# Steel structure raises the roof

The look and functionality of a rail station in Manchester is about to be transformed through clever use of steel and cladding

**PROJECT REPORT**
RUBY KITCHING

| | |
|---|---|
| Project | Manchester Victoria station redevelopment |
| Client | Network Rail |
| Architect | BDP Architects |
| Main contractor | Morgan Sindall |
| Structural engineer | Hyder Consulting |
| Steelwork contractor | Severfield-Watson Structures |
| ETFE cladding contractor | Vector Foiltec |

Victoria railway station in Manchester is undergoing a £44m transformation to bring it into the 21st century. Parts of the station date back to 1844 and were designed by Victorian railway engineer George Stephenson. In more recent years, the station's train shed has fallen into a state of disrepair, with a patch-repaired roof that creates a particularly unwelcoming environment.

Victoria's redevelopment includes improving the functionality of the station, so that it works more as an interchange for users of Northern Rail trains, Metrolink trams and local buses, as well as the nearby Manchester Arena.

Included in the cost is a £16m curved steel rib and ETFE roof structure, which will allow natural daylight to flood the station.

Demolition of the old station roof by main contractor Morgan Sindall is now complete and substructure construction has started. Construction of the new steel roof will begin in early 2014 and continue for 14 weeks. This work will take place while the original Grade II-listed station offices, Victoria Buildings, are restored.

Although the appearance of the structure is that of a canopy extending out from the top of the Arena block and stretching over the tram and train lines to the ground, structurally speaking, it works the other way round.

"Each rib springs from buttresses at ground level, is then supported by a 20 m-high column and then cantilevers from this point to the existing Victoria Buildings [and Arena]. The new roof doesn't actually touch the old building," says steelwork contractor Severfield-Watson project manager Gary Dooley. "The aim was to avoid putting extra loads on the existing buildings".

A weatherproofing detail ensures that the roof is watertight at this junction and allows the cantilever tip to move up to 150 mm, but does not allow load transfer to the buildings.

## Box clever

The ribs are fabricated box-sections 1.2 m deep and 500 mm wide with 50 mm-thick top and bottom flanges and 20 mm-thick side plates. A single rib is made up of welded sections up to 24 m long.

The sections are being fabricated in Severfield-Watson's Bolton factory. Once on site, the 24 m-long sections will be welded together to form a single rib up to 96 m long, before being lifted into position.

Severfield-Watson is also providing the holding-down bolts to connect each rib to its buttress. Some 20, 2 m-long, 50-mm diameter high tensile Macalloy bars are required per buttress.

A 750-tonne crawler crane has been identified to lift each rib. One of its main challenges will be to negotiate around the culverted River Irk, which crosses the site. Back in 1844, the single station platform was once accessed via a wooden bridge over this river. It is now contained within an 11 m-wide brick-lined tunnel beneath the station.

Ensuring that minimal construction loads are exerted over the tunnel has affected the choice of plant and type of structure on the project. The buttresses have been designed to bridge over the river.

Erection of the 15 steel ribs will take place during night-time railway possessions when rail and tram transport has ceased, avoiding any clashes with Arena users. However, this leaves just a three and a half hour clear window for each lift.

"We are able to mobilise and demobilise outside of these hours, so the nearby car park area will be used to assemble, weld and orientate the rafters [ribs] so that they will be ready to lift using bespoke lifting lugs when the possession begins," says Severfield-Watson lead designer Mick Slack.

"Working through the logistics of this project is as complicated as a game of chess for us – we're always thinking about what can go forward, what can be brought in, what needs to be on standby," says Mr Dooley.

He says that some members will be on site for up to three weeks during which time components will be welded, the welds tested and then the steel shotblasted in weld-affected areas before the final paint treatment is reapplied. Each rib is lifted as a single piece and connected at buttress and column almost simultaneously. There is no connection at the building end.

**£44m**
**Value of redevelopment**

## WHY ETFE CLADDING WAS USED

Choosing lightweight ETFE cladding (as used at the Eden Project's biomes in Cornwall) has allowed the steel ribs to span further than if glazing had been specified. The material is popular as its surface is self-cleaning and transparent.

The cladding takes the form of pillows which are pumped with air to keep them at the correct pressure. They also have the advantage of not shattering in a blast situation. This attribute is particularly poignant in the light of the original station having suffered damage during World War II and also an IRA bombing in 1996.

