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Edited and written by **Martin Cooper**

Industry Report

STRUCTURAL STEELWORK IN ACTION

SOUTHERN TOWERS

SOUTH BANK DEVELOPMENT USES STEEL FOR COMPLEX TOWERS AT WATERLOO

Situated between the London Eye and busy Waterloo Station, Southbank Place covers an area of more than 20,000m² and consists of two commercial blocks, six residential towers along with new retail units, restaurants and cafés, all of which are located around the existing Shell Tower, which will become one of the development's centrepieces when the project is completed in 2019.

The two new commercial office blocks, known as One and Two Southbank Place are both steel-framed structures, containing 11 floors and 17 floors respectively.

Number One will be a new landmark headquarters for Shell International's downstream business. It is already fully pre-let to Shell for 20 years and consists of 83,190m² of office space and two retail units on the ground floor. Two bridges will link this building with the adjacent Shell Tower.

Two Southbank Place is a 90,730m² speculative office and retail development that property investment company Almacantar is marketing and leasing to occupiers.

Apart from one residential tower, the two commercial structures are the first buildings to take shape on what is already a very busy and logistically challenging site.

Faced with the usual traffic, noise and lack of space all inner-city projects have to cope with, Southbank Place will eventually have a maximum workforce of 1,600 people.

With so many trades people due on site, it was important to get the commercial blocks up as quickly as possible. The steel erection has been carried out immediately behind the large-scale groundworks programme, which is currently progressing throughout the site.

KEY FACT

6,300t
Amount of structural steel used

Viewed from outside the hoardings, the project is a forest of tower cranes – there are currently more than 10 – needed to feed and lift the various materials being used.

"There is very little room on site and certainly no room for mobile cranes to be positioned or materials to be stored," explains Canary Wharf Contractors assistant project manager Sam Hayward. "All of the steelwork has to be delivered on a just-in-time basis and is being erected by tower crane."

Severfield began its steel erection programme in January 2017. Work was able to commence once the concrete formed basements were completed, along with the slip-formed cores.

Building One has two cores, a main core that reaches the full height of the structure, and a secondary satellite core that only serves the lowest four levels. Building Two has just the one centrally-positioned core.

"Building One is a fairly straightforward building, based around a repetitive 9m by 12m grid pattern," explains WSP associate director Andrew Martin. "Two, on the other hand, is much more complicated as its design is partially dictated by the Bakerloo Underground line that passes beneath its footprint."

The Tube line actually passes under the structure's south eastern corner and consequently no piles could be installed in this area. To avoid positioning columns over this important transport link, this corner, that houses the main entrance of the building, slopes inwards from the sixth floor, with the aid of two raking columns.

Top left: Steelwork erection quickly progresses on both buildings
Top right: Building One has steps to accommodate outdoor terraces

PROJECT TEAM

Project: One & Two Southbank Place, London
Main client: Braeburn Estates
Architects: Squire and Partners, Adamson Associates, Kohn Pederson Fox
Main contractor: Canary Wharf Contractors
Structural engineer: WSP
Steelwork contractor: Severfield

These raking columns make the building pull itself structurally towards this corner. To counterbalance this, temporary bracing has been installed. This has to remain in position until the structure's floors are complete.

Both buildings have used cellular beams throughout for efficient service integration. However, unlike Building One, which has some internal columns, Building Two has none, with clear uninterrupted spans reaching a maximum length of 17m.

"With such long spans, some of our connections are very big, as the finished main member is up to 30t in weight in places," says Severfield senior project manager Paul Walmsley. "We've also had to use a number of plated sections to achieve these spans and the supporting columns."

The north and west elevation of Building Two features a series of outdoor spaces accommodated on 2m-wide cantilevers. These spaces extend upwards from level 6, and they are formed by two further raking columns positioned at fourth floor level that extend up to the underside of the sixth floor.

