STEEL INSIGHT #11

COST UPDATE AND CASE STUDIES

STEEL INSIGHT

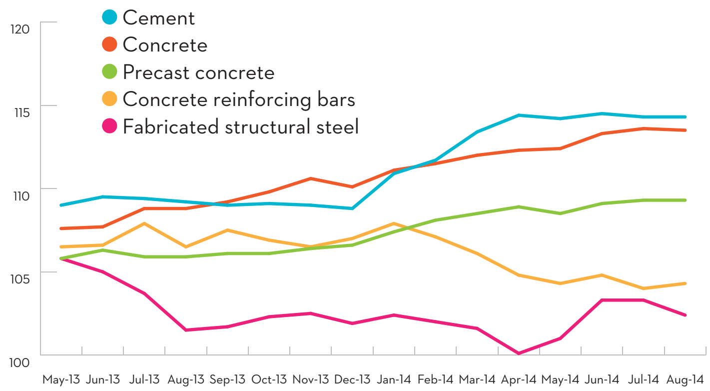
The latest article in the series provides an update from Gardiner & Theobald on construction costs, while overleaf we have two case studies of steel structures used on high-profile London projects

01
MATERIAL PRICES UPDATE

The September 2014 Business Innovation and Skills Construction Cost indices (see Figure 1) shows that while cement and precast concrete material prices were relatively stable over the second half of 2013, significant price rises have occurred across 2014, with cement prices 5% higher in August 2014 than in December 2013 and precast concrete prices 2.5% higher over the same period.

Concrete prices have continued to increase to a level 3% higher in August 2014 than in December 2013, 5.5% higher than in May 2013. Concrete reinforcing bar prices fluctuated for much of 2013 but have experienced a reduction of 2.5% across the first three quarters of 2014. Fabricated structural steel has also fluctuated, particularly over Q2 2014, but as at August 2014 is back to the same level as in December 2013.

Figure 1: Department for Business, Innovation and Skills Construction Cost indices (September 2014)



02
TENDER PRICES UPDATE

The economic recovery evident towards the end of 2013 in London and the South-east gained pace over Q2 and Q3 of 2014, fuelled largely by growth in the residential market caused by increased local demand and continued overseas investment demand in the UK.

This increased demand has also been witnessed in the commercial sector and has resulted in further rises to tendered construction costs across the last quarter.

With increased demand across the construction sector as a whole, tender price increases have again been recorded across Q2 and Q3 2014 for structural steel, concrete reinforcement and concrete.

Price increases by manufacturers have been seen for stainless steel flat product by £30/tonne in April 2014 and for structural steel sections by £20/tonne in May 2014. With CE marking for structural steelwork becoming mandatory on 1 July 2014, the number of companies able to supply the UK market has also decreased, adding to price pressure and affecting lead times, with structural steel lead times from order to delivery now regularly quoted at four months.

BCSA surveys suggest structural steelwork prices will increase steadily in comparison with other construction materials. While demand continues to increase and prospects for 2015 improve, BCSA members indicate they are confident the increased demand can be met.

For the remainder of 2014 and into 2015, continued increased demand for construction, combined with supply constraints and increased wage expectations, are all expected to result in further tender price rises.

This has been reflected in Gardiner & Theobald's Q4 2014 Tender Price Annual Percentage Change forecast, where average tender rates across the UK are forecast to have increased by 4% across 2014 (up from the previous forecast of 3.5%), falling slightly to 3.5% in 2015 and 2016 before rising again to 4% in 2017.

The impact of the increased demand is not being felt evenly across the UK, with spikes in tender prices recorded in areas such as London, Cambridge and the South-east on large commercial and residential schemes, as price and capacity pressures take effect.

The strength of the recovery and increased demand experienced across 2014 in London and the South-east in particular is reflected by a 6% forecast tender price annual percentage change for 2014 for London and 5% for the South East (up from the previous Q2 2014 forecasts of 4%), with both forecast to experience further increases of 4.5% for 2015, 4% for 2016 and 3.5% for 2017.

03
COST MODEL UPDATE

Steel Insight 3 analysed two typical commercial buildings to provide cost and programme guidance when considering the available options during the design and selection of a structural frame.

Building 1 is a typical out-of-town speculative three-storey business park office with a gross internal floor area of 3,200m^2 and rectangular open plan floor space. Cost models were produced for four frame types developed by Peter Brett Associates to reflect the typical available framing options; steel composite, steel and precast concrete slab, reinforced concrete flat slab and post-tensioned concrete flat slab.