Hyder Consulting explored other options before opting for the steel rib structure. "We considered a gridshell structure for the roof, but realised that it would require more temporary works than the ribbed solution and would have affected the running of the station," explains Hyder Consulting technical director Andrew Dugdale. "As we leaned towards the ribbed solution, we still needed to consider how it could be built within Network Rail's budget, and the only way to do this was to make the structure as lightweight as possible."

A lightweight steel structure was more efficient than the glulam structure, which was also proposed. "The timber option came in heavier and was more difficult to install," says Mr Dugdale.

The steel option was favoured for its quick erection and because it required minimal bracing, unlike the glulam option. Hyder also had to select a section shape which would give the lowest weight. A fabricated box section was chosen over tube or cellular beams.

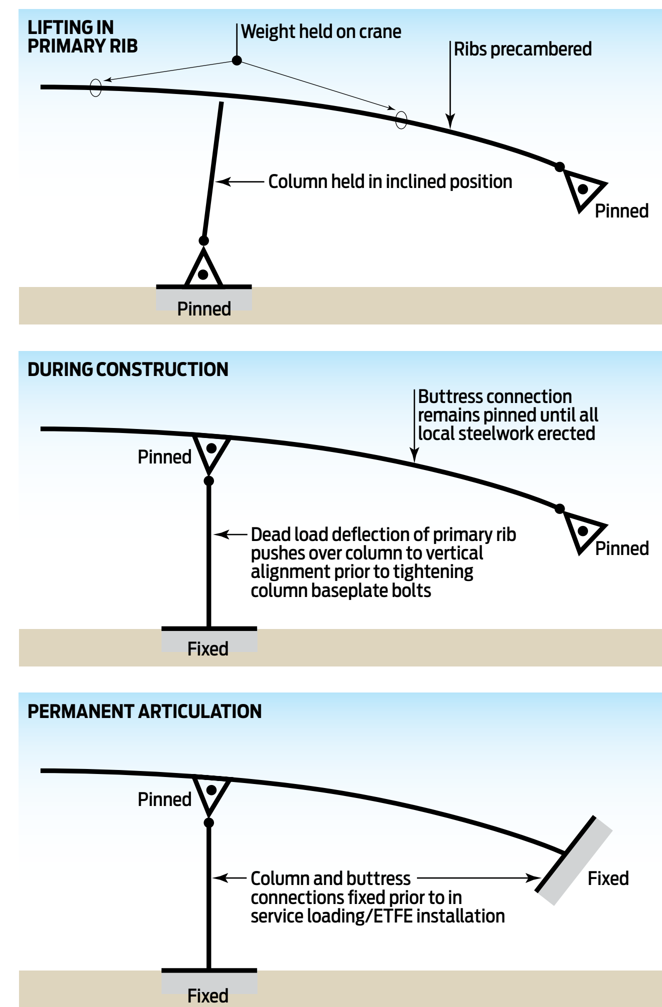
## Making connections

The ribs are precambered so that when it deflects under its own self-weight, it pulls the member into its final geometry. The columns have been designed to lean towards the buttress in the temporary condition so that as each rib is lowered and adjusts under its self-weight, the column is brought to plumb. Only then can the column base and buttress connections be made permanent (see diagram right).

The sequence of erection begins at the end of Victoria Buildings. Initially, the first four 660 mm-diameter columns will be erected using temporary supports, followed by the first two ribs. At this point there will be extensive temporary steelwork to brace the structure. Permanent bracing will then be installed followed by ribs three and four. All four ribs are then tied together with secondary steelwork.

The structure is stable from this point on and further ribs and columns can be erected in succession up to the last rib at the far end of the Arena block. The ETFE cladding is then added.

**RIB AND COLUMN CONSTRUCTION**




> **"Working through the logistics of this project is as complicated as a game of chess for us"**
> GARY DOOLEY, SEVERFIELD-WATSON

Three-dimensional computer modelling has enabled the design, fabrication and construction sequencing to progress seamlessly. "The model was only drawn once and could be used to understand stresses in the structure and then used in fabrication," explains Morgan Sindall engineering manager Dominic Hull.

"As the project has progressed, we've added more detail – the roof, Arena mezzanine level, buttresses, concourses, ductwork, train and tram [infrastructure]. There is continuity from fabrication to setting out and building on site".

The project is due to be complete in early 2015.

# Steel has all the angles covered

Steel has helped to deliver the functional requirements of a new cancer research facility, while also realising its bold design

**PROJECT REPORT**
RUBY KITCHING

Manchester Cancer Research Centre's new headquarters makes a big statement in the suburban town of Withington. Its crisp lines and bold angles scream out that this is a building making its debut on the world's stage – not just Manchester's.

