required to lift the network arches into position, one of which was among the largest crawler cranes available in the country. "The moment the steel arches were installed was when the press and the public really woke up to the positive impact a single piece of infrastructure would make," Mr Duguid says.

As well as the viaduct, the Ordsall Chord project included refurbishment of a masonry bridge dating back to the 1830 railway, demolition of a road bridge and installation of a new steel footbridge. The footbridge was fully designed and detailed using BIM, adopting a highly innovative arrangement to reduce programme, simplify erection and enable steel plate to be ordered early and at the best possible price.

"We collaborated with Aecom Mott MacDonald for 12 months on various structures on the Ordsall Chord project," says Severfield project manager Jarrod Hulme.

"Using our detailers and value engineering experience, we quickly developed a positive relationship, identifying ways together to build the best structure possible."

AWARD The Ordsall Chord viaduct
Architect BDP
Structural Engineer AECOM Mott MacDonald JV
Specialist Designer Knight Architects
Steelwork Contractor Severfield
Main Contractor Skanska BAM JV
Client Network Rail



MERIT 101 The Embankment, Salford
Architect Flanagan Lawrence
Structural Engineer Ramboll
Steelwork Contractor Elland Steel Structures Ltd
Client Ask Real Estate

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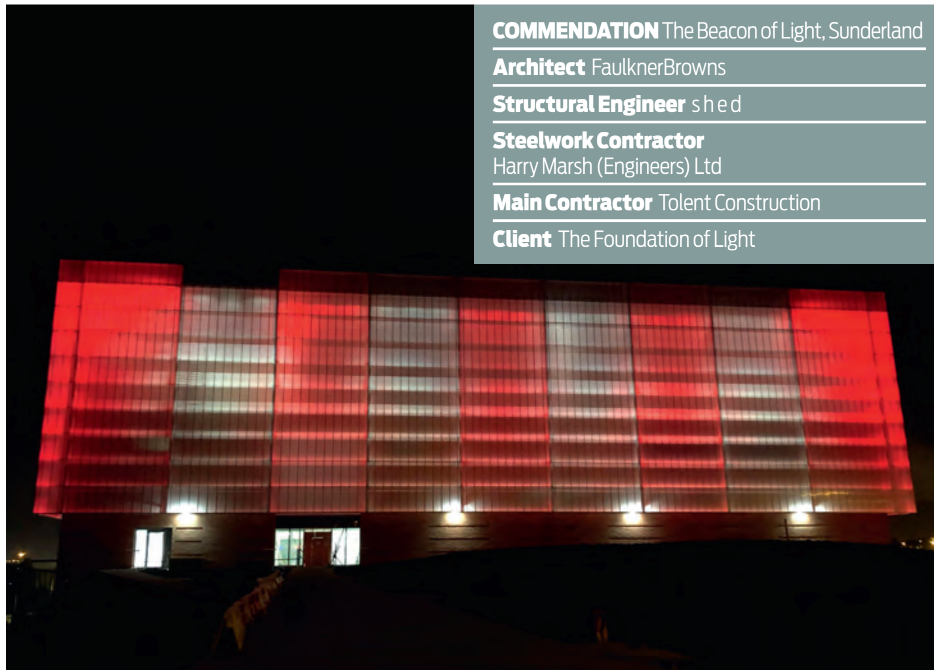


COMMENDATION The Beacon of Light, Sunderland

Architect FaulknerBrowns

Structural Engineer s h e d

Steelwork Contractor Harry Marsh (Engineers) Ltd

Main Contractor Tolent Construction

Client The Foundation of Light

Built over a former colliery, the five-storey Beacon of Light development comprises a school and offices on one half of the site and 12-court sports hall on the other, with a synthetic 4G football pitch occupying the entire uppermost storey.

Structural steel's high strength-to-weight ratio was essential to achieve clear spans of 60 m x 32 m in the sports hall and 60 m x 60 m for the unheated pitch enclosure.

Lightweight trusses span these spaces, while polycarbonate cladding wraps around the entire building. The two-way spanning roof truss over the pitch was refined to be as structurally efficient as possible and minimise the cladding envelope.

"Steel fabrication and detailing is all on show in the main hall and the football barn," says shed managing director Marc Horn.

