The Crystal, a dramatic urban sustainability centre built for Siemens in east London's docklands, uses an innovative steel framework to enable its complex crystalline form.

The Crystal is located on the site of the Royal Victoria Dock, east London.

No piece of glass or steelwork is the same, which is an interesting challenge.

Without the steelwork including columns and edge beams being fabricated box sections, eightieth percent of the roof connections were welded in situ, including the 72m-long main rafters, which arrived in two pieces.

The Crystal's design includes high-performance glazing. For winds and weather-safety reasons, the buttresses are able to support five of steel. In total, 30 sections of steel, each weighing between 2 and 3 tonnes, are used.

One of the biggest problems was making the roof columns and edge beams the same, which is an interesting challenge.

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The Crystal, which is nearing completion, will be BREEAM Outstanding and LEED Platinum. Conceived as an exemplar project for sustainable construction, the building includes high-performance glazing. For winds and weather-safety reasons, the buttresses are able to support five of steel. In total, 30 sections of steel, each weighing between 2 and 3 tonnes, are used.
A bravura performance

Steel-frame construction has enabled Populous and Arup to deliver the complex geometries of Leeds Arena to a tight budget

By Pamela Batey

Leeds Arena will be the UK’s first “supertheatre”, according to its architect, Populous. Under construction on a tight city-centre site, it will host both music and sports events and feature a dramatic, cranked and faceted steel framed bowl. The complex sports arena usually has an inclined, or horseshoe configuration, but the £60 million Leeds venue will be based on traditional theatre and sports hall designs due to the area’s heritage. Leeds is a city with a C13th cathedral, the highest point of which is about 30m high. The council is developing the scheme to enhance its significance.

The arena contains 4,200 tonnes of steel, which enabled the main steel structure to crank at a height of 30m. The building consists of two levels, with a lower concourse and catering facilities on the ground floor, and a main concourse on the second level. The roof trusses form the main skeleton of the roof, with spans ranging from 40m to 72m, and up to 75 tonnes in weight. These were spliced in the air and took 15 weeks to install.

Sixteen trusses from the main steel structure enable the building to crank at a height of 30m. A steel frame was a really good solution for the complicated geometries. Every element was inclined in two directions and it’s very difficult to draw that, which is where the power of 3D modelling comes in,” explains Arup’s Jim Bell.

The external facade is faceted on a series of grid lines relating to the seating bowl inside, where three tiers of seating hang off the main structure, with a row of boxes between the lower/main and upper tiers. Around the column-free bowl are a lower concourse and catering facilities on the ground floor, and a main concourse on the second level. VIP areas are on the third floor with another concourse on the fourth. Both the seating arrangements allow the arena to be divided into different sections, which are designed for flexibility and can be used in different ways.

The main challenge was to create a cathedral-like experience, says Populous associate principal John Rhodes.

“The building is a really nice performance space. We wanted to create a cathedral-like experience, says Populous associate principal John Rhodes. Due to the 45-degree angle of the glazing system, a lot of the steel connections had to be co-ordinated within hidden connections. With the 45-degree irregular angle, drainage was also an issue, especially over the entrance where the audience would be vulnerable to rain run-off.”

A second internal acoustic layer of wood and insulation suspended below the steel frame of the main structure. A second internal acoustic layer of wood and insulation suspended below the steel frame of the main structure. A second internal acoustic layer of wood and insulation suspended below the steel frame of the main structure.
Steel steps up to satisfy thermal mass demands

Despite belief to the contrary, thermal mass can be achieved in steel-framed as well as concrete buildings.

By Pamela Buxton

We only require a thin skin of concrete or masonry, and this can be constructed even as easily on a steel frame.

The concept of thermal mass is not new. Buildings of all kinds utilise materials such as concrete, bricks, stone and timber to absorb and store energy. However, there is a misconception that steel-framed buildings are unable to achieve the necessary thermal mass to reduce mechanical cooling needs. This is usually upheld by claims that thermal mass is achieved in concrete-framed buildings only. The majority of building engineers physics, electricians, building control officers, architects and civil engineers, believe that building with steel, including concrete, is a practical solution.

Thermal mass is the ability of the building fabric, particularly the exposed concrete slab, to absorb excess heat, thus improving thermal comfort and reducing the need for mechanical cooling. Thermal mass can make a substantial contribution to buildings, offering a cost-effective way to improve the energy efficiency of new buildings and existing refurbishments. The key to achieving sustainable buildings is to build them in such a way that they can take advantage of passive solar gains by storing heat in exposed concrete soffits.

Fabric energy storage

Thermal mass — also known as fabric energy storage — is the ability of the building fabric, in particular the exposed concrete slab, to absorb excess heat, thus improving thermal comfort and reducing the need for mechanical cooling. By employing the right building materials, it is possible to achieve similar levels of thermal performance to masonry buildings.

Concrete is an excellent material for fabric energy storage as it is non-combustible, non-corrosive and has a very high thermal conductivity, which means it can store and release heat very efficiently. Although exposed concrete soffits are the primary method of achieving good thermal performance, it is possible to achieve the same results by using exposed concrete slabs, which can be incorporated into the structure of a building.

Concrete is effective for this application mainly because of its high thermal conductivity. As the concrete slab is exposed directly to the internal environment, it can store heat efficiently and maintain a constant temperature. As concrete is a non-combustible material, it is able to store heat and release it slowly, even during cold weather.

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