The aim for the facility is for it to be a world-class centre of excellence according to its partnering organisations, Cancer Research UK, The Christie NHS Foundation Trust and Manchester University.

Currently under construction on land owned by The Christie, the three-storey building is needed to bring researchers and clinicians dotted around Manchester together and to enable their activities to expand. Another aim is to attract world-class scientists to increase the potential for breakthroughs in cancer research.

Its most distinctive features are its dramatic first floor cantilever, sloping façades – flaring out with height – and a central lightwell, which floods the interior with natural light. A steel-framed structure was deemed most suitable to accommodate all these elements as well as the different functional requirements for offices and laboratories.

**ON SCHEDULE**

The site for the new Manchester Cancer Research Centre was cleared in November 2012 and concrete piled foundations were installed in January 2013. Core and shear wall construction followed and then steelwork erection. Fitting out and cladding installation began in September with completion of the whole building due in summer 2014.

| | |
|---|---|
| Project | Manchester Cancer Research Centre, Christie Hospital |
| Client | University of Manchester |
| Architect | Wilson Mason and Partners |
| Principal contractor | M+W Group |
| Main contractor | Pochin Construction |
| Structural engineer | Aecom |
| Steelwork contractor | EvadX |
| Steel tonnage | 575 tonnes |
| Project value | £18m |

"Using a steel frame allowed us to create the desired structural shape," says Wilson Mason project architect James Potter, "while the hybrid [composite] design helped solve any vibration issues connected with the sensitive equipment which will be installed within the completed facility's laboratories."

The building comprises a central entrance and lightwell flanked by an office block along Wilmslow Road to the west and three blocks of interconnected laboratories to the east. While the entire building is steel-framed, floor construction is composite (steel decking with in situ concrete) for the office floors and precast planks for the laboratory areas.

In the laboratory the precast planks vary in depth, up to a maximum 350 mm thickness, depending on the research equipment to be installed. The soffits will be left exposed to optimise thermal mass helping to cool the building.

Spanning the lightwell, a steel footbridge will connect the offices with the laboratories at first floor level. Above this, the building's central void is topped with a series of north lights, which allows natural lighting to enter the laboratories.

### Steel stability

Eight cores and shear walls as well as additional steel bracing provide stability for the structure. During construction, temporary steelwork provided stability to the sloping columns, which are connected back to the cores in the permanent case. When full height sections of the building (including floors) had been completed, the temporary bracing was removed, allowing permanent steelwork connecting back to the cores to support the sloping columns.

"It's a very unusual building," says steelwork contractor EvadX project manager Andrew Roberts. "The steelwork leans out 12 degrees so the whole building has more floor space the higher up you go. Building the leaning façade was quite a challenge. That and the 11.5 m cantilever on the office block at first floor level."

Three EvadX draughtsmen worked simultaneously on the 3D model of the structure to ensure fabrication and erection would be hitch-free. The steelwork was erected in August and September of this year.

**11.5 m**
**Length of cantilever**

Cores and walls were built with cast-in plates so that as the shuttering was removed, they were ready to receive steelwork immediately.

The 11.5 m cantilever at first floor is achieved by hanging the first floor from a 5 m deep truss constructed between second floor and roof. The truss is fixed to a core at one end and supported by a straight column 16 m from the cantilever tip and a sloping column 11.5 m from the cantilever tip. The 16m length of truss was brought to site as a single fully welded section and lifted into position using two 50-tonne capacity mobile cranes during a single four-hour operation.

The construction sequence for the development pivoted around the erection of this cantilever, since the central section of the office block had to be built first to provide sufficient stability to support it. Steel erection commenced with the office block, then the laboratory blocks, followed by the entrance steelwork to connect the two areas.

### Tight turnaround

Office block construction commenced with the erection of 12.5 m-tall full height columns. Endplates welded on the columns at floor locations allowed beams to be quickly connected as construction headed south towards the cantilevering end bay.

When the end bay had been built to roof level, steel erectors returned to the central section of the office block and proceeded north to complete the office building.

"It was a very tight site and whatever was brought to it had to be erected straightaway," says Mr Roberts. "The overhang [tip of the cantilever] was right at the site boundary." Aside from during the truss lift, generally only one mobile crane has worked on the site.

> **"The complexity of the shape lends itself to steelwork"**
> DAVE MILLS, POCHIN CONSTRUCTION

Steel erection of the sloping laboratory buildings commenced at the front of the development (south) and worked towards the back. "With all the slopes, we had to sequence the erection very carefully so that we could get all the vertical members in and still get the sloping members at the correct angles," says Mr Roberts.

