

Structural Steelwork in action

Steel delivers low cost innovation to a wide range of projects in the UK and Ireland. This special report highlights key examples.

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New Civil Engineer in association with BCSA and Tata Steel



TATA STEEL



Letting the light into Birmingham

Birmingham New Street Station redevelopment
By Martin Cooper



Steel's flexibility and offsite construction benefits are coming into their own as the UK's busiest rail interchange has to be kept fully operational while a large steel framed department store is built beside and over it.

It is all change at Birmingham New Street as a major redevelopment transforms what is universally recognised as a dark and unwelcoming station into a light filled modern facility fit for the 21st century.

The project is due to be fully completed in 2015 and includes a spacious concourse and retail area enclosed by a giant ETFE clad atrium

(see box), more accessible platforms served by new escalators and lifts, and a new station exterior.

The retail part of the scheme is important, as it will transform the station into a destination for rail passengers and for city centre shoppers.

Situated above the concourse, the retail zone is known as Grand Central and will be anchored by a four-storey 23,500m² John Lewis store. This steel framed structure was recently topped out and is one of the more advanced parts of the overall scheme.

Approximately half of the store's footprint sits on top of an existing concrete station structure and this necessitated a thorough review of the existing frame and foundations which then resulted in a more complex design than would ordinarily be expected.

The John Lewis store was a late addition to the scheme and much of

PROJECT TEAM

Project: Birmingham New Street Station redevelopment and Grand Central incorporating John Lewis Partnership department store

Main client: Network Rail

Architect: Haskolls

Main contractor: Mace

Structural engineer: Atkins

Steelwork contractor: Severfield-Watson Structures

Steel tonnage: 2,850t

needed to be built over the existing station. To achieve this, some of the existing heavy concrete frame needed to be demolished and replaced with a new lightweight steel frame in order not to overload the remaining foundation," explains Atkins project engineer Mike Stephens.

Information about the existing piled foundations revealed that a limited amount of additional extra load could be accommodated. This still meant the new frame had to be as light as possible to achieve the desired four-storeys. Weight was one of the main reasons why steel was chosen as the framing material.

In some locations the new steel structure surrounds the existing reinforced concrete beams. To ensure loads are transferred through and not carried by the existing structure, an online monitoring system has been installed to the 18 new columns that sit

the design work for the station had already been completed before its inclusion.

"The demolition of Stephenson Tower created some space for the construction of the new John Lewis building. However, a substantial part

Tall order: The Grand Central retail zone will be anchored by a four-storey 23,500m² John Lewis store



Weight saver: The floors are of a composite design comprising metal decking and the thinnest possible topping



A new beginning: Severfield-Watson has erected a further 2,000t of steelwork for the new station concourses and platform entrances

“Some of the existing heavy concrete frame needed to be demolished and replaced with a new lightweight steel frame in order not to overload”

Mike Stephens, Atkins

Severfield-Watson has erected the project’s steelwork and has installed stairs and taken on much of the concreting works, such as slipforming the cores and installing the floors. To further save weight, the floors are all of a composite design comprising metal decking and the thinnest possible topping.

“Much of the frame’s stability is derived from the cores and we had control of their construction and the installation of the cast-in plates for our connections, all which are bespoke,” says Swift.

Most of the steel frame has been erected around a regular grid pattern of 10.9m x 9.6m. Most of the steel sections are of a transportable size with the exception of two large plate girders that span the new southern entrance.

Known as the Spanish Steps, this will be one of the main entrances into the redeveloped station. The plate girders, which support four levels of retail frame above and create a large column free area, are 33m long and had to be brought to site in three pieces.

Working on a major construction project in the middle of the UK’s second largest city is in itself a tricky undertaking, this is compounded by keeping New Street fully operational throughout the scheme.

It is the busiest interchange in the UK, with a train leaving the station every 37 seconds and over 140,000 passengers using the station every day, all of which adds to the project’s complexity.

“It’s a live station environment operating for almost 24 hours each day, so we have limited windows of opportunity for large lifting operations and the movement of materials,” explains Mace associate director Jeremy Haldane. “The site is also very confined and surrounded by busy city streets and all steel deliveries and lifts have had to be fully coordinated, all of which has been done very successfully through meticulous planning.”