> **"Some of our connections are very big, as the finished main member is up to 30t in weight in places. We've also had to use a number of plated sections to achieve these spans**

The uppermost floor of Building Two is known as the entertainment area. Formed with 12m high elliptical members, it is a glazed pavilion that is set back from the floors below and offers access to a rooftop terrace. Adjacent to this feature the structure also has a rooftop two-storey plant enclosure.

Meanwhile, Building One's standout features are the five further outdoor terraces, formed as the structure steps in at level five, eight, nine and Level 11 which is a plant space.

Both blocks will have different cladding systems, with Building Two finished with curtain walling, and One predominantly clad with large precast panels weighing up to 12t

Both buildings are aiming to achieve a Breeam "Excellent" rating, and are due for completion towards the end of 2018.

The project is one of the first to be operating as an Ultra Site under the considerate contractor's scheme.

STRUCTURAL STEELWORK IN ACTION

FRAMES FOR BRAINS

STEELWORK BRINGS TWO CUMBRIA SCHOOLS TOGETHER ON ONE SITE

Two schools in Whitehaven, Cumbria will soon be sharing new state-of-the-art premises that also incorporate an array of community accessible sports facilities.

Known as Campus Whitehaven, it will bring together St Benedict's Catholic High School and special education needs school Mayfield, into two new buildings at the former's site in Hensingham, Whitehaven.

The £28M project, which is due for completion in August 2019 has been funded by investment from a range of partners, including Copeland Community Fund, Cumbria County Council, the Nuclear Decommissioning Authority and Sellafield Ltd.

"This remarkable project has incredible potential to transform the education of young people in Whitehaven and improve the health and well-being of the whole community," says Cumbria County Council cabinet member for economic development and property, councillor David Southward.

As well as an indoor sports hall, fitness suite and a hydrotherapy pool, a range of outdoor facilities will be available to local community during non-school hours. These include multi-use sports pitches, one of which will have an all-weather 4G surface.

Main contractor Wates Construction started on site in May this year after earthworks to prepare what were previously sports pitches for the construction works. Foundations were installed, and steelwork erection began in June.

"We erected the entire 700t steel frame, which amounted to some 3,500 individual pieces, in 11 weeks," says Border Steelwork Structures (BSS) contracts director Stuart Airey.

KEY FACT

700t
Amount of structural steel used

> **"The trick is to order the steel early and get the fabrication started as soon as possible to iron out any snags**

Despite some very inclement weather – unfortunately the Cumbria coast is prone to a fair amount of precipitation – it was possible to complete the steelwork a week ahead of schedule. This then allowed BSS to continue with the other elements of its package, such as installing precast floor slabs and roof decking.

"That's one of the advantages of steel, it is quick to erect and only high winds, which we didn't really get, will halt its progress," says Wates senior project manager Simon Humphrey. "I've been involved in a number of steel construction jobs in the past and this one has been one of the most well organised. The trick is to order the steel early and get the fabrication started as soon as possible to iron out any snags, and this is precisely what we did."

Completing the steel frame quickly allowed the follow-on trades to get an early start, helping to achieve the project team's aim of creating a watertight structure before the onset of winter.

The campus has been designed with a focus on using intelligent planning to produce a creative and collaborative learning environment for students across a wide range of abilities.

Mayfield, for instance, is a Mobility Opportunities via

Above: The triangular entrance canopy connects the two schools Inset: Artist's impression of the campus entrance

PROJECT TEAM

Project: Campus Whitehaven
Main client: Cumbria County Council
Architect: Ellis Williams Architects
Main contractor: Wates Construction
Structural engineer: Curtins Consulting
Steelwork contractor: Border Steelwork Structures

Education Centre of Excellence, combining therapy and education to teach functional skills, such as sitting and walking to children with physical disabilities and complex needs.

Augmentative technologies will be used from the very first design phase to identify and propose flexible and innovative interior solutions to support these learning objectives and help students live more independent lives.