Building 2 is an L-shaped eight-storey speculative city centre office building with a gross internal floor area of 16,500m^2 and a 7.5m x 15m grid. Cost models were developed for a steel cellular composite frame and post-tensioned concrete band beam and slab, being two frame and upper floor types that could economically achieve the required span and building form.

With increases experienced for steel and concrete tender returns across Q2 and Q3 2014, specific increases have been applied to the relevant frame rates for concrete reinforcing bars (7%), concrete (8%) and structural steel (5%) to reflect these increases.

As noted previously, the G&T current forecast of tender price inflation for London in 2014 is now 6%, and therefore all general rates have been increased by a total of 4.5% to reflect three quarters of this increase.

The updated cost models tables for both Building 1 and Building 2 are set out, to the right.

As Figure 2 shows, the steel composite beam and slab option remains the most competitive for Building 1, with both the lowest frame and upper floors cost and lowest total building cost.

For Building 2, as shown in Figure 3, 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, with lower substructure costs, a lower roof cost and a lower floor to floor height resulting in a lower external envelope cost.

It should be noted that the cost adjustments are based upon the particular project being attractive to the market and the selection of an appropriate procurement route.

Across 2014 selective tendering by contractors has become a market feature, driven by factors including pressure on resourcing and hardening attitudes to risk transfer, complexity and the number of bidders, and this is limiting the number of returns being procured for many projects.

In London and the South-east, the clear market preference is now for two-stage tendering and while single-stage procurement is still a viable option in the regions, as resources become committed and contractors become more selective about future work, this is not likely to remain prevalent. As the updated BCIS location factors demonstrate, the gap between City of London and the UK mean of 100 has narrowed as the economic recovery picks up pace across the UK (see Figure 5).

In overheated areas of the market it is important that a careful and proactive procurement strategy is developed, with the critical path clearly identified to ensure that choice and options are maintained for as long as possible. Where the procurement strategy is not well thought through and doesn't respond to the changed market conditions, the cost impact on individual tender returns can be dramatic.

Looking forward into 2015 and beyond, the increases in demand for construction across the UK, currently forecast at a cumulative increase of 22% over the next five years, mean that consideration should be given to the inclusion of substantial inflation allowances for estimates for projects that are expected to be tendered in the remainder of 2014 and beyond.

The increases to tender prices seen across Q2 and Q3 2014 have also been reflected in the structural steel frame cost table (Figure 4).

To use the table a) identify which frame type most closely relates to the proposed project b) select and add the preferred floor type c) add fire protection if required.

Before using such standard ranges it is important to confirm the anticipated frame weight and variables such as the floor-to-floor heights to determine whether they are above or below the average and to adjust the rate used accordingly.

Similarly, all of the other key cost drivers of complexity, site conditions, location, function, logistics, programme and procurement strategy should be considered in turn. »

Figure 2: Building 1 Cost Model (key costs per m² GIFA, City of London location)

	Steel composite	Steel and precast concrete slabs	Reinforced concrete flat slab	Post-tensioned concrete flat slab
Substructure	£56	£60	£72	£67
Frame and upper floors	£150	£164	£157	£162
Total building	**£1,613**	**£1,643**	**£1,716**	**£1,696**

Figure 3: Building 2 Cost Model (key costs per m² GIFA, City of London location)

	Steel cellular composite	Post-tensioned concrete band beam and slab
Substructure	£60	£64
Frame and upper floors	£208	£228
Total building	**£1,958**	**£2,026**

Figure 4: Indicative cost ranges based on GIFA (Q3 2014)

TYPE	GIFA Rate (£) BCIS Index 100	GIFA Rate (£) City of London
Frame - low rise, short spans, repetitive grid / sections, easy access (Building 1)	80 - 108/m²	95 - 130/m²
Frame - high rise, long spans, easy access, repetitive grid (Building 2)	134 - 160/m²	149 - 180/m²
Frame - high rise, long spans, complex access, irregular grid, complex elements	154 - 180/m²	175 - 200/m²
Floor - metal decking and lightweight concrete topping	43 - 61/m²	50 - 70/m²
Floor – precast concrete composite floor and topping	48 - 65/m²	55 - 75/m²
Fire protection (60 min resistance)	7 – 16/m²	9 - 18/m²
Portal frames – low eaves (6-8m)	48 - 70/m²	58 - 80/m²
Portal frames – high eaves (10-13m)	58 - 80/m²	70 - 96/m²

Figure 5: BCIS Location factors, as 3 October 2014

Location	BCIS Index	Location	BCIS Index
City of London	112	Leeds	91
Nottingham	94	Newcastle	92
Birmingham	96	Glasgow	99
Manchester	92	Belfast	63
Liverpool	87	Cardiff	98