A NEW STATION FOR BIRMINGHAM

As well as the John Lewis store, structural steelwork is playing a significant role in other areas of this major project. Severfield-Watson has erected around 2,000t of steelwork to form the new station concourse and platform entrances.

Under a separate contract, structural steel has formed the new station

exterior, a faceted curving façade, which incorporates the John Lewis store, onto which stainless steel cladding is being installed.

Apart from the store the most prominent feature of the project will be the atrium of the Grand Central shopping mall that will be formed by a series of 30m long arched steel box section trusses.

weight in these areas,” explains Severfield-Watson project manager Steve Swift. “This has made the erection programme more complex and meant our steel team had to be educated about installing the monitoring system.”

The frame has a number of transfer structures, some of which limit the amount of load being transferred to the existing station structure. Above platform 12 a series of large plate girders has been installed within the store’s roof. Measuring up to 20m in length and weighing in excess of 15t each, they were all erected with temporary columns supporting the area directly above the station.

Once the building’s floors have been cast, the temporary columns will be removed and the floors above will hang from the plate girders, to ensure that in these areas the loads are carried by new piled foundations.

on the structure. This system consists of highly accurate level monitoring equipment, strain gauges and load cells.

Under the existing structure, steel columns have been installed to add support. A system of flat jacks has been fitted to these columns which allows settlement of the new foundations to

be jacked out and the forces above the and below the existing structure to remain in balance. The columns can also be monitored during the entire construction phase and the later fit-out programme, again ensuring the loads are not too high.

“This automated system allows us to check that we are minimising the

How to cost structural steelwork

Realistic cost estimating

For construction projects, cost is a key factor when making the decision on which framing material to select.

As Gardiner & Theobald (G&T) senior associate Rachel Oldham points out, crucial decisions on matters like frame material and configuration are made early in the design process, often before detailed design information has been fully established. It's therefore important to get the cost model right to avoid making the wrong choice.

"If the initial cost model and early costings are not fully considered, projects may proceed with a less cost efficient design, and it can be costly as well as difficult to change the choice of a key element like the frame at a later date," she says. "Alternative solutions need to be properly considered as well as the characteristics of the particular site and any project specific factors.

"This is particularly important when using standard cost ranges to avoid simply arbitrarily selecting a number, rather the rate applied should be tailored to the specific project being considered."

Understanding the key cost drivers properly is the crucial first step in the process. The building type and height

are the first factors to consider. For steel, the weight of the frame will vary significantly depending on the building type.

For example, an industrial building, or shed, could have a frame weight of 40kg/m² gross internal floor area (GIFA) whereas a city centre office building with typical long spans and carrying much higher loads, could be 90kg/m² GIFA, clearly affecting the cost per m² GIFA of the frame.

Furthermore, some building types have specialist requirements which also need considering. Hospitals and other healthcare buildings are among those with special acoustic or vibration requirements, which can be achieved by steel framed structures, but which will have an impact on the design and cost of any framing material.

Frame selection may also have implications on other elements of the building and it's important to factor them into the initial cost assessments. For example, different

"If the initial cost model and early costings are not fully considered, projects may proceed with a less cost efficient design"

Rachel Oldham, G&T

Site factor: Building costs are significantly higher in the City of London than in regional cities





COST RESOURCES

The different factors associated with accurate costing can change from project to project and the challenges faced will be covered in the forthcoming steel sector publication *Steel Construction: Cost*.

Gardiner & Theobald's (G&T) standard cost tables provide typical cost model pricing information for a number of building types.

Articles 1 and 2 in the Steel Insight series give comprehensive guidance on how to cost structural steelwork and the ongoing series of steel sector regular updates on cost are available from www.steelconstruction.info – the free to use, one-stop-shop for steel construction website where, along with a wealth of other steel construction material, the series provides quarterly updates on structural steelwork costs.