St Benedict's interior will draw inspiration from the local area's technological industries and provide solutions to facilitate a diverse curriculum, where students will be encouraged to explore robotics, renewable energy and low carbon technologies.

On plan, the overall project has a birdlike appearance with two long teaching wings positioned either side of a body structure that contains the entrance/winter garden and the sports areas.

Emphasising the avian likeness, the central body culminates in a triangular pointed entrance area that resembles a beak.

The schools will occupy one wing each, with St Benedict's getting a three-storey wing, and Mayfield being accommodated in a lower, two-storey building.

> **"Building schools with steel is an efficient way to build with the added benefit of built-in flexibility**

Both wings are of a similar design with steelwork supporting precast planks and columns mostly based around a 7m by 7.5m grid pattern. This creates two perimeter rows of classrooms separated by central corridors – 1.8m wide in St Benedicts and 2m wide in Mayfield – formed by intermediate columns.

"Building schools with steel is a tried and tested method," comments Curtins Consulting Director Andy Roberts. "It's an efficient way to build with the added benefit of built-in flexibility, whereby partition walls can be removed to create larger classrooms if and when desired."

All of the classroom services are accommodated within the corridors beneath the steel beams, with individual services then directed into each class.

Each wing is a fully braced frame with cross bracings positioned in some internal partitions as well as in stairwells, which are located at each end of the structures. Because the wings are each approximately 100m long, they are each separated from the central zone by movement joints.

As each wing is located either side of the entrance and the sports facilities, ease of access has been guaranteed to these areas as well as a fair amount of privacy.

The central shared zone of the campus, which will also be the part accessed by the local community is highlighted by the beak-like triangular pointed entrance, which provides access into a double-height circulation area known as the winter garden.

The fully glazed entrance is formed with a series of circular hollow section feature columns with universal beams and ties supporting the 159mm deep aluminium deck roof.

The winter garden is a large open space with just one internal column and has no heating, making it a pseudo-outdoor environment. A large circular roof light will allow plenty of natural light into the zone. The longest steel elements of the project were used to span this area, with some beams measuring up to 22m long.

Positioned towards the back of the winter garden are the shared dining areas, kitchens and sports areas. These consist of the number of double-height long span structures, with the largest being the main sports hall. The sports hall has a clear span of 18.4m, while the pool has a span of 15.1m.

"When looking at the structural choices for Campus Whitehaven, steel was the obvious choice. We have some large spans throughout the scheme and for economy wanted to keep the building height to a minimum. Steel helped us achieve this," says Ellis Williams Architects associate Ruth Clayton.

"The winter garden forms the main entrance to the campus and we wanted a light and airy feel to the double height space, while the dynamic triangular feature canopy that articulates the entrance was easily achieved in steel to give the minimal look we wanted."

SHARED TOOL

STEEL WEBSITE DRAWS TOGETHER MORE AND MORE INFORMATION FOR CONSTRUCTION PROFESSIONALS WORKING ON STRUCTURES

The steel sector's website – www.steelconstruction.info - is the number one destination for engineers and other construction professionals seeking to access steel related information.

Launched five years ago, www.steelconstruction.info brings together all of the sector's technical and cost information, which was only previously available from a variety of different sources.

Described as the free encyclopaedia for the UK steel construction sector, it was designed to be easy to use, as comprehensive as possible, and the one-stop-shop for technical guidance on steel construction.

British Constructional Steelwork Association (BCSA) technical development manager Chris Dolling says: "We set out to provide the best possible internet-based source for steel construction information and we feel this is exactly what we've achieved.

"Feedback has been very positive and the Google Analytics for the website continue to show year-on-year growth in the number of users."