This and the previous Steel Insight articles produced by Rachel Oldham (senior associate) and Alastair Wolstenholme (partner) of Gardiner & Theobald are available at www.steelconstruction.info

6 PANCRAS SQUARE

Part of the transformation of London's King 's Cross, 6 Pancras Square is the new UK headquarters for BNP Paribas. A steel frame has allowed long, clear office spans and rapid construction

King's Cross, once London's ugly duckling, is rapidly being transformed into a beautiful swan. The former down-at-heel industrial zone north of King's Cross Station now boasts public squares, canal-side eateries and vibrant street life alongside building developments that are homes to Central Saint Martins art college and University of the Arts London, with Google also set to move in. The regeneration scheme, complete with brand new postcode, London N1C, will include 50 buildings, 2,000 homes, 20 streets and 10 public squares spread over 67 acres.

Pancras Square is the focal point for a new office community south of Regent's Canal. Flanked on one side by King's Cross station and on the other by St Pancras International, the scheme consists of seven buildings situated around a central public square. A new underground entrance is also here, so it's no surprise to find big name companies moving in and 6 Pancras Square, due for completion in November, will be the UK headquarters for Paris-based BNP Paribas.

An 11-storey steel-framed structure, it will create 39,500m^2 of office space, with some ground floor retail, based around a large central atrium. "BNP had already appointed architect Jean-Michel Willmotte when we came on board and they had an idea of what the building would look like, with the atrium and double cores," explains Steve Toon, design director at structural engineer AKT II. "We very much drove a steel frame solution. The client wanted a City spec office building with long clear spans so, while we did examine options, this was always going to be a steel frame."

One of the key constraints on the project was the planning restrictions on overall building height, so the depth of the steel beams needed to be optimised to maximise office space. "The structural zones are critical and we worked closely with executive architect Adamson on the zones, M&E co-ordination and how the building goes together. It's a relationship that worked incredibly well," says Toon.

Erected by Severfield-Watson Structures, now Severfield (UK) Ltd, the building is formed with cellular steel. "We've used fabricated section cellular beams and all of the beams are the same size and depth. This gives a completely consistent bottom of beam soffit level, which works as perfectly as possible for integration of building services through the beams, and in the ceiling and lighting zones below the beams," explains Toon. AKT II carried out a detailed analysis of the optimum beam depth versus beam weight and by fine tuning managed to add an extra floor to the building.

"The challenge from the structural point of view is that this is very much a lightweight and cost effective structure," says Toon. "So you are always minded about the dynamic effect and a detailed dynamic response analysis was carried out."

The steel frame wraps around a central atrium which is glazed at rooftop level. At either end of the large void there is a slipformed core, each one containing two staircases, a goods lift and three passenger lifts. There are two scenic lifts within the atrium at either end. Some of the more bespoke elements of the steelwork design are on the atrium roof and the scenic lifts. "The structural steelwork supporting the scenic lift is very finely tuned," says Toon. "I'd advise getting the lift supplier on board as early as possible, although that's not always possible because of the way that buildings are procured."

AKT II also designed the interface where the steel comes down and hits ground level; the team transferred from a steel to a concrete structure at ground floor level. "We developed a prefabricated shoe to sit on top of the in-situ columns, partly connected to the concrete and partly to the steel. "The transition from steel to concrete actually occurs at two different ground floor levels within the building, [a lower] one facing Pancras Road and [a higher] one on Pancras Square," he adds."

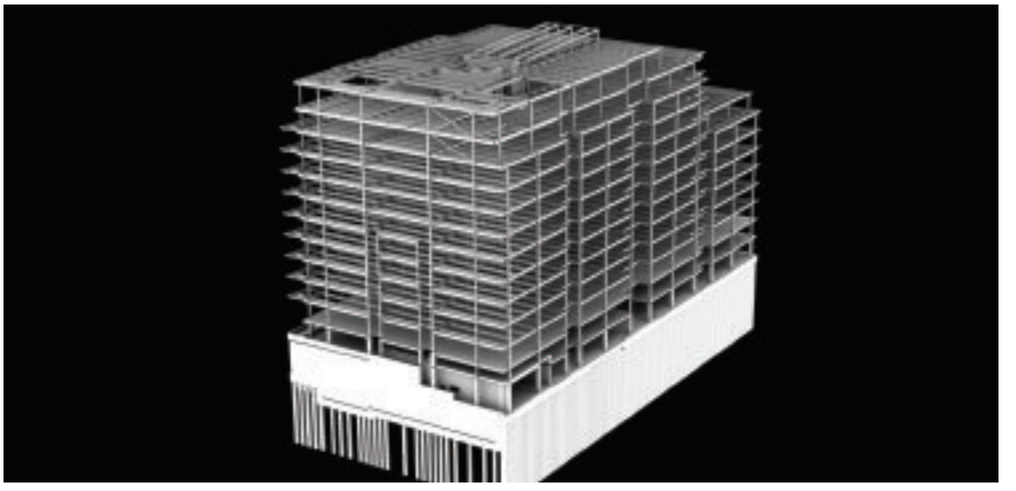
The structure proved quick to build. "The fabrication went well. It is very quick to install," says Phil Willmott, major projects director at contractor Vinci Construction. "We started in August 2013 and were finished by Christmas. It was very good for the programme sequence."