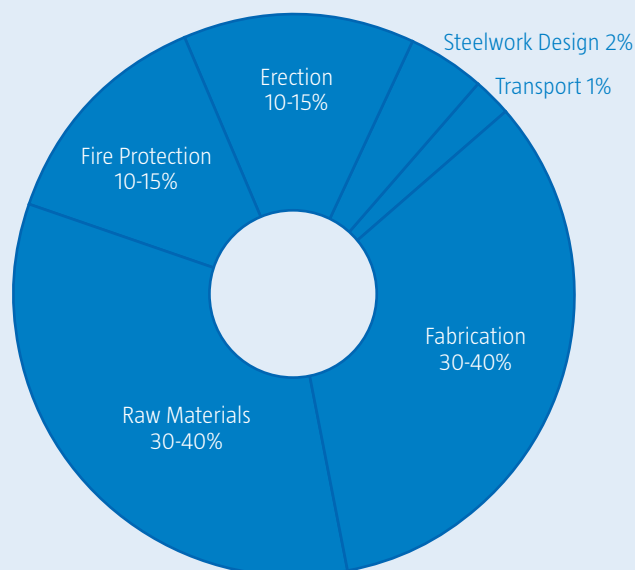
The Steel Insight series has grown since its inception, with nine issues now available. Written by Gardiner & Theobald, the series provides

frame materials will require different floor zone depths and that in turn will impact on the amount of cladding required and therefore building envelope costs for the same floor-to-ceiling height.

Similarly, the typical lighter weight of a steel framed superstructure means that foundations can be smaller or simpler and therefore lower cost. Looking at frame cost in isolation will not consider these associated effects but their impact on the whole building cost can be significant so they should not be overlooked.

Site location and constraints are also key factors. Prices will vary between different cities and regions, with building costs significantly higher in the City of London than in regional cities. Site specific factors that can impact on costs include restrictions on working hours, logistics and deliveries and any factors that could affect the construction programme should also be considered when producing early estimates.

Structural steelwork has maintained a dominant market share of around 70% of the multi storey



Breakdown: Typical cost components of a steel frame

guidance across a range of cost related topics in a number of market sectors for use by anyone in the supply chain with an interest in the cost of structural steelwork.

Issues have so far focused on

crucial topics including multi-storey, education, industrial and healthcare buildings.

Each issue includes a table of current indicative costs for structural steelwork and associated products.

Site specific factors that can impact on costs include restrictions on working hours, logistics and deliveries

building market for the last 14 years. It continues to provide an efficient and cost effective solution in this and many other sectors. Given its market share, it's important to understand how the cost of a steel frame is derived.

For structural steelwork, best value in design comes from balancing material and fabrications costs; opting to use the lightest columns and beams might mean that additional stiffeners have to be provided, which adds to cost and weight. Increasing beam or column weights might mean a relatively small increase in material cost but give greater savings in fabrication cost.

For steelwork, costs are built up from individual components which are columns, beams, special sections, connections, fire protection

and bracing. There are many cost factors that only become quantifiable during detailed design, such as the weight of fittings and fire protection.

It is wrong to assume that the frame with the minimum tonnage will have the lowest cost, since the steelwork contractor's cost is driven by the time and process of component fabrication as well as by the tonnage. Standard, repetitive designs will be cheaper than those involving non-standard or complex sections like built-up members, very deep fabricated plate girders or long trusses.

Erection of a frame is also a key component in determining the cost, as it typically accounts for around 10% to 15% of the total frame cost. Any features of the site or the design that might impact on erection need to be considered and factored into estimates. The decision on a frame, as with any building element, won't be based on cost alone but cost will be a key consideration.

■ **Extensive guidance and up-to-date information on costs and other topics are freely available at www.steelconstruction.info**

Keeping Ireland green

Steel powered energy design

By Martin Cooper



Long span economic steel framed structures will help to provide Wexford, Ireland, with a more sustainable energy supply. Steel's flexibility also came to the fore as the design developed even after erection started.

A replacement 460MW combined cycle gas turbine (CCGT) power station, under construction at Great Island, County Wexford will provide electricity to approximately 220,000 houses in south eastern Ireland.

The power station site is located adjacent to the confluence of the River

Suir and River Barrow near Waterford.

Client SSE says that by replacing the site's existing 240MW fuel oil unit, this modern natural gas fired power station will significantly reduce the locality's carbon emissions.