Key to the success of the website is the continuous stream of new content and the regular updates to ensure the information provided remains current. Highlights so far this year include:

- A new article discussing steel and the circular economy
- A major new release of the design software that calculates the Elastic critical moment for lateral-torsional buckling (M_{cr})
- A new interactive version of the "Blue Book" that provides design data for open and hollow sections to comply with Eurocodes and BS 5950 (*see box*)
- A new article bringing together and indexing all Advisory Desk Notes published since January 2010
- Quarterly updates to the cost table, cost comparison figures, and BCIS location factors to suit the latest data from Aecom
- A new series of written CPD Modules
- A new SCI guide (P419) on "Brittle fracture", presenting modified steel thickness limits for use on buildings where fatigue is not a design consideration (*see box*)

Recently the Structural Steel Design Awards article

> **"Articles are also regularly reviewed and updated where needed as part of a formal maintenance regime**

was updated to feature the projects which won awards, commendations and merits (*see box*), and fully hyperlinked "case studies" for each winning project have been added to the ever-growing bank of project data. More than 30 other case studies of projects under construction in 2017 have also been added so far this year covering a broad range of building types and sectors.

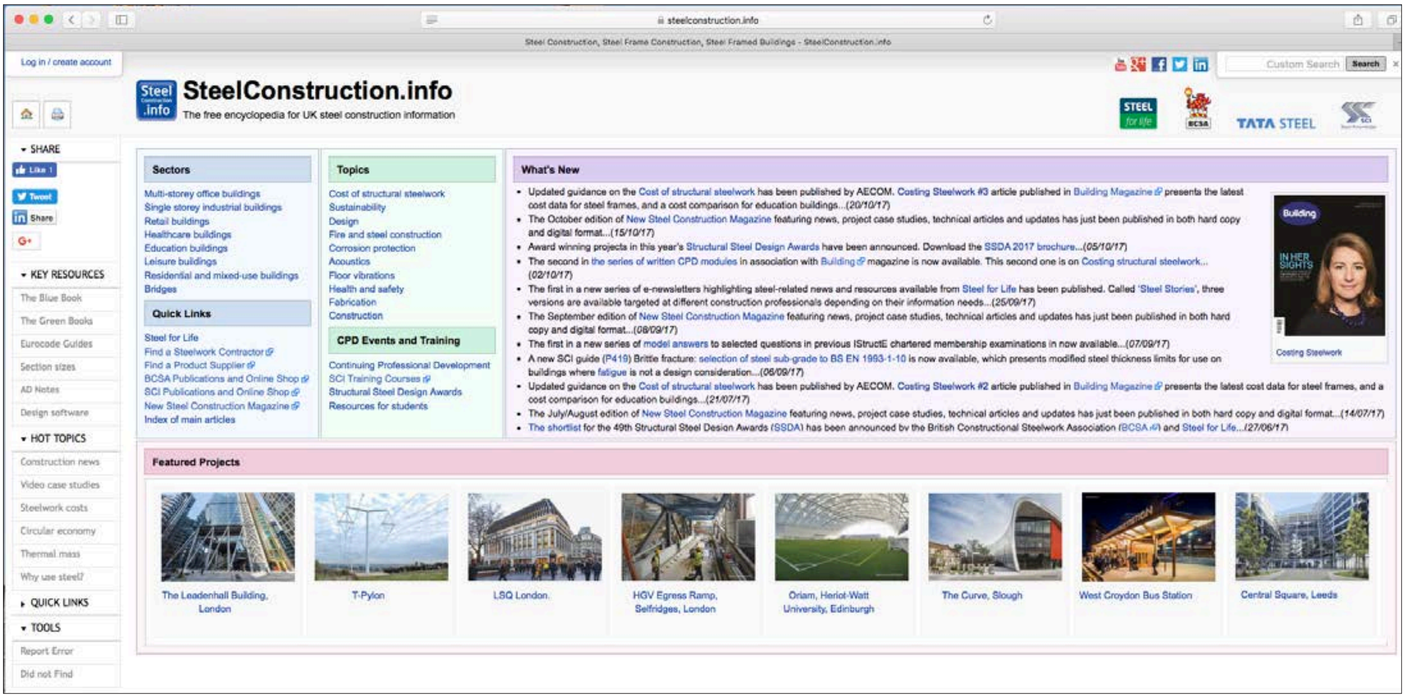
For those who are new to www.steelconstruction.info the site has well over 100 wikipedia-style articles, written by the steel sector's own experts as well as external consultants. They cover best practice in the use of steel across the construction sector, as well as topics such as fire engineering, costs, sustainability and health and safety.

