

EXCEL

The *Conference*

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and Exhibition **CENTRE**, LONDON



Exterior shot of ExCel conference centre side elevation fronting the River Thames at the Isle of Dogs, London. The side elevation of the ExCel conference centre shows the dramatic steel-work structure which forms the main architectural feature of the building. (Photo by Mandy Reynolds)



ExCel, London's new conference, exhibition and special events venue, is a new Docklands landmark that rivals the Canary Wharf tower in terms of sheer scale, although not of height.

Located on good transport links, ExCel is a major venue for trade shows and public exhibitions, part of an overall master plan by English Partnerships. The site extends across a reclaimed dock, building over water using marine piles. The total development area is 193,500m² (2,082,820 sq. ft.) gross, including 65,000m² (699,650 sq. ft.) of exhibition space. The remainder comprises car parking, a conference facility, public amenity spaces, cafés, restaurants, cloakrooms, central security and plant.

A second phase is planned to include additional developments for ho-



tels, shops, multi-story car parking and a crèche.

The primary development of exhibition and conference centre has sufficient flexibility to allow sub-division of the main halls to cater for the differing demands of exhibitions. The two major exhibition halls are 375m (1,230') long,

each with an 86.7m (284') clear span over a clear height of 10m (33'). The halls are subdivided by full height movable partitions located along the lines of the roof trusses at 7.8m (26') centres. The main halls are separated by a 29m (95') wide internal spine central access "street," the Boulevard, run-

ning east-west and leading from the main entrance. Externally, the halls are attached to breakout spaces for private functions and offices, extending for the full length of the building along the north and south elevations.

The roof construction

A key feature of ExCel is externally exposed steelwork, consisting of coupled pairs of “A frame” masts and ties supporting primary trusses near their midspans across the exhibition halls at 23.4m (76.8’) intervals. The exposed “A frames” and ties consist of pre-cambered tubular steel inclined masts and ties. Frame modules are located at 46.8m (26’) centres along the entire length on both north and south sides, forming the main architectural expression of the building. The entire steel frame, fabricated with nearly 10,000 tonnes of steelwork, was erected in approximately four months.

The main roof structure consists of lattice trusses at 7.8m (26’) intervals, supporting the deck, the main air-handling plant and the hanging partitions for the exhibitions below. The 67Kg/m² (14 lbs. per sq. ft.) roof structure is an exceedingly economic design, considering the large spans and the high imposed service loads involved.

The roof consists of a waterproof membrane laid on insulation resting on profiled metal decking which spans between purlins. The purlins span continuously via a pre-assembled stub purlin connection on the top of each truss, connected prior to lifting it into position.

Upper suspended floors within the breakout areas and central Boulevard are of conventional composite metal decking, acting compositely with steel framed beams via shear studs.

Running the entire width of the building, two expansion joints create three individual sections along its length, thus subdividing the building structurally to allow for thermal expansion. Each of the three sections is braced in two directions, providing the necessary stability for each portion of the building.

Features steelwork and connections

The elegant exposed steelwork was a significant design challenge and held fabrication challenges as well. Moxley Architects and Buro Happold Engineers worked closely with main con-

tractor, Sir Robert McAlpine, and steelwork subcontractor, Severfield Reeve, to arrive at an elegant yet economical solution that could be constructed within the programme. Long lead specialist fabrications were avoided, and complex connections were simplified to enable fabrication and erection, achieving the desired sophistication in the final solution.

With tubular members intersecting from a variety of angles in highly visible locations, cost of nodes manufacture was a key consideration. Severfield Reeve proposed manufacturing the members in tubular steelwork, avoiding time-consuming tensioning during erection stages. The visual interplay between the struts, ties and node connections was carefully considered.

The main struts are 762mm (30”) diameter circular hollow sections connected to 356mm (14”) diameter circular hollow section ties, joined by 160mm (6.3”) diameter pins via fabricated node connections. The tubular hollow sections are tapered at their ends, welded to connecting profiled single and double fin plates to achieve the elegance that resulted in the highly visible pinned connections. Care had to be taken where the geometry resulted in longer than desirable fin plates to avoid complications of movements in the pin connections close to the waterproof membrane. Articulated pins were kept external and clear of the membrane, and fin plates had to be checked for buckling instability, placing further limitation on options for the visual elegance of the connection.

These complications were resolved in discussions with the steel fabricator. Working closely with the architects, Buro Happold carried out various studies, including model making and 3D visualisations. In this way, the team arrived at a solution that was visually acceptable and achieved a buildable and economic design.

Fabrication and erection

A complete trial erection of a primary truss and “A frame” module carried out at the fabrication works

checked the effect of pre-cambering and fit up as well as the logistics for erection. Each truss weighed approximately 35 tonnes, erected in one piece with four cranes lifting simultaneously.

The main roof structure was designed to span under its own weight during construction, which represents approximately 25% of the total load on the roof. The mast and tie supports the imposed roof dead load as well as the live load. The imposed dead load includes four air-handling units located within the depth of the roof structure and partition loads that hang from purpose-designed tracks.

One of the reasons for adopting this form of construction was the push to erect steelwork quickly. This involved pre-erecting the steel superstructure frame directly from foundations in advance of the concrete deck and car parking infill slab below. Rapid pre-erection of the main lattice trusses allowed early completion of the envelope. Each truss was lifted in one piece, exploiting the inherent stiffness of the lattice trusses, spanning under its own weight together with significant pre-cambering of 500mm (19.7”) at centre span. The connections for the outer frame and ties followed the truss erection to enable completion together with the weather tight envelope, allowing construction to continue below at the same time.

The manufacture of the main node connection between the columns, the truss and the “A frame” members was not without its limitations on the size of fabrication. This was due to the need to preheat the complex arrangement of the plated assembly to satisfy welding procedures. The size of the pieces was limited by the size of oven used to achieve the necessary amount of pre-heat. The resultant configuration successfully resolves all the demands placed on this key connection, in an elegant and cost-effective way.

ExCel brings a new landmark exhibition facility to the heart of London.

The efforts by the entire design and construction team, with the support of the client, have contributed towards a building of distinction to grace the

ever- changing brownfield develop-
ments in London's Docklands area.

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CLIENT:

ExCel

CONTRACTOR:

Robert McAlpine,
Hertfordshire, England

ARCHITECT:

Moxley Architects,
London, England

STRUCTURAL ENGINEER:

Buro Happold, Bath, England

SOFTWARE:

Strap



Interior shot showing large exhibition space. One of two major exhibition halls lies at the centre of the building providing a 375m (1,230') long and 86.7m (284') clear span over a clear height of 10m. The space can be subdivided with full height movable partitions. (Photo by Mandy Reynolds).



Exterior shot of corner of building showing carpark rampways and entrance in background. The purpose built exhibition space allows for vehicle access straight into the exhibition halls. (Photo by Mandy Reynolds).