CCGT power generation is said to be the most energy efficient and cleanest method of fossil fuel power generation. It involves burning natural gas, which turns a gas turbine with the heat generated used to drive a steam turbine.

Structural steelwork is playing a leading role in the construction of the project's turbine and electrical buildings, as they need to be large open column free spaces to accommodate large pieces of generating equipment.

Both of these two main structures are founded on reinforced shallow pad

PROJECT TEAM

Project: Wexford CCGT power station

Client: SSE

Architect: Initec

Main contractor: Dragados-Cobra-Initec (Joint Venture)

Structural engineer: Initec Energia

Steelwork contractor: Kiernan Structural Steel

foundations, while deep piled foundations have been used for other structures due to the poor ground conditions.

"The choice of steel as the main framing material is based on both economy and versatility," explains Initec Energia chief designer for civil

engineering Santiago Paje.

"Steel has the ability to be quickly and economically erected with large spans which can absorb big loads. Steel frames are also versatile enough to be continually redesigned, even while the erection process is on going."

This is precisely what happened on this project as the steelwork needed to be altered and redesigned during the erection programme. "The turbine building is a 'live' frame as the majority of the design work was done at the end of 2012, but we were able to modify and add to it while it was being constructed," adds Paje.

The inherent flexibility of bolted structural steelwork has been key to the design of the turbine building. Paje says this will allow certain bays of the steelwork frame to be removed if large pieces of equipment need to be

Key provider: Once completed, the power station at Great Island, County Wexford, will provide electricity to 220,000 homes



Powerful presence: The 25m high turbine building is the largest building on the site



Delivery date: The power plant is due to be commissioned in 2014

removed and replaced.

Standing 25m high the turbine building is the largest building on the site and has been formed with a series of fabricated columns.

"Each of the columns weighs in excess of 9t as they also support crane beams running the length of the structure," explains John Kiernan of Kiernan Structural Steel.

"Consequently these plate columns have large 40mm flanges and 60mm thick baseplates that have full penetration butt welds."

To accept the crane beams, the columns have welded stubs at a height of 22m. The crane beams measure 1,400mm deep by 400mm wide and were brought to site in 13, 5m lengths, which corresponds with the width of the building's bays.

The columns also support 29m long

"Steel has the ability to be quickly and economically erected with large spans which can absorb big loads. Steel frames are also versatile enough to be continually redesigned, even while the erection process is on going"

Santiago Paje, Initec Energia

roof trusses, which in turn create the large open column free space needed for the turbine hall. The 3m deep trusses were brought to site in two pieces – one 10m long section and one 20m long section – bolted together on

the ground before being lifted into place as a complete unit.

The turbine building has been designed as a portalised frame with the addition of bracing in some bays. Fixed supports were required in both directions as wind and crane loads are expected to be very substantial.

Inside the turbine building there is an internal mezzanine level running alongside three elevations while a lean-to storage structure is attached to two façades of the building.

The steel erection process saw Kiernan Structural Steel use a combination of 200t and 80t capacity mobile cranes. The programme lasted nearly one year and the steel erectors had to be versatile with their programme schedule.

"When we erected the turbine hall we had to leave out one gable end

section so the turbines could be installed," says Kiernan. "Only after this large scale mechanical equipment installation operation had been completed could we finish erecting the final parts of the turbine hall's frame."

Prior to in-filling the gable end of the turbine hall, and while the turbines were being installed, Kiernan erected the electrical building and various other smaller buildings and pipe racks located around the site.

"It's been a very challenging project," says Kiernan. "We've had to schedule our delivery and erection programme, including working night shifts, in order to accommodate a number of other trades and professions. Access and space around the site was very confined and challenging."

The Great Island power plant is due to be commissioned during late 2014.

Protection from fire

Fire safety guide
By John Dowling

Tata Steel and the British Constructional Steelwork Association have published a new guide offering advice for fire protecting steel framed structures.

