Meeting the student deadline

Completing student accommodation in time for the start of the academic year meant steel was essential to enable fast-track construction

Text by Pamela Buxton **Photos by** Daniel Hopkinson

SITE PLAN OF THE ENTIRE DEVELOPMENT

1 Block A (completed) 2 Block B 3 Block C

Delivering student housing is highly time sensitive. Miss the start of the university autumn term and you've lost a year's potential rent. So speed really was of the essence at Ducie Court, a substantial 614-unit development of student accommodation in Manchester designed by Hodder & Partners.

While a swift construction was important, at the same time client Worthington Properties was keen to deliver a building with a sense of longevity, especially given the prominence of the site opposite Manchester's grade II listed Whitworth Art Gallery. The result is a building designed with a steel frame for speed but with red brick cladding to give it a robust character. The first phase has been completed in time for the autumn term and is now fully occupied.

Hodder was initially asked by the then owner to convert the existing building on the site – a Victorian school turned homeless hostel – into residential accommodation to take advantage of the proximity to the university. Feeling that it would be a huge compromise to create appropriate provision within the context of the original building, the architects instead made the case for demolition and a new build. The site was subsequently sold to Worthington Properties, who specialise in student housing.

"We were very keen, having witnessed more recent student accommodation, to revert to a more traditional arrangement of buildings around a courtyard with the sense of community that Oxbridge precincts give," says Stephen Hodder, whose practice designed acclaimed new housing at the grade I listed St Catherine's College in Oxford in 1994.

Another consideration was addressing the buildings' relationship to the street and nearby Whitworth Park and Gallery. "Worthington's were very keen that it be a building of quality and permanence," he says, adding the programme was "incredibly tight".

This time pressure made steel (supplied by BD Structures) a natural choice, especially given that the building rises to nine storeys and is extensively glazed.

"Speed was a big issue with very short lead times," says Peter Ward, partner at engineer Fairhurst. "A timber frame was not an option, and concrete was too expensive."

The architects were keen that the development should not give a monolithic definition to the street. Instead, they are creating a rhythm of three towers containing the cores along Denmark Road with lower scale L-shaped blocks of bedrooms in between, arranged in clusters of four and five bedrooms around communal living, dining and kitchen areas. To the rear is a courtyard. Behind, on Burleigh Street, is a further block, configured to contain its own courtyard. Students enter either from Denmark Road or to the rear through the corners of these private courtyards. The ground floor also contains a general common room for the whole block plus a laundry, WCs, and offices for the block managers.

"There was a desire to think about how it engaged with the street and courtyard, and how we could create intimacy within a very large development," says Hodder. "What could have been a really overpowering block of student accommodation is now broken down into smaller elements."

Worthington Properties development director Russell Worthington adds: "The courtyard feel will set it apart from other schemes being developed in Manchester, which have very high densities with 30% smaller rooms and no external space at all." He says Ducie Court's comparative generosity and use of open space will give it far more sustainability.

"Ducie Court is an exciting scheme and very much a calling card for us to show what we can do as hybrid developer-contractors."

The first phase contains 246, 5m x 2.7m study bedrooms and bathroom units. The two further phases will follow by September 2013.

PROJECT TEAM

Architect
Hodder & Partners
Developer
Worthington Properties
Contractor
Marcus Worthington Construction
Engineer
Fairhurst
Steel contractor
BD Structures Limited
Landscape architect
Pla-net

Phase one of Ducie Court, viewed from Whitworth Park.

View towards the common rooms on each floor.

SPEED

Both the design and construction of Ducie Court were fast track, with the building designed and on-site within three months – three times faster than usual. According to Peter Ward of Fairhurst, this was only possible because the architect and engineer worked simultaneously rather than consecutively, and because of the contractor-client's drive to be finished in time for the autumn intake.

"It was a phenomenal feat of construction by the contractor to provide a simple but quality building," he says. "It's a relatively simple building, built to last."

Hodder adds: "Putting up [nearly]400 tonnes of steel frame in six weeks is absolutely extraordinary."

The steel frame went up in just six weeks.

Time was the main challenge according to Bolton-based steelwork contractor BD Structures.

"A lead in time of just five to six weeks is very quick for the size of the project," says BD Structures managing director Chris Heys. "Fairhurst provided very good information to us and that helped us deliver so quickly."

The structure is a relatively straightforward main steel frame without concrete sheer walls, fully-diagonally braced and with a composite metal deck floor. There was more complexity in reconciling the different tolerances of the steel frame and the brick skin. Apertures were pre-cut in the steel and stiffened accordingly to enable the distribution of services throughout the building.

