Steel Insight 3 “Cost Comparison study” (April 2012) analysed two types of composite building, provide cost and programme guidance when considering available options during the design and selection of a structural frame. Building 1 is a typical off-tan-down speculative three-storey business park office with a gross internal floor area of 1,200m² and rectangular open-plan floor space. Cost models were developed for a steel composite frame developed by Peter Bent 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 a 1-shaped eight-storey speculative office building with a gross internal floor area of 1,560m² and 7.5m x 15m grid. Cost models were developed for a steel composite frame and post-tensioned concrete flat slab.

For Building 1 and Building 2 are regularly updated by G&CT and, the latest data for Q3 2016 is presented here. As Figure 1 shows, the steel composite beam and slab option remains the most competitive for Building 1, with comparable frame and upper floors cost and the lowest total building cost.

For Building 2 (Figure 3), the cellular steel composite option has both a lower frame and upper floors cost and a lower total building cost than the post-tensioned concrete beam and slab option, with lower core costs, lower roof cost and a lower floor-to-floor height, resulting in lower external envelope costs. The tender price increases seen in Q3...
Steel composite and precast concrete slab, reinforced concrete flat slab, post-tensioned concrete flat slab

Substructure | £217 | £212 | £213 | £214
Frame and upper floors | £1,177 | £1,224 | £1,163 | £1,222
Total building cost | £1,394 | £1,435 | £1,371 | £1,437

The Building Regulations, fire, and steel-framed buildings

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A new wind turbine manufacturing facility in Hull required some heavy-duty steelwork to accommodate its huge cranes. Will Mann reports.

Green Port Hull is an ambitious project that aims to make the city of Hull and the Humber a global centre for renewable energy, taking advantage of its proximity to North Sea offshore wind farms. At the heart of this vision is a new wind turbine blade plant being developed by Siemens. With partner Associated British Ports, the energy giant is investing £310m in manufacturing, assembly, logistics and servicing facilities at Hull’s Alexandra Dock.

The Siemens development includes a two-storey office block adjoining the manufacturing plant, also steel-framed. It is structurally independent, however, with stability coming from a series of moment frames. It features ‘slim floor’ construction, where precast concrete slabs are supported by girders attached to the undersides of the steel members, allowing the slabs to sit within the depth of the beams,” says Billington. Volker Fitzpatrick is due to complete the project by year-end.

The Siemens manufacturing facility is the hub of the Green Port Hull project, which is due to be operational by 2016. Siemens GmbH is working in partnership with Associated British Ports on the project, which is expected to create 1,000 direct and 2,500 indirect jobs. The Siemens facility is expected to produce blades for North Sea offshore wind farms.

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THE DESIGN OF THE STEEL FRAME HAS BEEN VERY MUCH DRIVEN BY THE REQUIREMENTS OF THE MANUFACTURING PROCESS

Mark Billington. Waterman Structures

The envelope of the facility is a combination of precast concrete panels up to 2.4 m and composite cladding to roof level. An unusual feature of the envelope is that the cladding is horizontally spanning because the building does not have sheeting rails. “The crane columns have been created by running a pair of I-beams round from their normal orientation – due to the size of the cranes – which means that the outer face of the steelwork is not a single plane,” says Billington. “So instead of using sheeting rails, additional vertical sections of steel were added to form the cladding connections.”

Siemens is working with engineering consultants Waterman Structures. Prior to main contractor Volker Fitzpatrick starting work on the plant, the site had to be raised 200mm above the flood plain, and a 1m-deep stone plateau engineered to the required level. Additional 4,000 driven piles were installed as part of the groundworks. The Siemens facility is due to be operational by 2016, with the first blades being produced in 2017.

THE DESIGNS ENGINEER AND STRUCTURAL ENGINEERING had to be spot on.”

Another area of concern was the connection between the crane girders and the columns, says Billington. “It is a common area for fatigue because of the cyclic loading condition created by the crane movement, and the changes in stress,” he says. “The fatigue zones on sharp corners and stress concentrations in the structure. So the detailing in the connection from Caunton Engineering had to be spot on.”

