2012 News

Malaysia First Ultra-High Performance ductile Concrete Composite Bridge at Marine Environment, Selangor

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Recently Westports Malaysia called tender to expand their container cargo terminal and there are four new access bridges (known as Bridge24, Bridge25, Bridge26 and Bridge27) to be built with the aim to connect the new wharf with the container stacking yard. This project is located at Pulau Indah, Port Klang. Bridge25 was designed as a special access bridge for overweight and oversize cargo with maximum trailer payload of 3072 tonnes.

The owner of this project is Westport Malaysia, and HSS Integrated S/B is the appointed consultant for the project. Among these four new access bridges, the consultant has specified to use ultra-high performance ductile concrete (UHPdC) prestress beam for Bridge25 due to the UHPdC beam is able to carry extra live load while maintaining a shallow beam depth of 1m deep. Besides that, these bridges are located at the marine environment, thus, resistance against salt attack is also a major advantage as UHPdC is highly durable and it's able to gives a service life in excess of 100 years. The other three bridges were designed for normal highway loading using Grade50 conventional RC composite bridge.

The superstructure of the access bridge consists of six multiple spans (i.e. five spans of 13m long by 22.5m wide and one span of 13m by 40.5m wide). The substructure of the bridge consists of 800mm diameter Grade80 spun piles driven to set at an approximate pile length of 36m. A total of 102 precast UHPdC beams were required, with each UHPdC beam spaced at 1.5m c/c. With the constraint of the limited freeboard below the bridge soffit, the beam depth had to be restricted. Therefore, the only option to achieve the high capacity of the beam with limited depth was to adopt the high strength concrete. Accordingly, the proposal of using UHPdC beams (Grade150) was presented to the client and was approved thereafter. The UHPdC beam has a shallower depth where a minimum free board of 1m from the high tidal water level can achieved. The UHPdC beam design also gives a significant dead weight saving compared to the conventional beam system (approximately 66% lighter each). The composite bridge comes with Grade50 in-situ RC deck which has an average thickness of 275mm.

The total length of each precast DURA beam is 12.1m. The top flange is 1490mm wide and consists of 6 pieces of 15.2mm diameter strands, whereas the bottom flange is 500mm wide and consists of 18 pieces of 15.2mm diameter strands. The web is designed as a thin membrane element of 175mm in thickness. Unlike conventional RC beam where steel reinforcements or stirrups are use as a primary resistance against all major tension force/shear that may occur in the stress/load path of a beam, the UHPdC beams do not has any conventional reinforcement and stirrups in its section, except the starter bars at the top flange which are required for the deck connection. Steel fibers are used to improve the ductility and enhanced the tensile/shear strength of the composite.

A very strict quality control and inspection plans have been used during the production of the UHPdC beams. In this project, a total of 104 prestress UHPdC beams have been produced (102 nos. for the bridge construction and 2 nos. for destructive load test). Manufacturing of the first UHPdC beam started at early April 2012 and completion of the 104 beams fabrication at the end of July. One single piece of the beam is produced with every new batch of concrete mixing; therefore control sample will be collected for every batch of the concrete mix. In this case, a total of 104 batches of UHPdC samples have been collected (which consists of minimum six 100mm cubes and minimum one prism).

Though every concrete batch have been tested to pass according to the required standards, however, the contractor/consultant suggested that the material testing results do not fully cover and elaborate on the structural performance of the beams. Therefore, the consultant further requested for the testing of five extra UHPdC beams to be tested to its design SLS loadings. Without any hesitation, the client has randomly selected five beams (i.e. Beam 22, 49, 55, 78 and 95) and subject to SLS load proof test. The passing criteria of the SLS test is the beams shall be able to withstand the specified SLS loadings without cracking the beam. And out of the five load tests, all the five selected beams were tested to pass.

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