"Most of our schemes are built in steel," says Russell Worthington, development director of developer Worthington Properties. "Concrete is far too slow. Steel frame is all to do with speed."

CORNERS

"The corners of the high-rise blocks are the giveaway that it's a steel–framed construction," says Hodder. These hold the common rooms, fully glazed to make the most of the park aspect and set back 1.5m with brise soleils to mitigate solar gain. The beams are the only part of the structure not clad in brick – here it was felt that it was more structurally honest, says Hodder, to use render, in conjunction with the brick-clad steel piers. On the upper levels of the towers are 12m-high feature columns, constructed in one piece by BD Structures, which pick up the projecting roof. These are H-shaped in section, and clad in a brick square box.

CORNER SECTION

1 Student bedroom
2 Student shower room
3 Common room
4 Rendered blockwork
5 Powder-coated aluminium brise-soleil
6 Rendered steel beam

Fully glazed communal areas are positioned on the corner, with balconies expressed in white render in contrast to the brickwork.

Grater London

Rogers Stirk Harbour's Leadenhall, the latest addition to London's high-rise landscape, is being largely prefabricated off site

Text by Pamela Buxton **Main photos by** John Safa

Visualisation showing the triangulated form of Leadenhall, which will be 225m tall when completed in 2014.

With its perimeter exposed steel structure, Leadenhall can trace its lineage back to Rogers' nearby Lloyd's Building, completed in 1986.

Leadenhall, aka the Cheesegrater, is going up fast in the City of London at a rate of approximately seven storeys per month. At 225m, the Rogers Stirk Harbour + Partners office tower will not break any height records. But it is remarkable for the unprecedented scale of its use of a "tube" structural perimeter envelope with an external support core.

Designed by partner Graham Stirk, it is firmly rooted in the practice's family of structures that goes back to the nearby Lloyd's Building and includes Lloyd's Register of Shipping and 88 Wood Street. After a two-year pause, the British Land development is now back on track with an estimated completion date of May 2014.

Leadenhall comprises a tapering, perimeter-braced diagrid structure containing the office floors alongside a northern support core, which houses all passenger and goods lifts, service risers, on-floor plant and WCs. Office floors are connected to the structural tube at every floor without the need for further perimeter columns.

The main structure is set out on a grid of 16m x 10.5m, creating clear and flexible spans that would be impossible with a conventional internal core – only six internal columns are required on the largest floors. The contrasting colours of the expressed steelwork show the division between office and service space.

The expressed triangulated mega-frame is divided into eight of what the design team terms mega-levels of 28m high, each containing seven floors, apart from the first, which is five floors.

According to project architect Andy Young, the development of the external mega-frame allowed the creation of a non-standard plan, which creates a generous public space at the base.

Each floor diminishes in depth by 750mm as it rises, in response to the sight lines from Fleet Street to St Paul's Cathedral, and this creates the distinctive cheesegrater shape.

Because of the large distances between the stiff node levels, the mega-frame structure requires a secondary stability system. This defines the main vertical emphasis of the building and consists of chevron-shaped, "K-bracing" located on the north-east and north-west corners. The bracing transfers lateral loads from all intermediate floor plates between the nodes back to the main frame at seven-storey intervals.

Behind this bracing are service riser and escape staircases. The tower is topped with a four-storey "attic" containing generators, boilers and cooling towers.

"We wanted to express the structural external framework in a very strong way," says Young. "The challenge has been dealing with the big loads within such a slender structure."

The architect worked very closely with engineer Arup and steelwork contractor Watson Steel Structures to design and deliver the optimal solution. With very few wet trades on site, construction is very much an assembly process, with an on-site team of only 150-200 compared to the 500-600 normally required for a building of this scale.

For fire protection, the whole structure is sprayed prior to site assembly with a marine-standard, epoxy intumescent coating in layers of 3-12mm, depending on the thickness of the steel. This gives 90 minutes of fire protection. When complete, the structure will contain 500 tonnes of paint.

The building will be Breeam "excellent", and includes a triple-glazed ventilated facade in the office areas. Here, there is a 1m-wide cavity between the outer and inner glazing, which incorporates the structural frame. Computer-controlled blinds in the cavity automatically adjust in response to solar gain and glare to prevent the glass heating up. The resulting warmed air is discharged through vents at node level.

Floor-to-ceiling heights of 2.75m will be achieved within each 4m-high office storey, which contains a 150mm-deep concrete slab laid over 700mm steel beams and a raised floor of 150mm.

