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JUBILEE BRIDGE IN THE HEART OF SINGAPORE

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Summary

The Jubilee Bridge was the brain child of the Singapore nation's late Founding Prime Minister and was first opened in tribute to him on 29 March 2015 to allow the large crowds to bid Mr Lee farewell.

Connecting two famed landmarks in Marina Bay - the Esplanade Theatre and the Merlion, the Jubilee Bridge is designed to counterpoise the more elaborate Helix Bridge across the bay. Offering an unobstructed panoramic view of Singapore's magnificent skyline, the Jubilee Bridge has since added to the city's vibrancy and contributed to its aspiration of becoming a walkable city.

The 220m long and 6m wide pedestrian bridge has a 95m main span with 1.5m mid-span depth over the busy navigable waterway. The very slender deck is curved in elevation and plan and connected to the adjacent Esplanade Bridge at the centre of the main span. It was constructed using the precast post tensioned balanced cantilever method. The precast segments, each with a unique shape, were fabricated 600km away in Malaysia and transported by road to the storage yard on Marina Bay and then by barge to the bridge.

The bridge has received widespread praise from the government and media in Singapore

Keywords: CBD location; aesthetics; planning; precast segmental balanced cantilever; navigable waterway

1. Introduction

In November 2015, Singapore celebrated the formal opening of the iconic Jubilee Pedestrian Bridge that commemorates the country's 50 years of independence. Connecting two famed landmarks - the Esplanade Theatre and the Merlion, the bridge offers unobstructed panoramic view of Singapore's magnificent skyline. It was the brainchild of Singapore's late Founding Prime Minister, Mr Lee Kuan Yew. In 2004, Mr Lee observed that the walkway along Esplanade Bridge was too narrow and thought that a friendlier connection should be provided. The bridge was initially opened a month early to accommodate the crowd wishing to farewell Mr Lee.

Measuring 220m in length, 6 metres in width, 3,000 tonnes in weight, the naturally curvilinear Jubilee Bridge forms the final link of the barrier-free 3.5km Marina Bay waterfront loop. The bridge is part of an 8km heritage trail around the Civic District and contributes to the walkable city theme in Singapore.

2. Client Aspirations

The URA demanded a solution that did not impose on or dominate the adjacent Esplanade Bridge, the symbolic Merlion or the iconic Fullerton Hotel while providing adequate clearance for the busy waterway below. A simple, elegant and slender bridge form was anticipated. The Esplanade Bridge was to be connected to the new bridge mid-stream. This interface created additional geometric constraints and differential movement considerations.

The Singapore Government (URA) held a design competition for this scheme in 2009/2010. The winning three span balanced cantilever box girder solution proposed by Cox/architects61/Arup provided navigation clearance through the 95m main span. The deck vertical alignment was able to neatly meet the existing esplanade levels at the existing sea wall alignment. By proposing a slender curved concrete bridge solution, the Client was given a low maintenance, aesthetically pleasing elegant bridge that met all client aspirations for the project. The Cox/architects61/Arup team were appointed by the URA to develop the bridge design and provide construction phase services for the construct only traditional contract.

3. Design

The bridge comprises a post-tensioned, single-cell concrete box girder of varying depth.

The bridge deck curves in plan in response to several criteria such as the deck length required to lift from promenade level at the abutments to above the navigation channel; requirement to connect to the Esplanade bridge at mid length; create an efficient span arrangement for balanced cantilever construction with minimal uplift reactions at abutments; and meet the esplanade promenade at appropriate landing locations for the abutments.

The box section deck is an appropriate response to torsion in the curved deck while the variable deck depth associated with a balanced cantilever solution responds to the geometric requirements of the waterway below. The decision to use precast segmental construction rather than insitu was driven by the site constraints despite every precast element being of a different geometry due to the vertical and horizontal deck curvature. Precast concrete elements would provide superior finish and concrete quality. This approach would reduce the construction noise and disruption to navigation, roads and footpaths during construction at the inner city location.

An elegantly slender bridge, the Jubilee Bridge has a main span of 95m in length, back spans of 59m and a uniform deck width of 6m. The deck depth is 3.5m at the main piers and 1.5m at mid-span. Typically, balanced cantilever bridges have a span-to-depth ratio of between 25 and 30 rather than the 63 adopted for this design. A consequence of this slender deck is the use of 80MPa concrete and high levels of prestress.

The deck is constructed integral with both piers. Arup proposed a flexible pier design using a system of twin blade columns. This configuration provides a robust stiffness against the transfer of bending from deck to pier, essential during construction of the cantilevers, but a relatively soft response to creep, shrinkage and thermal effects of the deck, important once the cantilevers are stitched together to form a structure with redundancy.

4. Construction

Sheetpile cofferdams were installed at the two pier locations so that the pile cap and pier construction could be completed in the dry. The pier concrete was cured before exposure to the partially saline bay water.

The precast segments were manufactured in bespoke steel framed timber lined forms using the match cast technique at a casting yard in Malaysia, some 600km from the site. Trial segments were cast and brought to Singapore for assessment by the project team. Compaction of the precast segments was undertaken using external vibrators.

The URA secured a dedicated storage site with waterway frontage to serve as a storage area for the precast segments and facilitated many other construction functions not available to the contractor at the confined bridge construction site. Bridge segment erection above the navigation channel was undertaken outside of the operation hours for water taxis and tourism vessels. Pre-cast segments were added, one by one, on alternating sides of the central pier to form cantilevers to each side of the pier, keeping the pier and cantilevers balanced. Exacting tolerances were required for the segment geometry and weight.

Finishing operations were only started well after the entire deck length had been stitched together. The final deck surface was then surveyed and the target finish levels for the tiled surface, balustrades and movement joints determined so as to optimize the impact on all the finishing trades.

5. Project Outcomes and Conclusion

The bridge has received widespread positive publicity from the Client and media in Singapore as its opening was accelerated to facilitate the many Singaporeans who turned out to bid farewell to the Founding Prime Minister, Mr. Lee Kuan Yew. The Straits Times (17/04/2015) provided a detailed feature write-up on the design and construction of the new landmark in Singapore.