These core articles act as roadmaps to each topic with links to more detailed information available from the sector and other external sources. A number of online CPD presentations are also included. These enable users to take a test and download a certificate for their records.

There is also a host of links taking users directly to web-based steel design software and tools, while the news section allows access to a number of BCSA and Steel for Life supplements that have appeared in construction and architectural publications, such as *New Civil Engineer*, *Construction News* and *Building*.

The steel sector has an ongoing pipeline of research and development work, and continuously updates its guidance in line with changes in legislation, standards and industry practice. Articles are also regularly reviewed and updated where needed, as part of a formal maintenance regime that ensures every article is kept up-to-date.

Users can register on the site to get quarterly email alerts highlighting all of its new features, updates and additional information.



GUIDE TO BRITTLE FRACTURE NOW AVAILABLE

Commissioned and funded by the BCSA and Steel for Life, a new Steel Construction Institute (SCI) guide "(P419) Brittle fracture: selection of steel sub-grade to BS EN 1993-1-10", has been added to the website.

Selection of steel sub-grade is an important responsibility for all steel designers, in order to manage the risk of brittle fracture.

The design rules in the Eurocode were developed for structures subject to fatigue such as bridges and crane supporting structures, and it is acknowledged that their use for buildings where fatigue plays a minor role is extremely safe-sided.

This new publication presents modified steel thickness limits which may be used in buildings where fatigue is not a design consideration.

STRUCTURAL STEEL DESIGN AWARDS 2017 WINNERS

The five winning projects at the 49th annual Structural Steel Design Awards (SSDA) were The Leadenhall Building, London (pictured); T-Pylon; LSQ London; HGV Egress Ramp, Selfridges, London; and Oriam, Heriot-Watt University, Edinburgh.

Commonly referred to as the "Cheesegrater", The Leadenhall Building also won the Project of the Year Award, a new award category recognising outstanding achievement and design in steel construction.

Reaching a height of 224m, the use of steel was fundamental in creating this landmark wedge-shaped building that now adorns the City of London.

From an initial shortlist of 17 projects, all of this year's entries scored highly in sustainability, cost-effectiveness, efficiency and innovation, with six schemes getting Commendations and six collecting Merits.

NEW INTERACTIVE BLUE BOOK NOW AVAILABLE

Produced by the Steel Construction Institute (SCI) on behalf of Steel for Life, a new interactive version of the Blue Book is now available and can be found in the Key Resources menu of the website.

The comprehensive web-hosted resource includes design information in accordance with the Eurocodes and BS 5950.

It provides design data for the full range of open sections and hollow sections (both hot-finished and cold-formed), and does not require any software to be installed on a host computer.

SCI associate director Michael Sansom said: "The new user-friendly and refreshed interactive Blue Book has a format that allow users to either print information directly or export information to a spreadsheet on their own computer."

SPORTS LEGACY

STEEL WAS THE COST EFFECTIVE SOLUTION FOR SUNDERLAND'S BEACON OF LIGHT

Different sized trusses are providing the spans to create the column-free spaces for Sunderland's Beacon of Light sports and education facility.

Known as the Beacon of Light and located adjacent to Sunderland FC's famous Stadium of Light football ground, the facility is said to be the first of its kind in the UK and will include engaging and interactive zones for education, health and fitness, as well as sport.