The 16,000-tonne steel superstructure is expected to complete by February. For Watson Steel Structures, the challenge has been meeting the requirements for both precision and aesthetic appearance for such complex connections and large-scale components – some weighing up to 40 tonnes – as well as ensuring that these could be assembled on site to the swift programme.

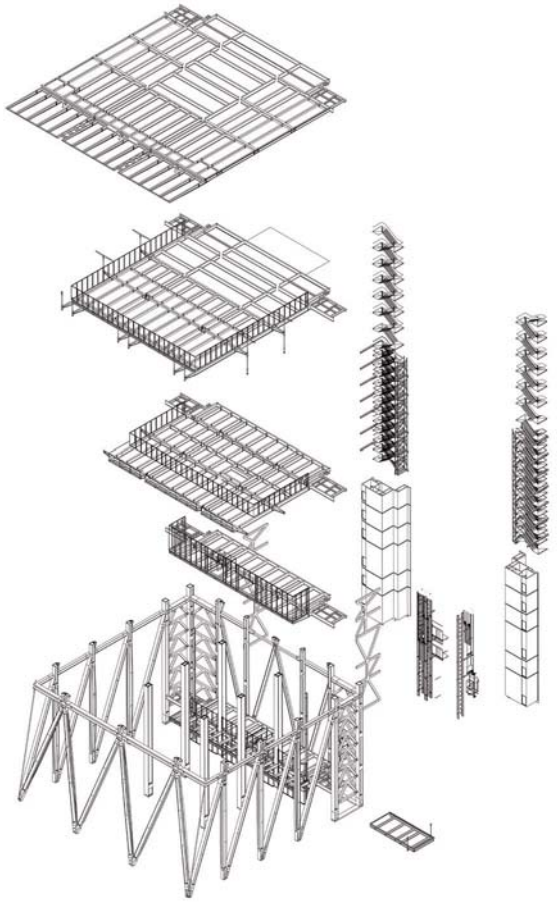
"It's been a very close collaboration between Laing O'Rourke, Arup, Rogers Stirk Harbour + Partners and ourselves, working very much as a joined-up team," says Peter Emerson, managing director of Watson Steel Structures.

Leadenhall will provide 56,000sq m of office space over 42 floors.

PROJECT TEAM

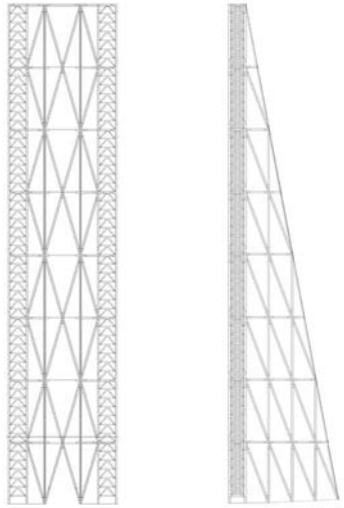
Client
British Land
Architect
Rogers Stirk Harbour + Partners
Engineer
Arup
Contractor
Laing O'Rourke
Steelwork contractor
Watson Steel Structures

ISOMETRIC OF GALLERIA FLOOR FRAMING



CGI: ROGERS STIRK HARBOUR + PARTNERS

DIAGRID ON THE NORTH AND WEST ELEVATIONS



North West

NORTH CORE

For speed and ease of construction, the components of the north core were largely prefabricated in "tables", three per level and each consisting of a floor level with columns attached.

These were made by Watson Steel Structures, then moved to another factory where they were fitted with primary M&E components and pre-cast concrete floors before being brought to site. Structures for the passenger and goods lifts are hung off the tables on either side.

The self-supporting core connects back to the main-frame on every level and is painted a distinctive yellow.

The north core is clearly delineated by its distinctive yellow colour.

THE GALLERIA

The first 28m-high mega-level, covering floors 0-5, is already taking shape. Known as The Galleria, it is conceived as an open, public area linking into the nearby St Helen's Square.

"It is the only building of its type to have a big urban gesture," says project architect Andy Young, adding that this ground-level amenity is a contrast to most tall buildings where the gestures are more about the skyline than the streetscape.

The diagrid terminates at ground nodes, which transfer loads into the four-storey basement. Designing the frame with the open structure at these lower levels was particularly challenging since this area lacks the lateral support of the floor plates. To compensate, the section size of the steel is increased, all sections are twin-webbed and the webs taper outwards in the middle of the section and then back to accommodate the bolt box connections. An additional central plate parallel to the webs projects through the flanges.

