An award winning entry

showcases:

how concrete was used in the project
concrete construction photos
completed project photos featuring concrete

Project Name: Chau Chak Wing Museum

Category: Mid-Rise Structures (4-15 Stories)

Project Completion Date: 1/8/2021

Project Size (Dimensions, Area, Span): 6 floors with 7740 m^2 in floor space. The main feature, the floating box, is 52 m long, 34 m wide, and 9 m tall, with a 14 m cantilever.

Concrete Quantity - Volume Area Tonnage: 6000 m^3

Construction Work Duration: 20 months

Description of Project: **Provide a detailed description of your project in 300 words or less.**

Chau Chak Wing Museum at The University of Sydney is the culmination of many years of strategic planning, consolidates the University's Nicholson, Macleay, Power and University Art collections, and showcases some of Australia's most significant artistic, scientific and archaeological artefacts. The brief specified a design life of 100+ years and the aspiration for the Museum to be as highly regarded as their iconic Great Hall and Quadrangle, the symbolic and ceremonial heart of the University.

The construction of the museum involved bulk excavation, construction of a six-level building (including a plant level and two basement levels) with 7,740 m^2 of gross floor area. The choice of concrete as construction material was simple. It enabled structure and cladding to be one, making engineering efficient and construction seemingly straightforward.

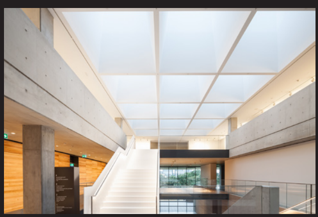
Delivered by FDC alongside JPW, Northrop, and Mahaffey Associates, this was an incredibly complex project. Numerous innovative and bespoke construction techniques were devised and adopted to create the Museum's most striking feature, the large, floating, concrete 'Box' perched atop its glass and sandstone podium.

The 'Box' is a complete in-place construction that was limited in terms of pour breaks, deflection, and propping to ensure the utmost quality was achieved with limited cracking and deformation. The podium is an array of carefully placed concrete elements that were precast off-site, with the structure then built over it.

All aspects of the concrete construction were carefully considered, from prototyping, concrete mixture designs, reinforcement detailing, and post-tensioning, through to pumping strategies. From the tinted precast elements that feature in the lower half of the building, to the ceiling of the entry level with all the cast-in services, through to the cantilevered box itself, concrete features prominently, and yet is unobtrusively elegant.

This timeless construction project will endure for generations to come, just as the University intended.

Description of concrete usage: **In 500 words or less, describe how the concrete was effectively utilized in the project, for example, to meet the end user requirements, to shorten the schedule, for sustainability, etc.**



In-place concrete was selected for the upper level, which is expressed as a floating box, as it unified structure and cladding. Large cantilevers, possible only with a concrete structure, protect internal spaces from direct solar gain and provide thermal mass, whilst the in-place concrete soffit of the box creates a sense of compression upon entry before dramatically opening out into the central atrium.

The team spent 9 months devising the concrete mixture, with careful creation and consideration of a number of on-site prototypes, to troubleshoot every perceivable scenario. Of utmost importance was the concrete box. A significant amount of data was considered before confirming the final concrete mixture design for the project.

Hydration temperature, drying shrinkage, sustainability targets, water demand, thermal expansion, aggregate size, placement methods, and ambient temperatures were all elements that were discussed and scrutinised, to ensure consistency and colour control. The solution was a mixture with 30 kg cement reduction, replacing the originally proposed aggregate due to its shrinkage characteristics; introduction of a water reducer that delivered a higher water cut and improved setting time; and a total reduction of 12 l/m^3 of water to aid shrinkage control.

The 52 m long, 34 m wide, 9 m tall 'floating concrete box'; soaring 14 m cantilevers; and reinforced, prestressed, concrete finished façade was a monumentally challenging structural engineering task. Concrete construction was reimagined from the ground up, borrowing techniques from high-rise jump forms, bridge construction, and a temporary works solution to form the 400 mm thick, reinforced, prestressed walls.

The precast concrete plinths and terraces were made as impossibly large 'sandstone' blocks 3.6 m wide by 7 m tall. Coloured by natural sands, they express the craft of their making in the surface finishing and in how they are put together.

Design challenges led to the following solutions:

- Cracking was controlled by conventional post-tensioned strands in the wall elements, as well as high-strength, large-diameter, post-tensioned bar and traditional reinforcement.
- Horizontal construction joints were introduced to limit pour heights. This created structural engineering challenges due to the development of vertical bars, which was solved through the introduction of reinforcement couplers.
- Construction methodology and temporary works to support the concrete box during construction. Careful structural analysis was required to determine stressing sequences and timing for the post-tensioned elements, and timing and sequence of the removal of propping elements which required staged, coordinated 'de-propping'. The vertical deflection of the whole cantilevered structure achieved an amazing 4 mm after the propping was removed.

The University also set a target for recycled materials in concrete to ensure at least 25% of all fine and coarse aggregate inputs were manufactured sand or other alternative materials. Also, the content of portland cement used in the concrete mixture had to be reduced by at least 30% compared to a reference case.

The project consumed approximately 6000 m^3 of concrete. 71% of all sand was substituted via manufactured sand. 94% of all the water used was recycled water. A total reduction of over 1000 tons of cement was achieved.

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