The Beacon is also the final project of the wider regeneration of the former Monkwearmouth colliery site. Other projects on the site, as well as the stadium have included a hotel and an aquatics centre boasting a 50m competition pool.

Built over five-storeys and occupying 4.75ha, the Beacon is a large cube-shaped structure, which will be illuminated at night. The upper areas will be clad with translucent polycarbonate cladding allowing light from within the structure to seep out, creating a highly visible beacon on the city's landscape.

"Steel has been chosen for the Beacon of light to enhance the concept of a simple lightweight enclosure over a brick base. This is of particular importance within the polycarbonate enclosed football barn where the primary and secondary structural elements remain visible."

Here, connections have been designed carefully to minimise visual impact and painted hot-rolled box elements have been used to create an unimposing support frame. The use of steel in the roof provides a strong but lightweight solution, maximising light penetration through the fabric covering, creating a glowing beacon effect at night," says FaulknerBrowns architect Paul Reed.

KEY FACT

880t
Amount of structural steel used

At ground floor level the building will accommodate a large multi-use sports and performance hall, adjacent to which sits a four-level teaching and learning block. Above this, and topping the entire structure, is an indoor 4G football pitch.

"Structural steelwork was the obvious choice and it is the only material that could form the building, particularly the trusses, cost-effectively and efficiently," says Marc Horn, a director at structural engineers Shed.

There are a lot of trusses in this structure. Working from top to bottom, the uppermost and longest trusses, at 60.5m long, are the nine that form the Beacon's roof, creating the column-free space for the third-storey football pitch.

They are fabricated from box sections, 150mm by 150mm by 10mm top boom and 200mm by 200mm by 8mm bottom boom. The top boom was pre-cambered for steelwork contractor Harry Marsh (Engineers) by specialist bending company Angle Ring. The trusses are 4.1m-high and weigh 13t each. They were brought to site in three pieces and were erected individually using Harry Marsh's on site mobile tower crane.

"It's a two-way spanning roof, as connecting the main trusses, are sets of secondary trusses formed from secondary members," says Horn. "This design proved to be more efficient and lighter."

Because of this design, each truss, was supported during erection at third points by two temporary trestles. These had to stay in position until the entire series of nine roof trusses and their connecting steel members was in place, thereby making the entire structure stable.

The main structure of the Beacon is formed with

Top left: The steel frame is clad in a translucent polycarbonate material

Top right: The Beacon is next to Sunderland FC's Stadium of Light

Bottom right: Cross section of the building, showing the structural steelwork

PROJECT TEAM

Project: Beacon of Light, Sunderland
Main client: Foundation of Light
Architect: FaulknerBrowns Architects
Main contractor: Tolent Construction
Structural engineer: Shed
Steelwork contractor: Harry Marsh (Engineers)

universal column sections up to the underside of the top floor. Above this point, a series of vertical trusses made from square hollow sections, up to 4.8m high and measuring up to 21m in length, form the football pitch area's elevations and support the roof trusses.

Below the football pitch, another two series of trusses were required to create the column-free space for the multi-use sports and performance hall on the next level down, as well as the areas that overlook it. Spanning a distance of 34.7m and each weighing 13.7t, nine 4m high trusses form the hall's roof and support approximately half of the floor for the football pitch above.

They were brought to site in three sections, and then bolted up to form two larger pieces, consisting of one third and another two thirds element. Using two mobile cranes, they were then lifted into place, with the final connection between the two pieces being completed while they were being supported by the cranes.

These trusses are supported at one end by the building's perimeter columns, and internally by another series of three spine trusses.

> **“Structural steelwork was the obvious choice and it is the only material that could form the building, particularly the trusses, cost-effectively and efficiently**

The storey-high spine trusses are positioned in a row, at second floor level, across the building's width, effectively forming the demarcation between the sports hall and the teaching zone.