A public galleria will be created at ground level.

PREFABRICATED NODES

A family of 12 node types was designed to avoid site welding and instead facilitate easy Meccano-style assembly by using far fewer, but far bigger, "mega-bolts". These join, typically, six mega-frame elements. In this way, the highly complex node construction and welding – involving up to 87 components and taking two people four weeks to complete – can be carried out at Watson Steel Structures' fabrication workshop before being taken to site and bolted to the columns and diagonals of the main structure in a relatively simple process.

"We're making the fabrication job on site as easy as possible," says Peter Emerson of Watson Steel Structures.

Nodes are typically 6m x 3m and weigh up to 30 tonnes. Connections transfer forces of up to 6,000 tonnes in at least three different directions simultaneously. Bolts are high-strength, threaded pre-tensioned bars up to 76mm in diameter. Connections can be made within the profile of the members and transfer their pre-stress to the ends of the members and nodes via stiffened plate bolt boxes between the flanges of the mega-frame sections.

One of the complex steel nodes, constructed off site.

NODE PHOTOGRAPH: DIRK KROLIKOWSKI AND MARK GORTON

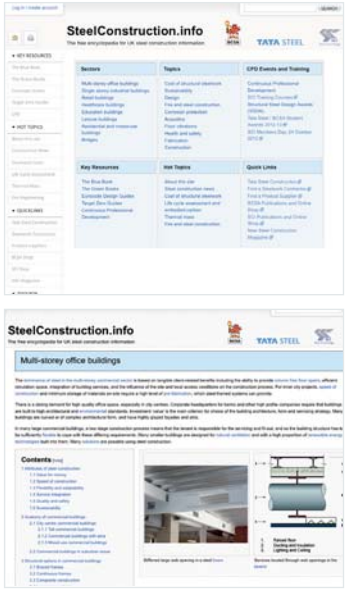
A repository of knowledge

A new website offers a wealth of information about steel design and application

A new online encyclopedia for anyone designing with steel has been launched by the steel construction sector. Launched last month, the website, www.steelconstruction.info, has been developed over the last two years by the British Constructional Steelwork Association (BCSA), Tata Steel and the Steel Construction Institute and brings together all the key steel design and construction information into one place.

"It's a collaborative effort by experts from across the steel construction sector," says project manager Chris Dolling. "The intention is for it to be the first port of call for anyone who wants to know anything about steel construction. While there was previously a lot of good information on various websites, it wasn't always as easy to find as it perhaps should have been. The idea is to bring it all together in one place so it's much more accessible."

'The idea is to bring it all together in one place'



Content on SteelConstruction.info, which has been in development for two years, is organised by sectors and topics.

More than 100 interlinked articles written by industry experts are on the website, with content organised by sectors and topics. Resources include key industry documents such as the Blue Book for steel section design and the Green Books on structural steelwork connections. Information on Eurocode compliance is also available, plus the Target Zero guidance on sustainable construction [see box].

There is also extensive information and advice on topical issues including thermal mass, fire engineering, lifecycle assessment and steelwork costs. Best practice is demonstrated by the winners of the Structural Steel Design Awards. There are also product and service directories, and advice on health and safety.

The site aims to keep users up to date on the latest research on steel design, with content on hot topics such as structural steel cost, lifecycle assessment and embodied carbon, and thermal mass [see boxes].

In addition to the search facility, there are two interactive mechanisms built in to encourage a dialogue between users and the experts behind the site. If users can't find what they need, they can use the "Did Not Find" button, and the site partners will consider adding the required information. A "Report Errors" button will allow users to point out what they feel are mistakes. The webmaster will then give feedback and, if necessary, correct the site.

"Share functions are also on the site," says Dolling. "You have to move with the times. If architects find anything they like there's the ability to create a PDF file, which can then be shared with colleagues and friends. You can also follow the site on Twitter or join a LinkedIn group to keep up to date with additional information and what others are saying."

A number of online CPD presentations are also included, which enable the user to take a test and download a certificate for their records.

The hope is to attract around 50,000 unique visitors per month to the new website, which is at **www.steelconstruction.info**

CASE STUDIES

The Co-operative Group's new 16-storey headquarters in Manchester, designed by 3DReid, is among more than 40 case studies of steel-framed buildings on the new steel website. The building – which will be the first in the city to achieve a Breeam "outstanding" rating – contains steelwork weighing 3,200 tonnes, installed by Fisher Engineering. It will provide 30,000sq m of office space, and is due to open this autumn. Each building type on the website features five or six case studies, including award-winning buildings such as Foggo Associates' Cannon Place, and the St Botolph Building designed by Grimshaw Architects, both in London, as well as CZWG's distinctively curved Maggie's Centre in Nottingham.