When the laboratory steelwork was complete, an internal bridge at first floor level and entrance roof steelwork connecting the two blocks could be built.

The entrance lightwell is created by a series of northlights at roof level. Their structure comprises a series of welded right-angle triangle frames on a pair of columns which are bolted onto second floor steelwork spanning between the office and laboratory blocks. Craning these frames into position required careful planning around the office and laboratory blocks.

"The complexity of the shape lends itself to steelwork with reinforced cores," says Pochin Construction project manager Dave Mills. "We have split levels, cantilevers and sloping façades, all of which would have been difficult to achieve with any other material."

**RESEARCH SPACE**

The building will provide space for 150 university cancer researchers and 100 clinical trials support staff. Doctors and scientists will work together to develop research projects followed by clinical trials with a view to developing personalised cancer treatments based on improved knowledge of each individual patient's disease characteristics.

The building features a tiered 150-seat lecture theatre, foyer exhibition space, breakout zones to encourage collaborative working, laboratories for multiple research teams and shared write-up space for laboratory-based researchers. It aims to be a leading centre for research into cancer biology, drug discovery and clinical trials.

The building has been designed with the concept of interaction as its main theme, to allow research groups to share knowledge, resources and equipment.

"Making sure the building is able to facilitate the fundamental need for interaction was a major design consideration," says Wilson Mason senior partner Derek Southworth. "The research centre has shared write-up space so that laboratory-based teams have a dedicated area where they can get together with colleagues from other teams to discuss research programmes.

"There is also shared breakout space on two floors of the building which all users can access, including The Christie's clinical trials support staff, who will be based on the second floor."

The building has been designed for a BREEAM Excellent rating. It incorporates natural ventilation and lighting. Entrance roof lights are orientated to minimise unwanted solar gain. Wall, floor, window and roof design exceed Building Regulations thermal performance requirements by 40 per cent and the building's envelope has been designed to improve on Building Regulations air tightness requirements by 50 per cent.

These improvements will contribute to reduced energy consumption by limiting heat loss through the building fabric.

# Steel speeds laboratory project

A £25m extension to the National Composites Centre in Bristol will help companies to push the boundaries of product design and help the UK lead the world in manufacturing

**PROJECT REPORT**
RUBY KITCHING

Back in 2009, the government decided that one way of supporting the UK's manufacturing industry was to create technology and innovation facilities where companies could prototype, de-risk and optimise their products. Highlighted in particular was the importance of advanced composites – durable, lightweight and high-performance material used in aircraft, wind turbines and car manufacturing.

A composite material is made from at least two different materials, resulting in a new material with different properties to its constituents. One example of an advanced composite is carbon fibre reinforced plastic.

Support for developing the potential of advanced composites continued through the change in government in 2010 and Phase 1 of the National Composites Centre – owned by the University of Bristol – opened on the northern outskirts of the city in 2011 (see box).

This 8,500 sq m facility attracted some of the biggest names in manufacturing – Rolls Royce, Airbus and GKN Aerospace. These companies use the NCC to prototype component parts for cars, entire train carriages and even aeroplane wings made from composite materials.

Soon, the advantage of being able to test products without having the overheads of premises and expensive test equipment attracted the attention of smaller companies wishing to use the facility on a much smaller scale.

Equally, the larger companies also expressed a need for facilities which would suit only single prototype development, but also for developing products for mass production.

The result of these talks between industry and NCC is that just two years after Phase 1 opened, work has started on building a 9,000 sq m extension next to it. Costing £28 million, Phase 2 is made up of a three-storey Knowledge and Innovation Centre (KIC) and a single storey 'high volume manufacturing and large demonstration' area.

**Scheme** National Composites Centre
**Client** University of Bristol
**Main contractor** Sir Robert McAlpine
**Steelwork contractor** Billington Structures
**Structural engineer** BDP
**Architect** Stride Treglown
**Cost** £28m

### NCC BACKGROUND AND FUNDING

Phase 1 of the NCC's investment is supported by the Department for Business, Innovation and Skills, the South West Regional Development Agency and the European Regional Development Fund.

The NCC is owned by the University of Bristol and draws on established links to world-class composites research at Bristol, the University of Bath and other UK universities.

Its mission is "to be an independent, open-access national centre that delivers world-class innovation in the design and rapid manufacture of composites and facilitates their widespread industrial exploitation".

