New Technology for Cable-stayed Bridge Design of Zhanjiang Bay Crossing

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Summary

ZhanJiang Bay Crossing linking with the provincial expressway S373 in Guangdong is a major bridge crossing over Maxie Channel. The main Bridge is a composite cable-stayed bridge with double pylons, two cable planes and main span of 480m. The side span adopts concrete beam, while the remaining part of this bridge adopts steel box girder. Having two pylons of curved torch shape, streamline hollow steel box girder, and advanced collision protection structure for pylon foundations, this bridge has several technical breakthroughs in cable-stayed bridge design.

Zhanjiang Bay Bridge was commenced on July, 2003, completed and opened to traffic on December, 2006; the total project cost is about CNY 1.25 billion.

Several new technologies in terms of structural design, anti-collision of pylon, and health monitoring system of this bridge are introduced herein.

Keyword: cable-stayed bridge, technical breakthroughs, structural design, new technology

1. Introduction

The bridge has dual 2-lane carriageway now, and will have dual 3-lane in the future. The design load is over-Class-20 truck; and design speed is 80km/h. The maritime shipping class under bridge is per as sea ship with 50000t bulk cargo; the height clearance of navigation is 48 m, and the width clearance should be no less than 400m.

2. Main Bridge Structure

Fig. 1: Photograph of Main Bridge

The bridge proposal crossing main navigation channel adopts a (60+120+480+120+60) m composite cable-stayed bridge with double pylon, two cable planes and total length of 840m. The bridge is 28.5m wide, in order to resist the longitudinal seismic effect, STU (anti-seismic gears) are set up at the intersection of pylon and main girder.
The main bridge adopts composite beam: the side span and the extending part of 1.8m behind each auxiliary pier adopts concrete beam; while the remainder adopts steel box girder of 3.0m height. The diamond shape pylon adopts reinforced concrete structure of 155.1m height, looking like a curved torch.

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3. The Technical Characteristics of Main Bridge

3.1 Collision Protection Design for Pylon Foundation

A floating energy adsorption structure (hereinafter called FEAS) was proposed. The structure is arranged at the perimeter of the pile cap with the length of 62 m, the width of 43m, the height of 10m, and the thickness of 6.5m. Its main structure consists of inner wall, outer wall, base board, lower deck and upper deck etc. with several disconnected water tight cabins placed inside. It will be filled with water against flotation. Energy adsorption box and rubber cylinder are attached outside of FEAS. FEAS can reduce the impaction energy through compression and rotation so that to protect not only the pier but also FEAS itself and the ships involved.

3.2 Cable Anchorage on Steel Box Beam

The anchor plate consists of a steel plate, a tube, a cushion plate and some ribs. The steel plate is about 20 to 40 mm in thickness which is directly welded onto box girder and is a main component carrying load. A seamless tube with wall thickness of 20 to 40 mm is inserted into the groove at the upper end of the anchor plate, and the thoroughly penetrating welding seam makes the tube and plate become a complete integrated component. The cushion plate is welded beneath the tube. Four ribs, two at each side, are welded on to the anchor plate along the direction of stayed cable. The rib bottom is welded onto bridge deck.

Fig. 2: Cable Anchorage on Steel Box Beam

3.3 Curved Pylon Design

The pylon design of curved torch is a breakthrough in the existing cable-stayed bridges dominantly in current China. Its imposing manner, fancy appearance can be in harmony with the city's culture and scenery. The height of the main pylon which is made of C50 reinforced concrete is 155.11 m. The part above the bridge deck of the pylon is about 103m high, with torch like top. The cross section of the pillar is a single concrete box with its size varying from 6.0x3.2m on top to 7.0x5.0m at bottom, of which the wall thickness is from 0.7m to 1.3m.

The pylon is novel and beautiful in shape. It withstood the tests of several typhoons even during the construction, which demonstrates sufficiently the structural security of the pylon.

3.4 Streamline Hollow Steel Box Girder

The streamline hollow steel box girder with 3.0m height was selected. The top plate of steel box girder is 28.5m wide, and the cross section of the steel girder is a single box consisting of three rooms. The bottom plate having thickness of 12mm is streamline in circular line, with radius of 72.5m. The bottom plate together with the inclined side plate forms a "wind mouth" so that the girder can resist the wind force effectively. The steel diaphragm adopts hollow truss structure which is different from other conventional designs. The steel diaphragm at intervals of 3.2m consists of angle steels and connection plates.

Fig. 3: Hollow Steel Box Girder

4. Conclusion

The safe, economic and aesthetic principles have been implemented in the entire design process of Zhanjiang Bay Bridge. Having absorbed the recent techniques in bridge engineering worldwide, several breakthroughs were achieved. It represents the new frontier of the current bridge techniques. The bridge has already been open to service, and contributes much to the development of bridge techniques in the world.