Determining the fire protection requirements for structural steelwork in a building is a straightforward procedure and is consistent across most types of building. This process has now been consolidated into one comprehensive guide, produced by Tata Steel and the British Constructional Steelwork Association (BCSA) and entitled *Steel Construction: Fire Protection*. It can be downloaded free of charge from the steel construction encyclopaedia at www.steelconstruction.info/steel_construction_news

The guide is aimed at construction professionals rather than fire engineering specialists. "It walks you through the entire process and will be relevant to designers and specifiers working on the majority of buildings," says BCSA manager of fire and sustainability John Dowling.

Within the guide three distinct stages for determining the necessary fire protection for structural steelwork are outlined:

- Determine the fire resistance period through the "Approved Documents (Part B for England and Wales,

Technical Handbook 2 for Scotland or Technical Booklet E for Northern Ireland)", BS 9999 or specific sector requirements. Building Regulation powers were devolved to Wales on 31 December 2011. The Approved Documents current on 31 December 2011 for England and Wales will continue to apply to Wales. As guidance is reviewed and changes made Approved Documents for Wales will be published. The Welsh Government has set out its review schedule to 2014 but Approved Document B has not been included

- Decide on the type of fire protection required and set the specification for the applicator

- Provide the required fire resistance period

The fire resistance period for a building is defined in terms of minutes.

The performance of fire resistance products, materials or systems which ensure that a building continues to resist the effects of fire for that period is proved in a standard fire test. That test is extremely onerous, more severe in fact than any fire which is ever likely to happen in practice.

Therefore, one should not think that a building which has, say, 60 minutes fire resistance, the most common period in England & Wales, will fail in a fire of that duration. In practice, it is very unlikely to do so.

Unprotected structural steel typically has between 15 and 30 minutes



Smart cover: Boards are supplied in two formats: heavy boards are usually used where aesthetics are important and lightweight boards are available for other situations

Image: Promat

inherent fire resistance. To prolong this fire life, insulating materials are usually applied. The systems most commonly used in the UK are thin film intumescent coatings, board protection, sprays, partial protection and, for structural hollow sections,

concrete filling with or without reinforcement. The first two are by far the most popular.

Thin film intumescent coatings are paint-like materials which are inert at low temperatures but, at temperatures of between 200°C and 250°C,



Fully protected: Unprotected structural steel typically has between 15 and 30 minutes inherent fire resistance.

CARDINGTON FIRE TESTS

Fires such as the one at Broadgate Phase 8, London in 1990 and at Churchill Plaza, Basingstoke in 1991 were the catalyst for a series of full-scale fire tests that transformed the understanding of how structural steelwork behaves in fire.

The Broadgate composite steel deck structure had some partially applied fire protection and was subject to a four hour fire. According to the understanding of structural behaviour available at that time, which was based almost exclusively on tests of isolated elements of structure, the building should have collapsed.

The building not only survived but it was fully repaired after the fire, demonstrating that buildings with a steel composite frame and floor system had much greater fire resistance than expected.

The fire acted as a catalyst for further research to try to find out where this additional strength had come from. As part of that, a series of fire tests was carried out on an eight-storey steel framed building with composite steel deck floors at the Building Research Establishment's (BRE) Cardington facility between 1994 and 2003.

It was found that a composite steel floor acts as a system providing

enhanced fire resistance not apparent by tests on single isolated elements of the construction. The fire tests demonstrated that where secondary beams are unprotected, but perimeter beams and columns are protected, the slab develops tensile membrane action. This phenomenon allows the floor to withstand much higher temperatures in fire. As the unprotected beams lose their load carrying capacity, the composite slab utilises its full bending capacity in spanning between the primary beams. With increasing displacement, the slab then acts as a tensile membrane carrying the loads in the reinforcement which then become the critical element of the floor construction. Using the conservative assumption of simply supported edges, the supports will not anchor these tensile forces and a compressive ring will form around the edges of the slab.

Following the Cardington tests, a number of simple structural models were developed which combine the residual strength of steel composite beams with the strength of the slab in fire.

The most widely used of these is TSlab, which can be downloaded from www.tatasteelconstruction.com. The tests also formed the basis of the detailed finite element models used in advanced fire engineering.

“The guide walks you through the entire process and will appeal to the majority of people working on the majority of building”

John Dowling, BCSA

substantial cost differences between the two, heavy board should only be used where needed.”