### Steel speed

With speed of construction a major factor, a steel-framed structure was chosen for both buildings in Phase 2, similar in form to that used in Phase 1. Furthermore the University of Bristol engaged in talks with steelwork contractor Billington Structures, ahead of appointing a main contractor, so that steelwork design could get under way immediately. Billington had also worked on Phase 1 of the NCC, so it could carry forward much of the knowledge gained.

Contractor Sir Robert McAlpine started on site in June of this year, when the site was levelled and pad foundations were installed. Billington began erecting steel in August and continued until the end of November.

The construction sequence involved building the KIC first to full height before work started on the demonstration area.

The 24 m-wide by 57.5 m-long KIC block is of conventional composite steel beam and column construction with bolted connections and an in situ floor slab cast onto metal decking.

Due to thermal effects it has been built as a structurally separate building to the demonstration area to allow each structure to move independently.

What makes the innovation block more unusual is that for similar spans, there are varying beam sizes. This is because the university specified very different loading criteria for all the different areas. Rooms were designed to accommodate a wide range of activities from investigating the properties of small components to testing part of a plane.

"There are different floor loadings for every area – not just one universal load has been applied," says Billington Structures project manager Paul Hayes. "Even where the loads are heaviest, we have had to design beams which fit within the allocated structural zone".

Beam sizes vary from 356 mm-deep sections to 533 mm, while column sections are 203 mm or 254 mm-deep.

At ground floor, the KIC block contains the main rooms for specialist research including laboratory-specification 'clean' rooms for testing and freezer stores for temperature-sensitive composite materials.

A lecture theatre occupies the first floor with computer rooms, study areas and informal break-out zones. An open-plan office occupies the second floor and the flat roof will support plant and a roof garden.

### Flexible future

Having worked on Phase 1 of the project, Billington understood the need to cater for a range of occupant needs. Some partitions are designed to allow subdivision to allow greater flexibility for presentations and workshops, but generally the office areas are open plan to assist with an open collaborative working environment. Within the build this means that there is a mixture of blockwork partitions, composite clean room walls, and plasterboard or folding walls across the KIC block.

Similarly, services in the building are positioned to allow flexibility for future changes to the demonstration area so that new equipment can be accommodated, whether the space is intended for sole use or for sharing.

The 10 m-tall demonstration area occupies approximately 5,000 sq m. Although it is a vast space, it does have three rows of internal columns with roof beams spanning more than 20 m. Northlights in the roof allow natural light to enter the building without allowing direct sunlight to disrupt test conditions.

Since the space is intended for large-scale prototype manufacturing, three gantry cranes supported by double columns dominate the manufacturing area. Two 30-tonne cranes travel across the main area and a 12-tonne crane services a state-of-the-art hydraulic press. Beam sizes are generally 914 mm deep while column sections are 406 mm or 356 mm-deep.

The hydraulic press, believed to be the only one of its size and specification in Europe, is one of the most important pieces of equipment in the facility and will enable rapid manufacture of large composite components.

The press requires an 11.5 m-long by 7 m-wide by 5.5 m-deep pit, but details of its location and size were finalised after the main steelwork had been designed. When the best location for it turned out to be along a line of internal columns in the demonstration area, two columns had to be removed and replaced by a truss spanning between the two columns flanking the pit.

"The challenge has been to build a building to accommodate equipment while the exact details of the equipment are still being finalised," says Sir Robert McAlpine project manager Peter Munn.

**"The challenge has been to build a building to accommodate equipment while the exact details of the equipment are still being finalised"**
PETER MUNN, SIR ROBERT MCALPINE

This was another reason why a steel framed structure suited the build – any changes could be accommodated easily using additional steelwork or reprogramming the erection sequence.

**10 m**
**Height of the demonstration area**

Martin Stubbings, Phase 2 National Composite Centre project director, says: "The NCC is an open access facility and so one of the big challenges of the build is balancing the needs of the existing industrial partners but enabling a wider range of services.

"One aim of NCC Phase 2 is to attract companies in sectors that have in general less experience of maximising the light-weighting and corrosion-resistant properties of composites such as automotive, construction and rail. It's also vital that as well as offering companies rapid prototyping opportunities, the NCC assists with faster dissemination of knowledge, information and skills to ensure there is a skilled available workforce."

Phase 2 will open late in quarter 2 of 2014 and will allow those companies willing to invest in innovation and technology development to push the boundaries of product design, helping the UK sustain its position as a world leader in composites manufacturing.

# Steel – costs and comparisons

Steel is the dominant framing material for multi-storey offices. Gardiner & Theobald provide guidance for design teams to ensure that the price is right at early design stages

**COSTS**
RUBY KITCHING

Steel-framed construction has dominated the UK commercial multi-storey building sector for the past 20 years.