"The challenge of detailing these connections sympathetically was overcome through close collaboration."

This 10-storey office building on top of a three-storey car park on the banks of the River Irwell sits within the retained sandstone walls of a Grade II-listed viaduct.

The top of the car park is aligned with the top of the retained wall so that the building reads like a modern office block on a masonry plinth.

In fact, the entire building is steel-framed, save for a transfer slab at podium level which resolves the different structural grids for the car park and office floors.

"The requirement for 15 m open-plan spaces within the office building was ideally suited to a steel frame, with cellular beams used to minimise overall floor-to-floor heights and to allow the integration of services," says Ramboll Associate Niall Meyers.

MERIT 1 & 2 London Wall Place

Architect make

Structural Engineer WSP UK Ltd

Steelwork Contractor William Hare

Main Contractor Multiplex Construction Europe

Client London Wall Place Limited Partnership

Providing 500,000 sq m of office space, 1 & 2 London Wall Place maximises the development potential of its wedge-shaped site.

WSP director Stephen Jackson says: "Cantilevers were introduced to allow us to build up to the site boundary above ground-floor level without landing columns in the areas outside the footprint of the existing basements on the site, which were heavily congested with public services and utilities."

In plan and elevation, the building introduces massing techniques, cantilevers and recesses to honour rights of light and protected views.

Multiplex project director Phil Clarke adds: "Engineering the steel frame was a technical and logistical challenge – a mix of design vs programme vs what [can be built] in a city."

Dual-use crossing keeps L

Combining a weir and a bridge is bringing multiple benefits to Leeds

RUBY KITCHING

AWARD Knostrop Weir Foot and Cycle Bridge, Leeds

Architect Knight Architects

Structural Engineer Mott MacDonald

Steelwork Contractor S H Structures Ltd

Main Contractor BAM Nuttall

Client Leeds City Council and the Environment Agency

A new weir across the River Aire at Knostrop was needed to protect Leeds from flooding. The city council wanted to combine the asset with a new bridge that could form part of the Trans Pennine Trail walking and cycling route.

Building across a river with limited access for equipment is challenging at the best of times, but combining the needs of two pieces of public infrastructure on the same footprint was even trickier. Due to concern that extra flood protection was needed before the onset of winter, the weir was built in advance of the bridge. This fixed aspects of bridge design that interfaced with the weir's three curved walls.

The 70 m-long Knostrop weir foot and cycle bridge comprises a steel deck supported by three steel piers. The bridge's form responds to the weir's skewed angle, while its curves reference the undulating watercourse below.

With a curved soffit and rippled edge, the deck's widest sections create viewing platforms over the piers. Its free-flowing design uses single rather than double-curved steel plate, as an earlier version of the scheme depicted. Rationalising its geometry in this way simplified fabrication and brought cost and programme benefits.

Achieving a durable, largely maintenance-free structure in a wet environment required careful detailing, specification and construction. "The superstructure consists of hermetically sealed weathering steel box girders with an external four-coat paint system normally reserved for highway structures that are difficult to access," says Knight Architects associate Sam White. Vapour phase corrosion inhibitors were also installed within each sealed box section.

"The site itself was the cause of some of the biggest challenges on the project," says S H Structures sales and marketing manager Tim Burton. "It required the addition of a temporary stone platform for the installation crane. The material was carefully removed after the works were completed."

Prefabrication was key to simplifying work and reducing risk. Designing the bridge in seven parts – four deck sections and three piers – cut erection time to just two weeks.

Three weir walls support fin-like bridge piers. These 50 mm-thick plate members are so slender that they are barely visible when viewed head-on. More standard forms, such as box sections, were considered for the piers.

However, as the bridge's thermal dynamics became better understood, the plate solution emerged as the more efficient option, offering a solution that did not require bridge bearings.

Bearings are usually used on top of bridge piers to allow the deck to move due to expansion and contraction. But, due to the difficulty of repairing, replacing or maintaining them over the weir, they were not feasible at Knostrop.

"Using detailed finite element modelling and non-linear buckling analysis, we predicted how the thin piers respond to thermal effects," explains Mott MacDonald associate bridge engineer Daniel Bowmer. "We designed them to be slender enough to flex to accommodate superstructure movement without the risk of buckling developing."