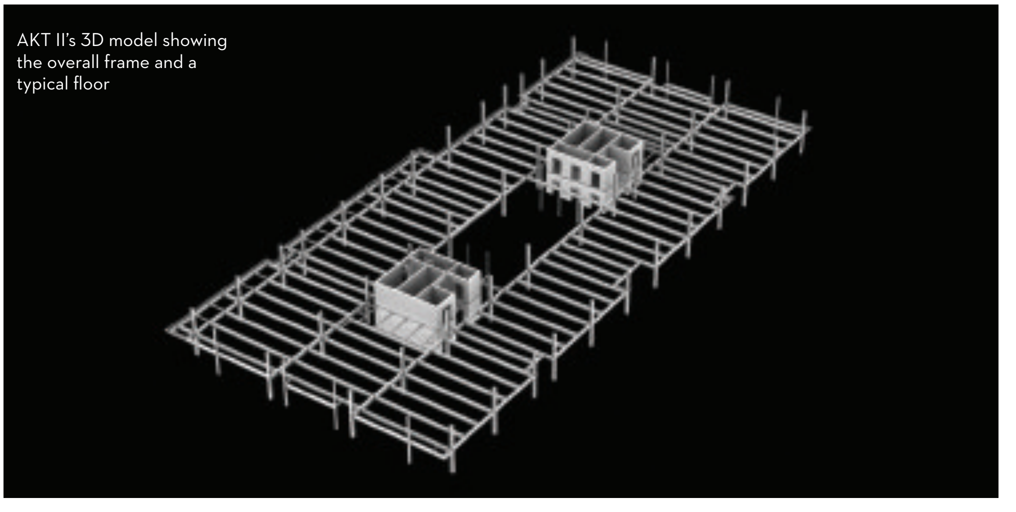
Vinci installed composite slabs with cast-in fixings for the cladding. "We spent a great deal of time and attention making sure that the steel frame was within the tolerances required to allow the cladding to go on without any hiccups. There were no issues with the cladding clashing with the steel in setting out or line and level," says Willmott.

M&E contractor SES and Severfield (UK) shared the project's structural model early in the process and used BIM to ensure all of the cellular beams arrived on-site with their openings in the correct position as well as the right shape and size.

With five buildings on the Pancras Square site all going up at the same time, close co-ordination with other contactors was essential, particularly in terms of tower cranes. A podium deck that has since been landscaped was used for deliveries across the development and there is now a shared basement.

BNP will take floors up to level 5 in November as well as Level 11, and Google is taking levels 5 to 10 while plans for its Kings Cross HQ progess. Pancras Square also has an office and leisure centre for Camden council, and two more steel-framed office blocks are planned to start later this year. N1C is taking shape. »





AKT II's 3D model showing the overall frame and a typical floor

THE CLIENT WANTED A CITY SPEC OFFICE BUILDING WITH LONG CLEAR SPANS SO, WHILE WE DID EXAMINE OPTIONS, THIS WAS ALWAYS GOING TO BE A STEEL FRAME

STEVE TOON, AKT II

PROJECT TEAM

CLIENT BNP Paribas Real Property Development UK
MAIN CONTRACTOR Vinci Construction
ARCHITECT Jean-Michel Willmotte
EXECUTIVE ARCHITECT Adamson
STEELWORK CONTRACTOR Severfield (UK) Ltd
STRUCTURAL ENGINEER AKT II

20 FENCHURCH STREET

20 Fenchurch Street is the latest arrival on London's skyline. How did the project team overcome the challenges raised by its unique curving structure?