All fire protection systems are specified in terms of thickness required to achieve the limiting temperature for a particular section factor. Dowling however counsels against architects and engineers becoming involved in specification at that level.

“Usually the responsibility of the architect/engineer stops at the point where the specification is set,” he says.

“Determining the thickness of fire protection required should generally be left to the applicator.

“The engineer, however, should be aware that small sections, in particular when the building has a high fire resistance requirement, may require very thick fire protection and there may be scope for increasing the size of the section to reduce the coating thickness and therefore reduce overall costs.”

The guide also outlines how specific building types have requirements for additional fire protection measures, such as sprinklers.

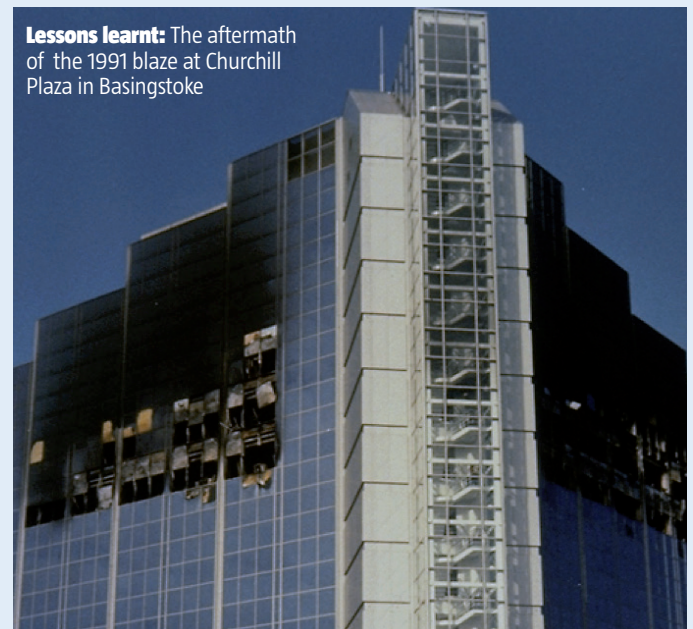
Single storey buildings, car parks, hospitals and shopping centres are also highlighted in the guide as structures requiring special attention.

they swell to provide an insulating foam typically about 50 times the thickness of the original coating.

They are predominantly used in buildings where the fire resistance requirements are up to 90 minutes. In recent years, a number of products have been developed that can provide 120 minutes fire resistance.

Intumescent coatings can be applied either on site or offsite. They are widely used to achieve attractive surface finishes although increasingly they are used where appearance is not important.

“Boards come in two generic forms,” says Dowling. “Heavy boards which allow the application of plaster and render are usually used where aesthetics are important but lightweight alternatives are normally used elsewhere. As there are



Lessons learnt: The aftermath of the 1991 blaze at Churchill Plaza in Basingstoke

A new green landmark for the City

Sustainability

By Martin Cooper

The reuse of existing piles resulted in a 16-storey London commercial development replacing an old eight-storey structure.

A prime objective on any commercial development is to maximise the available office space while creating a sustainable and cost effective building.

The reuse of existing piles on a project at 6 Bevis Marks in the City of London has not only allowed a 16-storey structure to replace an old eight-storey building, doubling the lettable space, but cost, programme and CO₂ savings have also been achieved.

"A steel framed structure with precast slabs was demolished and replaced with a 16-storey steel structure incorporating composite deck," says Julian Traxler, Waterman Structures director. "This lighter form of construction allowed us to reuse the existing foundations and achieve the net lettable areas the client wanted."

A total of 67 piles were reused, while the existing retaining walls were

also incorporated into the new building, all of which contributed to a carbon saving of approximately 1,000t.

Reusing 52% of the original structural mass contributed significantly to the shortening of the construction programme and the aim of achieving a BREEAM 'Excellent' rating.

Keeping the weight of the structure as low as possible has been adhered to throughout the steel design. For efficiency the main beams are typically 600mm deep fabricated cellular sections, with varying sized circular and rectangular holes for service distribution.

A total of 37 new larger diameter piles and 66 mini piles were installed to accommodate the different loading patterns of the new structure, while the two lift cores for the new larger building had to go in similar locations as those of the former structure.