Each deck section was brought to site and spliced at pier locations. Deck sections were also pre-fitted with stainless steel parapets.

BIM was used from the outset to enable collaborative working. The bridge's 3D Revit model included every steel plate and connection and was issued to the steelwork contractor in place of conventional 2D drawings. "It was interesting and rewarding to see a philosophy of 'design more – build less' produce such tangible benefits," Mr White says. "The striking architectural form of the steel pier was also very practical, developed with a shared understanding of fabrication techniques within the design team that made sure a strong concept was deliverable within budget and programme."

The integrated bridge and weir plays an important role in protecting Leeds city centre from flooding and makes previously under-used recreational areas along the River Aire more appealing and accessible, while also becoming a new attraction itself on the Trans Pennine Trail.

eeds dry


© S H Structures


© Philip Vile

MERIT Victoria Palace Theatre Refurbishment, London

Architect Aedas Arts Team

Structural Engineer Conisbee

Steelwork Contractor SDM Fabrication Ltd

Main Contractor 8Build Ltd

Client Delfont Mackintosh

The Victoria Palace theatre has undergone extensive remodelling to expand its stage and improve facilities. For work to be carried out, various structural solutions were employed, requiring new steelwork to be erected and connected back to the existing building.

Expansion to the rear used a 6m-wide strip of land. "Our focus has been on transforming small spaces into larger, more useable ones, without losing the charm of a Victorian theatre," says 8Build construction manager Robert Salmon.

Working on many fronts at once was also challenging. "BIM was an important tool in the delivery of the structure and to ensure steelwork and following trades were efficiently co-ordinated," says SDM Fabrication contracts manager Rebecca Buchanan-Ward.


© Heini Schneebeli

MERIT Walthamstow Wetlands

Architects Witherford Watson Mann and Kinnear Landscape Architects

Structural Engineer Entuitive

Steelwork Contractor Gorge Fabrications Ltd

Main Contractor Rooff Ltd

Client London Borough of Waltham Forest

New facilities at Walthamstow Reservoirs involved imaginative adaptation of industrial buildings, such as adding a terrace in a former engine house and a viewing platform with a feature staircase in a Grade II-listed tower.

Using exposed steel removed the need for further trades and finishes, simplifying the programme and utilising prefabrication. A new external spiral staircase for the engine house had to be co-ordinated with Network Rail's upgrade programme. Located just 4 m away from a railway, it was brought to site as "a kit of parts" that could be erected during a weekend line possession. "There were also challenges erecting internal steelwork using lifting equipment that could fit through doorways," says Rooff contracts manager Ian Murray.

The new Queensferry Crossing, located to the west of the Forth Bridge and Forth Road Bridge, completes the trio of majestic bridges over the Firth of Forth in Scotland.

The crossing's six-span 545 m-long viaduct on its southern approach consists of twin parallel composite decks that are 21.8 m apart and supported by six V-shaped piers. Steel box girders measuring 8 m wide, 33 m long and 5 m deep make up each deck, which were progressively launched in 100 m-long sections.

"The launch solution was hugely ambitious in scale," says Ramboll major crossings director Steve Thompson.

"Steel offered strength, lightness, versatility, durability and speed, which made it an environmentally sustainable solution that minimised damage to the estuary banks."

A temporary mast and stay system counteracted girder deflection at the tip of each launched section as it reached the next pier, while also reducing bending effects as it cantilevered.

Getting these colossal members to site was as challenging as erection itself, recalls CBUK project manager Michael Whinn. Each half-box girder was designed to be as large as possible to reduce handling on site. "Special trailers and loading frames were developed for transportation, plus a gantry crane located in the assembly area which enabled easy offloading and rotation of the boxes."

Due to the length of each member, expansion and contraction under varying temperatures was a significant issue, yet construction tolerance – limited to between 10 mm and 25 mm – was tight.

"We undertook daily surveys during assembly and before sunrise, as the structure would expand dramatically from the heat of the sun," says CBUK site services manager Mike Condren.