London's skyline is continuously evolving. From BT Tower and Centrepoint in central London, to the Gherkin and Tower 42 in the City, The Shard south of the Thames and out east to One Canada Square, nothing stays the same for long. The new kid on the block is 20 Fenchurch Street from joint developers Land Securities and Canary Wharf Group, dubbed the Walkie Talkie in recognition of its unique curving shape.

"The brief from Land Securities and Canary Wharf was to create a unique building, maximise the tenant space and offer the best views and the best services that would be required by a tenant," explains Marcos Blanes, architect at Rafael Viñoly Architects. The building is certainly unique. From a relatively narrow base the building gradually flares outwards providing larger floor plates on the upper levels. Topping off the structure is a fully enclosed sky garden that will include dining options as well as 360 degree views over the capital.

"One of the main features of this building is the spectacular sky garden and the shape and form of the building," says Simon Bourne, project manager at Canary Wharf Contractors. "You've got this concave facade on the north and south elevations and a convex shape on the east and west elevations. The building swells as you get up to the top."

Its striking curves required the project team to come up with a number of innovative solutions. "We came up with a clever way of constructing the perimeter steelwork columns, whereby we faceted each column at every other floor level, so each

AT THE UPPER LEVELS, BECAUSE WE WERE LIMITED BY THE LENGTH OF THE SPANS, WE CAN CANTILEVER WITH THE STEEL TO ACHIEVE THE DESIRED CURVE

MARCOS BLANES, RAFAEL VIÑOLY ARCHITECTS

two-floor increment we changed the direction of the steelwork," explains Bourne. "We had a spigot detail and we dropped the column onto that spigot, and repeated that as we went up the building."

Steelwork contractor was William Hare. "The unusual geometry of the building envelope gave us some real obstacles to overcome," says project engineer Dan Fenn. "The fact that none of the columns are vertical meant that we had to find a way to connect them and introduce the different faceting angles into each of the joints."

Steel was the natural choice for this building. "Long floor spans are required for an office building," says Paul Walters, project director at structural engineer CH2M Hill. "The spans we've got here go from 9m up to 13m. Steel is strong for its weight so that means that we can have long spans, designed efficiently, of minimum depth to keep the floor-to-ceiling height that we want."

The steel also proved instrumental in achieving Viñoly's design intent. "The benefits of the use of steel were many in this building," says Blanes. "One of the main ones was the cantilever that we achieved on certain floors. At the upper levels, because we were limited by the length of the spans, we can cantilever with the steel to achieve the desired curve." The building's internal spans vary from 11m up to 21m, but you can only achieve a constant structural depth on spans up to 18m. The solution was to install the columns up to level 22 at an outwards incline matching the facade. Beyond that, the north and south elevation columns change direction and pull away from the facade. You then have a 3m cantilevering effect combined with an 18m internal span, which on the topmost office level gives the desired 21m span.

"Another advantage of steel is the size of the columns," says Blanes. "As architects, we always try and reduce the amount and size of the columns within the spaces – steel has allowed us to do that in most of the areas. Steel also allowed us to get all the building services within the depth of the beams and not below the beams, allowing us to maximise the number of floors within the building."

Construction has been rapid. "We had to supply 8,000 tonnes of steel to site for the frame, in around 4,500 sections, and we had to be able to erect the 37 storeys in a 36-week period," says Fenn. "We welded up frames to try and minimise the number of lifts on site and we did a lot of BIM modelling with the design team and other contractors. We used 4D programming and sequencing analysis to understand how the programme would fall out on site and look at any potential changes."

Undoubtedly, one of the key features of the building is the sky garden. "The roof is spectacular," says Canary Wharf Contractor's Bourne. "To be able to have dinner, 175m up in the air, with 360 degree views over London, is what makes this building so special." For the sky garden, steelwork played an important role. "Really, it's the only material we could use to achieve clear spans over 50m and yet create the light and airy feel that the architect wanted," says Walters.

The building has achieved a BREEAM "Excellent" standard. "About 93% of steelwork is recycled and there is very little wastage – and any wastage that there is can also be recycled," says Walters. "Combine that with the fact that it's got a high strength compared to its weight, and it means that there is quite a low embodied carbon content in the construction of the frame of the building."

The team deserves credit for an efficient and cost-effective design for a building that, on first glance, didn't look like it would be easy to deliver.

PROJECT TEAM

DEVELOPERS Land Securities, Canary Wharf Group
ARCHITECT Rafael Viñoly Architects
STEELWORK CONTRACTOR William Hare
STRUCTURAL ENGINEER CH2M Hill
CONSTRUCTION MANAGER Canary Wharf Contractors (subsidiary of Canary Wharf Group)