The crane movement was also a concern for both engineering consultants Waterman Structures. “It features ‘slim floor’ construction, where precast concrete slabs are supported by girders attached to the undersides of the steel members, allowing the slabs to sit within the depth of the beams,” says Billington. “So instead of using sheeting rails, additional vertical sections of steel were added to form the cladding connections.”

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At the heart of this vision is a new wind turbine blade plant being developed by Siemens. With partner Associated British Ports, the energy giant is investing £150m in manufacturing, assembly, logistics and servicing facilities at Hull’s Alexandra Dock. The 40,000m² factory will mould turbine blades 7m long - the world's longest. Additionally, the site will store the blades ahead of delivery to their offshore destinations, along with the nacelles - the fuselage containing the generating components that the blades connect to – and the masts.

Given the size of the turbine blades – not to mention the size of the cranes used in the manufacturing process – the scale of the Siemens facility is substantial. The steel-framed multi-span braced structure measures 300m long by 116m across. The biggest spans are 47m, the roof’s maximum height extends to 15m.

"The design of the steel frame has been very much driven by the requirements of the manufacturing process," says Mark Billington, regional director with engineering consultants Waterman Structures. Prior to main contractor VolkerFitzpatrick starting work on the plant, the site had to be raised 200mm down the flood plain, and a 3m deep stone plateau constructed. Additionally, 4,000 driven piles were installed as part of the groundwork.

The building itself is split into two main sections. The northern section, which houses the manufacturing and painting, has four spans: two 36m-wide spans each containing manufacturing and moulding lines, a 75m long – the world’s longest. Additionally, the site is a finishing area with three spans.

"The southern section is a finishing area with three spans. The northern section is where the roof is highest, reaching 15m to the eaves, because of the need to accommodate the cranes, the biggest of which have a 40t-capacity. This was one of the most challenging aspects of the steelwork design, says Billington. "As industrial cranes go, these are very big," he says. "The spans are formed by twin-braced lattice columns supporting roof trusses that measure up to 2.1m deep because of the size of the cranes."

There are overhead cranes in all the production areas, which run across the spans on rails, while smaller console cranes run on steel support rails underneath. The crane movement was a concern for both the design engineer and steelwork contractor Caunton Engineering.

"With cranes, there are obviously vertical and horizontal loads to consider; the gantry has to accommodate basic loading," says Billington. "At tender stage, we designed a traditional I-beam for the vertical loads, with a channel welded into the side of the I beam for the horizontal loads. However, Caunton Engineering was concerned about welding the channel into the I-beam, because of the size of the loads. So we changed the design and, instead, the I beam connects to a heavy steel plate."

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The southern section of the facility – the finishing area – has no cranes, so the roof level here drops to 10m. It is as wide as the northern section, but it is formed from three spans, two at 47m and a third measuring 12m. With no cranes to support, the truss-supporting columns are 610 UBs rather than twin lattice sections.

The longest trusses were brought to Alexandra Dock in three sections, while the 22 m-long trusses were made in two parts and bolted together on site. To free mobile crane usage for the steel erection, the envelope of the facility is a combination of precast concrete panels up to 2.4 m and composite cladding to roof level. An unusual feature of the envelope is that the cladding is horizontally spanning because the building does not have sheeting rails.

"The crane columns have been created by running a pair of I-beams round from their normal orientation – due to the size of the cranes – which means that the outer face of the steelwork is not a single plane," says Billington. "So instead of using sheeting rails, additional vertical sections of steel were added to form the cladding connections."

The Siemens development includes a two-storey office block adjoining the manufacturing plant, also steel-framed. It is structurally independent, however, with stability coming from a series of moment frames.

"It features ‘slim floor’ construction, where precast concrete planks are supported by slabs attached to the undersides of the steel members, allowing the slabs to sit within the depth of the beams," says Billington. VolkerFitzpatrick is due to complete the project this autumn.

The first blades to be manufactured by the new Siemens facility are set to leave the site by year-end.
The Met Office’s new facility at Exeter Science Park will house one of the world’s most powerful supercomputers and, in keeping with the technology, the site has a futuristic look about it.

The complex comprises two separate buildings, one of which has an unusual, hexagonal shape – a design inspired by the movie *Tron* according to architect Atkins.