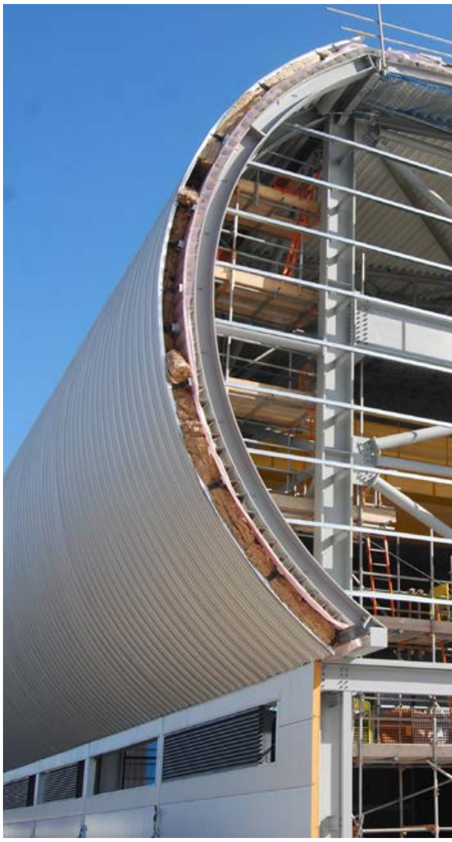
As well as supporting the sports hall trusses, these multi-purpose trusses also support three levels of structure and allow the first floor below to have just two columns within the viewing gallery overlooking the sports hall.

The gallery will be used by spectators during sports contests and concerts. More spectators can be accommodated on moveable stands, which can be stored, when not in use, in a recess beneath the first floor.

The three-level accommodation block is formed around a semi-regular 6.75m grid pattern, which also corresponds with the set-out pattern for the project's trusses.

“A number of discussions were held about the grid as it has to accommodate classrooms, offices and work spaces,” adds Horn. “The chosen column spacings proved to be the most efficient for all of the intended uses.”

RESEARCH FOCUSED



STRUCTURAL STEEL WAS CHOSEN FOR A SENSITIVE LABORATORY SITE AT HARWELL

A steel-framed facilities building at the Harwell Science Campus has been designed to provide column-free testing and storage space, as well as to fit unobtrusively into the rural landscape.

Home to more than 200 organisations, Harwell is a vast world-renowned science and innovation campus covering 284ha in the Oxfordshire countryside a few miles south of Didcot.

It has been claimed that every major industry sector in which the UK economy is actively involved either resides at Harwell in some form or visits the campus to conduct research and product development.

One of the main tenants is Rutherford Appleton Laboratory (RAL), operated by the Science & Technology Facilities Council, which provides research into a diverse range of areas such as particle physics, space science, materials, astronomy, and computational and e-science.

RAL is constructing a new £23.7M facilities support building that will provide specialist support areas allowing researchers to test and commission new scientific equipment.

Being built by Willmott Dixon, the facility consists of two large open plan halls; the handling hall and the test hall. Each is a single storey, steel braced frame measuring 70m long by 35m wide.

The two halls sit side by side, share a central row of columns and are part of one large steel frame. However, due to the sloping site, there is a 5m difference of floor level from the testing hall at the top of the site to the lower handling hall.

"Steel was the obvious choice for this project because of the building's size and the required spans," says Clarke Nicholls Marcel structural engineer Steven Coates.

"We did initially look at a portal frame design, but as both halls' steelwork supports large overhead cranes there would have been too much lateral loading, and so we have vertical bracing providing the structural stability."

Each hall has an overhead gantry crane, serving the full length of the building. The crane in the handling hall has a maximum lifting capacity of 50t, while the crane in the test hall has a maximum capacity of 35t.

Creating the halls' open column-free spaces are a series of 2m deep 35m long triangular roof trusses, which slope downwards from the central row of columns. This means that the interior height of each hall is 19m in the middle and 14m at the perimeter elevation.

Tubular members were chosen for the trusses as they are less likely to collect dust, something which is highly important in a sterile scientific and research environment.