Reasons include that office buildings often require a quick build programme, need long spans to create open-plan areas and steel provides the ability to integrate services within the structural floor depth – often resulting in extra levels being accommodated within the height of the building.

A steel-framed structure, usually with composite floors or cellular beam openings to accommodate services, often fits the bill perfectly.

But every design team has to start from scratch when working on a new building to meet a client's aspirations and each site's constraints.

Choices are made early in the process on which framing material to use. Making the right choice can lead to more cost-efficient designs, not only on frame but on other elements of the building and changes later in the design process can be costly.

**Benchmark rates**

Gardiner & Theobald was commissioned by Tata Steel and the British Constructional Steelwork Association to provide benchmark rates based on real project costs. Table 1 provides current benchmark rates for Q4 2013, which should be adjusted for location using the BCIS index. The rates are updated quarterly and published in the cost section of www.steelconstruction.info along with the BCIS index.

Gardiner & Theobald also provide current comparative cost data for standard construction options for two typical building types: a high-rise city centre building (Building Two) and a low-rise business park building (Building One).

The comparisons were independently developed by Gardiner & Theobald with structural engineer Peter Brett Associates (PBA) and contractor Mace. Peter Brett developed four viable structural solutions for Building One (see box):

- Steel composite beams and composite slab;
- Steel frame and precast concrete slabs;
- Reinforced concrete flat slab;
- In situ concrete frame with post-tensioned slab.

Two viable structural solutions were developed for Building Two (see box):

- Cellular composite beams and composite slab;
- Post-tensioned band beams and slab with in situ columns.

Typical construction programmes according to current working practice were put forward by Mace, while Gardiner & Theobald assessed cost implications.

Results for both buildings demonstrated that it was important to consider whole building costs and not just frame costs because each frame type affected other elements in the project, such as the substructure, roof, services and cladding.

Gardiner & Theobald senior associate Rachel Oldham says: "If you just consider the floor and frame, then you will not be including elements which have a significant impact on the cost of the whole building."

The study compared the cost of different building solutions, taking into account programme, design and whole-building costs.

For both buildings the steel-framed options were lighter than reinforced concrete ones and, therefore, required smaller foundations and are quicker to construct. It also points out that there are losses and gains from all structural solutions and that any costing exercise needs to weigh all of these up.

**Cost comparison**

In terms of cost, the steel composite solution for Building One had the lowest with £1,535/sq m compared with the highest cost solution, £1,610/sq m, for the post-tensioned concrete flat slab.

The study says: "The steel composite beam and slab option has both the lowest frame and upper floors cost and lowest total building cost. This option has the lowest substructure costs of all frame options due to the lighter frame weight and the lowest roof cost due to the lightweight steel roof deck."

The steel cellular composite option for Building Two at £1,861/sq m cost less than the post-tensioned concrete band beam and slab, which was £1,922/sq m. The cellular steel composite option has both a lower frame and floor cost and lower total building cost than the post-tensioned concrete band beam option. The steel option also benefited from lower substructure costs due to the lighter frame weight and a lower roof weight.

The steel option has a lower floor-to-floor height (4.18 m compared with 4.375 m), which results in a 5 per cent smaller cladding cost and also lower preliminaries costs due to its shorter programme.

The study also investigated the embodied carbon for Building Two's structural frame options. It found an 18 to 30 per cent lower embodied carbon content for the whole building (excluding operational costs) for the cellular steel option than the post-tensioned band beam option.

**TABLE 1: BENCHMARK RATES**

Indicative cost ranges based on gross internal floor area (Q4 2013)

| | BCIS 100 £/sq m | City of London £/sq m |
|---|---|---|
| Frame 1 – low rise, short spans, repetitive grid / sections, easy access (building 1) | 75-100 | 90-120 |
| Frame 2 – high rise, long spans, easy access, repetitive grid (building 2) | 125-150 | 140-170 |
| Frame 3 – high rise, long spans, complex access, irregular grid, complex elements | 145-170 | 165-190 |
| Floor – metal decking and lightweight concrete topping | 40-58 | 45-65 |
| Floor – precast concrete composite floor and topping | 45-60 | 50-70 |
| Fire protection (60 minute resistance) | 7-14 | 8-16 |

To determine the cost of a building using the table, add the cost of the frame type, floor type and fire protection. The standard ranges should be adjusted to reflect different locations and any variation form the described arrangement.

