23 May 2008

One Raffles Quay

BCA Design and Engineering Safety Excellence Awards 2008 Background

One Raffles Quay (ORQ) was conferred a Design and Engineering Safety Excellence Award 2008 from Building and Construction Authority (BCA) on 22 May 2008.

The award recognises ORQ and its Mechanical & Electrical (M&E) engineers Meinhardt (Singapore) Pte Ltd. for implementing innovative features coupled with safety, construction methods and economy in the design of ORQ that was an engineering and technical achievement, given the site challenges.

1 Building overview

- ORQ consists of two office towers with total gross floor area (GFA) of 214,000 square metres. North Tower ascends to 50 storeys high and South Tower to 29 storeys.
- Facilities include an underground retail and pedestrian link tunnel to Raffles Place subway station, two basements, above ground car-park floors, vehicular and pedestrian drop-off points, covered and open public plazas and various other public amenities.
- Singapore's first commercially applied District Cooling System (DCS) spaces, landscape
- The column free floor plates of each tower are tailor-made for the financial services industry and are equipped with state-of-the-art architectural, M&E, IT and intelligent building features.
- ORQ was developed by Cheung Kong Holdings, Hongkong Land and Keppel Land.

2 Construction challenges

- The presence of existing twin Mass Rapid Transit (MRT) subway tunnels at an angle of approximately 30 degrees through the northern portion of the site, directly beneath the proposed North Tower.

- The extremely soft sub-soil conditions and deep layers of consolidating marine clay, with underlying variable strength bouldery clay.

- The medium-rise South Tower posed a challenge to accommodate the large column free floor plates tailor-made for the financial services industry.

3 Structural solutions

North Tower

- The safety of construction and of the MRT tunnel operations were the prime considerations of Meinhardt, as well as to minimise building weight, devise transfer solutions for the central core walls and perimeter columns, and plan a foundation system to fit within the restricted space of the development boundaries.

- The unique transfer solution - the first in the world for a building of such height – was devised utilising the central core to act as a transfer structure. The transfer of the east and west perimeter columns of the tower was achieved through mega steel trusses and raking columns on each side of the MRT tunnels.

- For the floor system of the tower, composite steel-concrete floor system was selected due to the key considerations of safety, minimizing building weight, structural efficiency and cost-effectiveness.

- Wind loads were also an important consideration for the 50-storey North Tower. Excessive sway and acceleration levels were controlled though the adoption of a rigid lateral load resisting system comprising of concrete core, perimeter concrete filled steel tube columns, two levels of outrigger trusses and floors acting as diaphragms.

South Tower

- Concrete was adopted in the flooring of South Tower as opposed to steel-concrete system used for North Tower, its conventional strength and serviceability demands. It is also necessary to control floor vibrations - a critical consideration for long span floors serving busy offices and trading floors.

4 Foundation and basement system

- The main sub-soil layers in the site geology consisted of 2 metres to 20 metres of reclaimed land, underlain by 5 metres to 30 metres of marine clay, followed by bouldery clay (a highly variable material with boulders in a stiff clay matrix). Large diameter piles were bored through the bouldery clay which was implemented through careful quality control and safe construction methods.

- The basement and foundation system was designed to ensure that the structural integrity of the tunnel is not compromised. The success of the adopted design and construction was reflected in the final measured cumulative movement of the MRT tunnels which was around 15mm limit (specified in the Code of Practice for Railway Protection)

5 Risk Analysis

- Detailed risk analysis related to equipment planning and mobilisation, excavation methodologies and steelwork installation was carried out at various stages of the construction process.

- Comprehensive instrumentation and monitoring were implemented to detect problems early and fully executable contingency plans were put in place to mitigate the risks.

6 Safety and protection

- To verify the feasibility of the design concepts, an extensive structural analysis and parametric studies were carried out using three dimensional computer models and software programmes.

- For the first time in Singapore, permanent shielding walls were constructed adjacent to the MRT tunnels to ensure safety and protection during construction.

- Also implemented for the very first time was a comprehensive instrumentation regime for close monitoring of the ground, MRT tunnels, retaining walls and tower movements to ensure full safety during construction.

- For construction of the underground pedestrian mall linking the development to Raffles Place MRT station, massive traffic diversion was required at one of Singapore's busiest streets, i.e., Raffles Quay / Collyer Quay. This was successfully completed through carefully controlled and progressive lane diversions without any negative public feedback.