According to Willmott Dixon site manager Noel Cafferty, the sloping roofs have been designed to add architectural interest to the structure while helping the halls blend into the surrounding countryside.

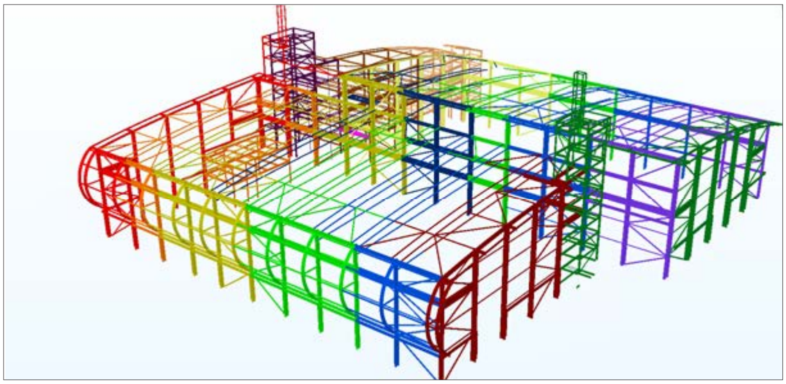
The facility is set into a dip in the landscape, dug out by Willmott Dixon early in its construction programme. The building is also set on the very edge of the campus and so the upper parts of both halls can be seen from afar and importantly from a popular walking trail.

The sloping roofs are intended to help the structures become less obtrusive, while the Kalzip roof and wall cladding has a striped design and a colour that marries into the horizon.

Steelwork contractor Hambleton Steel brought the tubular trusses to site in three sections. Two mobile

KEY FACT

900t
Amount of structural steel used



PROJECT TEAM

Project: Rutherford Appleton Laboratory, Facilities Support Building, Harwell Science Campus, Oxfordshire
Main client: Science & Technology Facilities Council
Architect: Oxford Architects
Main contractor: Willmott Dixon
Structural engineer: Clarke Nicholls Marcel
Steelwork contractor: Hambleton Steel

cranes erected the trusses, one lifting two bolted up sections, while the other lifted the third piece. Once both pieces were bolted to the supporting columns, the final connection between each piece was made, while the steelwork was being held in place by the cranes.

Hambleton's steel erection programme started with the structurally independent four-storey braced steel frame that forms an office building, which is connected to one end of the test hall.

The offices are constructed using cellular beams supporting 150mm thick concrete slabs on profiled metal decking. The curved roof of the office matches the profile of the curved roof of the adjacent test hall.

After erecting the offices, Hambleton progressively erected the two halls, with two gangs working simultaneously. Once the main frame and roofs were up, Hambleton then installed a number of interior features along with an architectural bullnose element that runs along the main elevation of the handling hall. The

Top left: Secondary curved steelwork forms the bullnose elevation
Top right: The building has been constructed to be visually unobtrusive within its setting
Bottom right: Steel model of the entire scheme

> **Steel was the obvious choice for this project because of the building's size and the required spans**

bullnose feature was created by attaching a series of secondary curved members to the main frame.

Inside the handling hall there are two structurally independent buildings; the laboratory and the handling office. The laboratory is a single storey load bearing blockwork building with precast planks forming the flat roof, which will be used for storage.

The two-storey handling office is a braced steel frame with composite beams supporting a 130mm-thick concrete slab on profiled metal decking. The roof beams are cellular to allow distribution of services within the structural depth.

Two steel-framed stair towers are located at either end of the building and were both installed by Hambleton during a return visit sometime after the main frame had been completed.

Both stairs provide access to the roof and are approximately 27m high. The stair flights are precast concrete units spanning the width of the stair well. The roofs of both stair towers are precast concrete hollowcore planks. Positioned on top of the stair tower roofs are steel-framed braced chimney stacks.

The facilities support building is due for completion in Spring 2018.