

The Convention Centre Dublin

Tuesday, 8th December 2009

**Presentation to
The Institution of Structural
Engineers
(ROI Branch)**



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O'Connor Sutton Cronin & Associates Consulting Engineers



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T-KM/CP

**RE: THE CONVENTION CENTRE DUBLIN
Structural Engineering Perspective**

Located in Dublin's Docklands area and overlooking the River Liffey, The Convention Centre Dublin (The CCD) project is currently on site in Spencer Dock. The project is a Public Private Partnership (PPP) project initiated by the state. The PPP Company is a joint venture between the Spencer Dock Development Company as developers, Construction Management Partnership (CMP) as design and build contractors and the NEC group as operators.



The OPW tender documents for the project were issued in late 2004, with the formal appointment of the successful consortia in early April 2007.



The OPW brief calls for a 2000 seat world class auditorium, a 2000 seat banquet hall and a 1200 seat banquet hall, along with numerous meeting rooms and back of house facilities. The OPW brief also calls for the building structure to be designed for a 100 year design life

for all structural elements, with major replaceable components (cladding etc.) being designed for a 40 year design life.

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All of the concrete structure in contact with the ground was specified as GGBS concrete to meet the 100 year design life criteria and the requirement to provide resistance to sulphates in the ground. The basement structure is designed as a Grade 2 / 3 environment and this is achieved using a Type B structure (crack width design) to BS 8102 1990. The external cladding system is designed such that the perimeter steel columns are in a fully internal dry environment. The exhibition halls are designed for an imposed loading of 12.5 Kn/sq m, the auditorium 7.5 Kn/sq m and the remaining floors 6.0 Kn/sq m, all in accordance with the brief.



The site is very restricted, being surrounded by a canal, busy roads, an existing office building and a light rail tram system (LUAS) currently under construction. As a result of the site dimensions all of the exposition/banquet and auditorium spaces are stacked vertically. From basement level there are two levels of car parking, a 45m x 60m exhibition hall at ground level, a 35m x 47m exhibition hall at first floor level and a 2000 seat auditorium positioned on top with public access from three separate levels.



Designing a building with three large open areas, all on top of one another, required considerable interaction between the team members. The structural steel finite element analysis model designed by O'Connor Sutton Cronin took nine months to develop, during which time several key design evolutions were taken on board. From this model the project was priced by Fisher Engineering on a lump sum fixed price basis. Following this, further development of the model to full fabrication status took a further period of six months.

The Spencer Dock site mainly consisted of former railway sidings and warehouses which once served the adjacent port. Initial enabling works were commenced by CMP on this Brownfield site in November 2006 and involved clearing the ground and demolishing existing structures. A 600mm/900mm diameter secant piled wall was formed from ground level around the perimeter of the site and capped with a structural RC capping beam, with the site then excavated to a depth of 7.5m. Loadbearing 600mm, 900mm and 1050mm diameter CFA piles were then cast, followed by part of the basement slab. The two southern concrete cores were then jump formed in readiness for steelwork erection which started in late 2007.



Steel erection began on the south side of the site and has since progressed, in six phases, steadily northwards away from the two southern concrete cores. The structural stability for the building is derived from the two southern RC cores, steel sway frame action of two main frames and also braced frames. The southern RC cores

needed to be constructed before steelwork erection began, and they also contain the main escape stairs which provide important access during construction.

Steel begins at basement level, with two levels of car parking based around a standard 7.5m grid pattern. Above this, at ground level and upwards the structure takes on its highly architecturally driven and challenging form.

At ground floor level there is a banquet hall with a capacity for 2,000 delegates, then at first floor there is another 1,200 capacity banquet hall and finally at second floor level there is a world class 2,000 seat auditorium.

The three large functioning levels need to be open plan with a minimum number of columns. The structure's steelwork is based around eight internal 800mm x 800mm fabricated plate columns (carrying a maximum load of 40,000Kn) with steel trusses (2.3m deep) spanning 22m between columns. Six of these columns extend



up through the two exposition halls and top out at the roof level of the auditorium. The concrete floor plates utilize composite action metal decking, typically 150mm deep.



The internal columns are arranged in two rows of four, and this is a key point as they then do not interfere with sightlines and there is a clear view into each exposition hall from their respective entrances.

The exposition hall on the first floor also incorporates a stage area and to allow a column free area 4 large 22m long x 3.5m deep x 48T Vierendeel trusses have been erected on the level above to support the main auditorium stage.

The upper auditorium terrace seating is formed using a series of frames which are positioned at 2.5m centers on a radius around the auditorium, each of which have long propped-cantilevers. A number of the columns supporting these frames are transferred out at the second floor using trusses which also form the roof of the first floor exposition hall. This auditorium also accommodates two sway frames which provide the structure with a proportion of its lateral stability in the east-west direction.

Part forming the roof over the auditorium is the project's largest single steel element; a 160t 48m long roof truss. With plate girders forming its top and bottom cords, the 6.5m deep truss was lifted into position in 24 individual pieces. It required temporary towers to support it until the entire truss was bolted into position with its connecting steel members and secondary trusses. Once the primary roof steelwork was erected the auditorium's precast seating was then installed.

The integration of services into the main structural frame played a big role in the overall steelwork co-ordination/fabrication drawing process. The whole building is highly serviced and the steel frame needed to accommodate all of the building's M&E services whilst staying within the architectural constraints and the OPW brief.

Aside from the challenging steelwork, The CCD will have stone cladding on three elevations supported on a proprietary cladding rail system, with the front (main entrance) elevation incorporating a 37m span Werner tubular steel glass drum which is effectively hung from the roof structure of The CCD. With the



floor to ceiling heights being so high, the perimeter steelwork incorporates secondary 400mm x 200mm and 350mm x 350mm box sections to accept the rail system for the stone cladding.

The 24m clear span (5m clear height) underground service yard, to the north of the site, also incorporates the foundation and transfer structure to accommodate a 35 storey (155m high) privately owned hotel tower overhead. The basement slab under the service yard, at 2.5m thick, was poured in two separate sections, the larger of which was poured in a single 17 hour operation at approximately 2450 cubic metres. At the time of pouring this was the largest single concrete pour in the country and involved over 300 concrete delivery trucks. The loadbearing perimeter columns, which are designed to support the hotel superstructure, are 1000 x 800mm fabricated plate sections and will be capped above the ground floor level in readiness for the superstructure.

Once The CCD building is complete in 2010, the PPP Co. will operate and maintain The CCD for a period of 25 years, after which the facility will revert to the State.



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