© Transport Scotland

COMMENDATION Approach Viaduct South, Queensferry Crossing

Structural Engineer Ramboll

Steelwork Contractor Cleveland Bridge UK Ltd

Main Contractor Forth Crossing Bridge Constructors

Client Transport Scotland

London Bridge raises the b

Major refurbishment has nearly doubled capacity and vastly improved the passenger experience

RUBY KITCHING

It's difficult to comprehend the extent of work that has taken place at London Bridge station. This dark, damp and rundown interchange has undergone the ultimate Cinderella transformation to be bright, open and modern. Natural daylight, large column-free spaces and new structures and systems have created a place worth visiting, even if you're not travelling anywhere.

Remodelling London Bridge to increase its passenger capacity from 56m to 90m a year, while improving connectivity and access, required all 15 platforms to be completely rebuilt with new canopies and three of the nine terminating platforms to be converted to through platforms. New track was laid, a street-level concourse built and shopping arcades created.

The huge programme – which included erection of some significant structures – was phased around normal rail operations over five years from 2013. The station is part of the £7bn Thameslink programme to enable faster, more frequent and reliable journeys across London.

Steelwork was key to keeping the project on programme and the station functioning. Where possible, prefabricated modules were designed that could be assembled offsite and delivered to a strict schedule, often installed within hours of arriving. This reduced the number of deliveries to the city centre site and simplified erection.

The 80 m-wide under-track concourse is one of the most prominent features of the scheme. It is large enough to fill the pitch at Wembley and neatly resolves the problem of level-changes across the site. "This expansive concourse, with its civic scale, provides a generous public space to accommodate the increase in passengers," says Grimshaw associate principal Stuart Grahn.

Huge longitudinal V-columns support a 5 m-deep Vierendeel truss that supports the new concourse roof. Glazing between the truss's vertical members allows natural light to enter. "Construction was challenging given the size of the truss, which was delivered in three sections," says WSP Arcadis JV director John Parker. "The design took advantage of the maximum pre-assembled size that could be delivered to site."

Rising through the concourse are columns that support new bridge decks. Cleveland Bridge UK fabricated, pre-assembled, delivered and installed the decks sections, which are made up of three pairs of braced girders. These girders are encased in concrete to form the slab that supports new track and platforms above the concourse. The cedar-clad bottom flanges of the girders form the concourse's ceiling and are made from weathering steel for durability.

"Due to the limited space on site, we looked to maximise offsite fabrication," says Cleveland Bridge head of infrastructure Andrew Morris. "We did trial erections of the 29 plate girder decks, consisting of six main girders braced together. This significantly reduced the onsite programme."

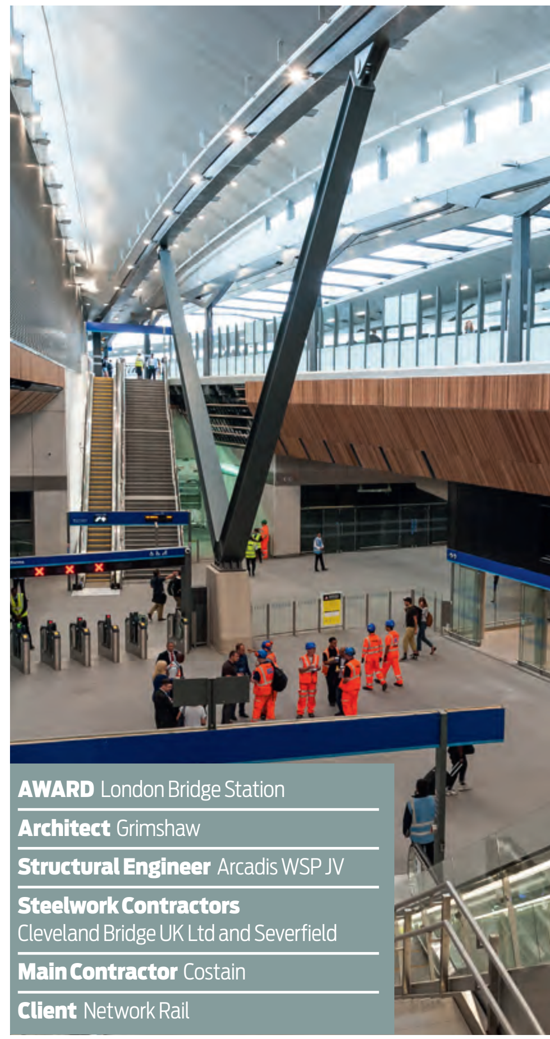
Cleveland Bridge planned the lifting operations for this steelwork, which included using heavy-capacity scissor lifts mounted on top of self-propelled modular transporters (SPMTs).