With floor plates up to 53m long, the span between columns has been dictated by the position of the cores and client's requirement for flexible column free spaces. The beams generally span up to 13.5m and the clear open plan spaces are exemplified by the fact that there are only three

Recycling: The reuse of existing piles at 6 Bevis Marks has allowed a 16-storey structure to replace an old eight-storey building



PROJECT TEAM

Project: 6 Bevis Marks, London

Main client: Bevis Marks Development
City Office Real Estate

Development manager: City Office Real Estate

Architect: Fletcher Priest Architects

Main contractor: Skanska

Structural engineer: Waterman Structures

Steelwork contractor for main

frame: William Hare

Steelwork contractor for sky

garden: Tubecon

Steel tonnage: 2,200t

internal CHS columns on each floor.

The perimeter columns vary from 300mm x 300mm CHS sections to 550mm x 350mm RHS sections.

"The flanges are recessed to ensure that there is no projection beyond the primary profile," explains Chris Field, senior engineer at Skanska.

"This limits spatial constraints and helps create the desired open plan offices by giving clear lines without intrusive columns."

Confined site

The new L-shaped building is located adjacent to the 41-storey Gherkin at 30 St Mary Axe and on a street with predominantly eight-storey structures.

In order to fit comfortably into its



“This lighter form of construction allowed us to reuse the existing foundations”

Julian Traxler,
Waterman Structures

open on Bevis Marks at all times,” says Skanska project director Andy Hankin. “This meant our operations were severely restricted and so we had to come up with a method for utilising large cranes without closing the road.”

Skanska designed two 7.5m high steel trestles that were erected straddling the site and the road. A large 500t capacity mobile crane was then able to position two of its outriggers on top of the trestles, with the other two located within the permissible zone of the partially closed road.

“The trestles, which were easily dismantled and re-erected, allowed us to use a crane to help install piling equipment, a tower crane and the large steel transfer beams,” explains Field.

The mobile crane’s position was fixed, and its reach was limited by the nearby cores. This presented a problem when it came to lifting three large transfer beams.

These beams, which span a ground floor loading bay and the structure’s reception represent the largest steel elements of the entire project and required a lot of planning to install.

The largest beam, installed above the loading bay, measures 15m long by 1,500mm deep with 1,000mm x 100mm flanges and twin 50mm webs. Weighing 38t the centre of gravity of this beam had to be shifted while it was lifted in order to avoid the core.

Ten tonnes of kentledge was bolted to the end of the beam, moving the centre of gravity, by 450mm and allowing the beam to be successfully installed.

Three slightly smaller transfer beams for the roof of the entrance area, each 9m long and weighing 25t each, were lifted into place in a similar way. All the transfer beams were successfully erected during one day, meaning partial road closure was kept to minimum.

SKY GARDEN

The 6 Bevis Marks development is topped by an ETFE covered roof garden, which will be a dramatic addition to the local skyline.

Formed by a framework of CHS steel members the garden is open to the elements on two sides. The tubular steelwork wraps around two elevations of the structure, forming a curved profile and attaches to the main frame at level 11 on one side and level 15 on the other.

A total of eight 355mm diameter CHS column ‘trees’ support the steel frame at roof level. To form the framework up to seven rafters – typically 193mm diameter CHS members – are connected to each column.

“Each column tree is bespoke and the roof framework was trial erected at Tubecon’s fabrication yard, prior to being delivered to site, to make sure each piece fitted correctly,” explains Chris Field, Skanska senior engineer.



Picture perfect: The tubular steelwork wraps around two elevations of the structure to create the curved profile

surroundings, 6 Bevis Marks steps down from 16-storeys to 11-storeys towards the lower height buildings. Stepped roof terraces at levels 13 and 15 add some extra architectural interest, while both of these features are overlooked by the much larger rooftop sky garden (see box).

Constructing a new commercial development within the City of London always presents a number of challenges.

When Skanska started on site in January 2012, the Olympic Games were on the horizon and this meant road closures in London, needed for the delivery of large items such as cranes, were restricted.

“We had to keep a 3m wide lane