William Dixon was awarded the £20m construction contract and began work in September 2015. The project is on a greenfield site on the outskirts of Devon’s county town, close to the Met Office headquarters.

The computer itself will occupy 875m², and the Met Office says it will make the UK a world leader in weather and climate prediction. Weighting 140t, it will be able to perform more than 16,000 trillion operations per second. This is more powerful than the Met Office’s current system.

The Met Office’s new facility at Exeter Science Park will house one of the world’s most powerful supercomputers. Will Mann reports.

The steel programme began with the IT Hall frame, which is the most challenging structure and requires sophisticated stability systems to resist the forces generated by its angular design.

Although steel might have seemed an obvious choice for the framing material, the design has been through a series of iterations. “Throughout the design process, a variety of materials were considered for both buildings,” WSP Parsons Brinckerhoff associate director Ian Branch says. “The choice of steel was made primarily to suit the challenging programme requirements.”

IT Hall building also includes a huge services package, designed and installed by M&E subcontractor NG Bailey, to support the computer. The more complex Collaboration Space structure is formed around a two-storey internal steel frame, which uses a 7.2m by 4.8m grid. This box was erected first and initially stabilised by temporary bracing. The two sloping elevations, built out from the internal steel box, are formed by two further rows of raking CHS columns.

The completed Met Office site will look like (below) stages in the construction of the collaboration hall.

**A complex steel frame is being constructed on Exeter Science Park for a new Met Office facility that will accommodate a powerful new supercomputer. Will Mann reports.**

**THE MET OFFICE BUILDING, EXETER**

**IT WAS A DIFFICULT SHAPED BUILDING TO WORK WITH**

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The Collaboration Space also features folded ends, formed by two further rows of taking CHS columns. The members in the bottom row slope outwards, while the top row slopes inwards, and a central bolted connection holds the fold shape in position. These columns were all designed as moment frames.

The structure will be completed by construction of a concrete lift shaft, together with curtain walling and exposed glazing. Installation of these packages was also aided by the 3D model. “It was a difficult shaped building to work with and our envelope subcontractors used the BIM model to help us understand where there were clashes,” Cartwright says.

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This complicated steel structure leans in two directions, challenging from a design engineering perspective. The Met Office's new facility at Exeter Science Park will house one of the world's most powerful supercomputers and, in keeping with the technology, the site has a futuristic look about it. The complex comprises two separate buildings, one of which has an unusual, hexagonal shape – a design “inspired by the movie Tron” according to architect Atkins.

William Dixon was awarded the £20m construction contract and began work in September 2015. The project is on a greenfield site on the outskirts of Devon’s county town, close to the Met Office headquarters. The supercomputer itself will cost £97m, and the Met Office says it will make the UK a world leader in weather and climate prediction. When completed, it will be able to perform more than 16,000 trillion operations per second, making it more powerful than the Met Office's current system.

“Throughout the design process, a variety of materials were considered for both buildings,” WSP Parsons Brinckerhoff associate director Ian Branch says. “The choice of steel was made primarily to suit the challenging programme requirements.”

The steel programme began with the IT Hall frame, and the steelwork contractor William Haley Engineering used the BIM environment to work closely with their M&E contractor NG Bailey to run the design back between the M&E and steel structural models, while the steelwork contractor William Haley Engineering used the BIM environment to schedule deliveries of the steelwork and programming the erection.

Although steel might have seemed an obvious choice for the framing material, the design has been through a series of iterations. “The complex steel frame is being constructed on Exeter Science Park for a new Met Office facility that will accommodate a powerful new supercomputer. Will Mann reports.

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Kristian Cartwright, Willmott Dixon's project manager, says: "The design was so complex, we needed to work with our envelope subcontractors used the BIM model to help us understand where there were clashes and how to position the purlins and the mullions," Cartwright says.

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The structure will be completed by construction of the internal concrete and exposed behind glazed facades. The supercomputer facility is being wrapped in glazing, curtain walling and zinc cladding. Installation of these packages was also aided by the 3D model.

The Met Office supercomputer facility is being installed in three phases, with the final phase due to be completed in Spring 2017. As well as helping to improve weather predictions, the computer is intended to be a catalyst for further growth on the Exeter Science Park, supporting collaboration and partnerships between science, business and academia.