**BUILDING 1: LOW-RISE OFFICE**

This rectangular three-storey business park office building with a gross internal area of around 3,200 sq m has a floor plate width of 18 m, floor-to-ceiling height of 2.8 m, one central core, two lifts and is clad in brick. Windows occupy 35 per cent of the façade area.

£/sq m, gross internal floor area (City of London location) at Q4 2013

| | Substructure | Frame and upper floors | Total building |
|---|---|---|---|
| Steel composite | 52 | 140 | 1,535 |
| Steel and precast concrete slabs | 55 | 151 | 1,561 |
| Reinforced concrete flat slab | 67 | 153 | 1,628 |
| Post-tensioned concrete flat slab | 62 | 150 | 1,610 |

**BUILDING 2: CITY-CENTRE OFFICE**

This eight-storey city centre office building with a gross internal area of around 16,500 sq m is L-shaped with a double height reception area, central core and internal secondary escape stair. The floor-to-ceiling height is 3 m, structural grid 7.5 m by 15 m and the external envelope is a curtain wall system constructed in storey-height panels 1.5 m wide with feature fins.

£/sq m, gross internal floor area (City of London location) at Q4 2013

| | Substructure | Frame and upper floors | Total building |
|---|---|---|---|
| Steel cellular composite | 56 | 194 | 1,861 |
| Post-tensioned concrete band beam and flat slab | 60 | 210 | 1,922 |

**COST GUIDANCE**

New guidance on how to cost steel frames has been published by Tata Steel and the British Constructional Steelwork Association, taking building professionals step by step through the stages of the cost planning process. The guide – Steel Construction: Cost – is based on the quarterly Steel Insight series prepared by Gardiner & Theobald whose articles, as well as the new guidance document, can be downloaded free of charge from www.steelconstruction.info.

Cost information used in the printed version of the new guidance is based on prices current in Q4 of 2013. Regular updates on cost are made available at www.steelconstruction.info, where the electronic version of the new guidance will always be kept up to date with the latest figures.

# Radical rooftop garden for residents

A mixed-use development in Canning Town will see a supermarket roof play host to a private garden for people living alongside a major road

**PROJECT REPORT**
RUBY KITCHING

Bouygues Development and the London Borough of Newham are delivering one of the most exciting and significant town centre regeneration projects in London. Forming part of the wider £3.7bn Canning Town and Custom House Regeneration Programme, Canning Town in east London is currently undergoing a five-phase, £600m regeneration scheme to create 1,200 new homes and 30,000 sq m of leisure and retail space. Hallsville Quarter, as it is now known, is a 6 ha site located at the junction of the A13 flyover and Silvertown Way, both busy dual carriageways in the London Borough of Newham.

The development is ideally located for main roads in and out of London, and is well placed for public transport from Canning Town Tube, bus and Docklands Light Railway station.

To inject some greenery into the urban landscape, Phase 1 of the scheme – which is currently on site – will include a 7,000 sq m private garden including allotments, mature trees and a playground. It will sit on the roof of a steel-framed supermarket 9 m above street level. That might sound unusual, but it makes a lot of sense.

Phase 1 is a mixed-use development with 179 residential units. The 100 sq m site will include three, seven-storey residential blocks and a row of four-storey town houses. These buildings sit in a horseshoe arrangement around the central shared private garden.

The ground and first floors of the entire site are a double-height retail space, which will be dominated by a supermarket. A car park, mainly for its customers, will be located at basement level.

The steel-framed structure for the supermarket and roof garden has recently been completed by steelwork contractor Graham Wood Structural. The main contractor is Bouygues UK, led by Bouygues Development.

The primary beam structure comprises I-section plate girders 1.2 m-deep and 50 mm-thick , weighing around 7-11 tonnes each. Secondary beams are 1,016 mm-deep I-sections weighing 5 tonnes each. Cranes lifted the pieces into position while steel erectors made connections from mobile elevated working platforms.

“Since the roof garden, or podium structure, includes such large steel beams,” says Graham Wood Structural operations director Gregor Hunter, “there are relatively few members to erect, despite covering an area of 7,000 sq m.”

“We've erected 500 of the 700 tonnes of steel on the project, but this represents only a quarter of the steel members on the project”.

The remaining, much smaller steel sections will be installed to create mezzanine retail levels and to support the townhouses and feature screen (see box).

Bouygues UK senior engineer. Rory O'Sullivan says the steelwork has been straightforward. Just 15 plate girders span the supermarket roof and take the heavy garden loads. “The supermarket has spans of 15.5 m and the structure is also required to support about 1 m depth of soil and trees up to 6 m tall. It took just three weeks to erect,” he says.