New curving platform canopies made from steel and aluminium, supported by Y-shaped columns, add another level of interest to the station. The bottom of each of the Y-columns is connected to the bridge deck slab via a cranked steel beam, while the tops are connected to subsequent Y-columns via a longitudinal beam formed from fabricated box sections. These box sections also contain services. Each canopy module measures about 9 m x 3 m, but the precise geometry of each varies to match the curved alignment of the platform below.

"London Bridge station's 15 tracks all have a slightly different curving alignment, which means that each concourse bridge and platform canopy is different from the next," says Arcadis WSP JV technical director Pete Anstock. "To cope with this challenge, the steelwork contractors used the Arcadis WSP site-wide BIM model to ensure that every piece of steel fitted into place first time."

He adds that, by creating families of structural steel components, bespoke modular steel structures were simpler to achieve.

Some 1,200 modules were designed for quick installation during limited night-time engineering hours. Severfield fabricated and installed the canopies complete with cable management systems to reduce additional work on site.



AWARD London Bridge Station
Architect Grimshaw
Structural Engineer Arcadis WSP JV
Steelwork Contractors Cleveland Bridge UK Ltd and Severfield
Main Contractor Costain
Client Network Rail

Construction of London Wall Place involved demolishing some original 'high walk' steel and concrete bridges between existing buildings.

Six footbridges have been reinstated with a modern interpretation, all from weathering steel and with slimmer, more sculptural forms.

Steel plate up to 100 mm thick make up the integral deck and parapet sections. "When the high walks opened to the public, we were all proud of what we had achieved," says Multiplex project director Phil Clarke

One of the bridges spans 28 m over remains of the ancient London Wall and is entirely supported by 1 London Wall Place. "An elegant solution using a stainless steel pylon and cables suspend the bridge from the new building," explains WSP project director Stephen Jackson.

ar for station refurbs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COMMENDATION Somers Town Bridge, London
Architect Moxon Architects
Structural Engineer Ove Arup & Partners Ltd
Steelwork Contractor S H Structures Ltd
Client King's Cross Central Limited Partnership

This slender cycle and footbridge spans 38 m across Regent's Canal to connect a new cultural quarter with an urban nature reserve. Somers Town Bridge manages the transition between these two disparate destinations by being both on-trend and organic in form.

"Installing a new bridge is always an exciting experience as it brings a tangible benefit to a community," says S H Structures sales & marketing manager Tim Burton. "This bridge is even more special, as it works so well as a part of the surrounding area's overall landscape."

Made up of externally stiffened welded steel plate, the single-span steel structure was designed to be unfussy and installed as one piece by crane. Its structural depth is just 1,100 mm at mid-span and 400 mm at its ends, crossing the canal at an angle.

It has been designed to be highly durable, with tuned mass dampers to control dynamic response. Mr Burton adds: "The bridge is formed from a shallow curved steel trough, with the top flange and feature balustrade made from high-grade duplex stainless steel. The structural interface between the two materials required careful detailing."

MERIT Walkway Bridges, London Wall Place
Architect make
Structural Engineer WSP UK Ltd
Steelwork Contractor William Hare
Main Contractor Multiplex Construction Europe
Client London Wall Place Limited Partnership

Fifteen tubular steel ribs, the largest of which spans 95 m, support a new curved ETFE roof at Manchester Victoria station.

Designed for adaptability, the design and shape of the roof's ribs offer the ability to be extended to create additional platform space in the future.

Installation was confined to overnight engineering hours to limit disruption to services. Erecting the longest rib in just three-and-a-half hours was challenging.

"The logistics of assembling the ribs and using a 750-tonne crawler crane for erection on a very compact site was a daily challenge and involved very detailed planning," explains Severfield senior project manager Gary Dooley.


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MERIT Manchester Victoria Redevelopment
Architect BDP
Structural Engineer Arcadis Consulting (UK) Ltd
Steelwork Contractor Severfield
Main Contractor Morgan Sindall – Manchester (Construction)
Client Network Rail