STEEL INSIGHTS

SteelConstruction.info also includes the Steel Insight series of quarterly analysis on structural steelwork by cost consultant Gardiner & Theobald. The series provides guidance across a range of cost-related topics and market sectors for quantity surveyors and others interested in the cost of steelwork. Each Steel Insight includes indicative prices for steelwork – for example, on the structural options for both a business park office and a city centre office. The latest update shows that the total cost for the steel-framed solutions was around 5% lower than the comparable concrete options. Costs are also broken down into storey heights, frame types and site location.

Market share surveys commissioned by the BCSA and Tata Steel, show that steel frames have a 67.7% share of the multi-storey buildings sector compared with concrete at 20.7%, load-bearing masonry at 6.6%, precast concrete at 2.8%, and timber at 2.3%. For multi-storey offices alone, steel has 69.1% of the market.

Research also shows the continuingly tough state of the market, with the total market contracting by a further 6.3% in 2011. Overall floor area constructed in all multi-storey buildings is only 71% of the size of the market at its peak of 2008.

Each article in the Steel Insight series contains indicative prices for steelwork and focused guidance on a key market sector.

ONLINE CPD

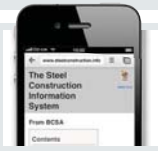
The site currently offers 12 online CPD courses as well as information on how to access face-to-face in-house technical seminars. Those who opt to do the course online can watch the module on the subject, and then take an online multiple choice test, which they must pass by 80%. They can then print off a CPD certificate.

"It's a much quicker way of doing CPD and you don't have to pay, so hopefully it will become a popular part of the website," says market development director Alan Todd.

The website sets out all CPD modules available, both in-house and online. Subjects include sustainability, acoustics, design for fire, and weathering steel, a particularly popular topic of enquiry from architects.

TARGET ZERO

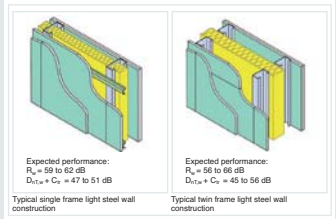
Resources also include the Target Zero guidance on the design and construction of sustainable low and zero-carbon buildings. This looks at five building types: a school, a high-rise office, a supermarket, a mixed-use development and a large distribution warehouse. The research focused on the use of energy-efficiency measures and low and zero-carbon technologies to improve environmental performance, and how this might be influenced by alternative structural forms.



FIND A STEEL CONTRACTOR APP

The site has a link to the searchable Find a Steel Contractor function on the BCSA's own website, which is also available as an app for use on iPhones and iPads.

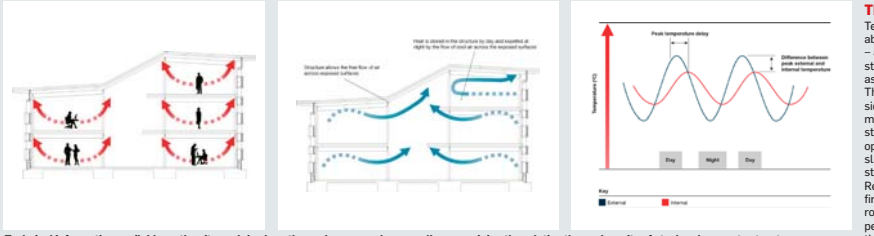
The directory lists all BCSA members, and is searchable by categories such as geography, type of work undertaken and size of project and certification requirements.



The site includes acoustic analysis of typical light steel walls.

ACOUSTICS

Technical advice on how to achieve the best acoustic performance in steel-framed buildings is also included on the new website. This sets out the acoustic regulations for various building uses such as residential, schools, hospitals and commercial buildings, and looks in detail at different types of wall, floor and ceiling construction and their integration, such as the junctions between wall and floor. There are also links to other technical resources, further reading, and CPDs.



Technical information available on the site explains how thermal mass works, as well as examining the relative thermal merits of steel and concrete structures.

THERMAL MASS

Technical information is available on how thermal mass – also known as fabric energy storage – can be achieved just as easily using a steel frame. This includes research considering the relative thermal merits of steel and concrete structures, including the optimum thickness of concrete slab for thermal mass in both steel and concrete buildings. Research indicates that the first 25mm plays the greatest role, with very little thermal performance gain beyond a thickness of 100mm.