A steel frame was also the ideal choice for bolt-on mezzanine levels in other retail locations.

Phase 1 is due for completion in April 2015 and construction of Phase 2, costing £100m, is expected to start in June 2014 with completion due in 2017. Phase 2 will unite two parts of Canning Town which are currently separated by the A13 flyover. The remaining three phases are expected to be completed by 2024.

**“There are relatively few members to erect, despite covering an area of 7,000 sq m”**
GREGOR HUNTER, GRAHAM WOOD STRUCTURAL

| | |
|---|---|
| Scheme | Hallsville Quarter Phase 1, London |
| Cost | £70m |
| Owner | London Borough of Newham |
| Developer | Bouygues Development |
| Structural engineer | MLM |
| Main contractor | Bouygues UK |
| Steelwork contractor (main) | Graham Wood Structural |
| Steelwork contractor (feature screen) | S H Structures |
| Architect | Haworth Tomkins Associates |

The steel frame for the supermarket, which will support the roof garden, was built in just three weeks

### BUILD SEQUENCE

Bouygues UK arrived on site in December 2012. Construction has involved excavating the 2.5 m-tall basement car park, installing piled foundations and a 350 mm-thick ground bearing slab.

Concrete basement columns support a 100 mm-thick pre-stressed precast ground floor with 150 mm in situ topping across the site. Steel columns from ground to first floor level support the podium steelwork, which forms the supermarket roof garden.

When the build programme had reached ground floor in the residential blocks, erection of the podium steelwork and supporting columns could begin. Steelwork for the supermarket roof has been erected and steelwork contractor Graham Wood Structural is currently erecting steelwork to support the town houses.

**15**
**Number of plate girders spanning the roof**

### A PRIVACY SCREEN THAT MAKES A STATEMENT

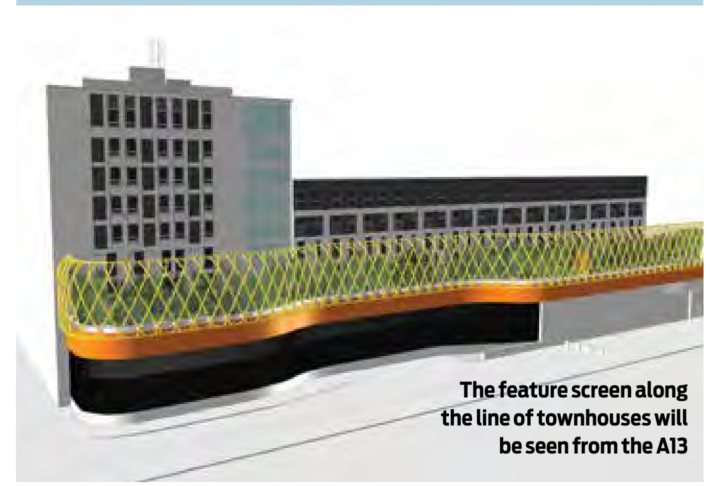
To screen townhouse residents from the A13 flyover and provide a feature for road users, architect Haworth Tomkins Associates has designed a 110 m long, 8 m tall lattice structure that will support a curtain of vegetation. The steelwork contractor for this structure is S H Structures.

Painted yellow, the screen is made up of 168 mm diameter circular hollow sections arranged in a lattice truss, which cantilevers off the main steel frame at podium (first floor) level. In cross-section, the screen is hockey-stick shaped with the long leg making up the 8 m height and the short leg creating an overhang at the top. A lightweight wire mesh curtain will be suspended from the overhang to support climbing plants, such as wisteria. The bottom of the curtain will be tied into the main steelwork.

The screen will be fabricated and trial-assembled in S H Structures' factory in Sherburn-in-Elmet, North Yorkshire, and brought to site in sections. “We'll build it in full height panels in our factory and then split it horizontally for delivery, because a complete panel will be too wide for road transport,” explains sales and marketing manager Tim Burton.

Locating brackets pre-welded on to the truss will ensure the panel halves align exactly on site before being welded. “The weld will be ground flush and the final topcoat [of paint] will be applied on site. The impression will be of a seamless connection,” he adds.

Graham Wood Structural is currently designing the eight-bolt connection between the base of the screen and the main steelwork. The connection has to resist a large overturning force at the base of the screen. The screen top has been designed to deflect up to 180 mm.



The feature screen along the line of townhouses will be seen from the A13

The gardens will sit on top of the supermarket roof. Townhouses can be seen on the left