Key Techniques for the Main Navigable Bridge of the Main Passageway of Ningbo–Zhoushan Port

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Abstract

The main navigable bridge is a three-tower steel box girder cable-stayed bridge with a span of 78+187+2×550+187+78 m. The design reference wind speed is 42.3m/s. The main navigation span can navigate 100,000-ton ships. In order to improve the overall stiffness of the bridge under unbalanced live loads, some measures are studied, such as the restraint conditions, the stiffness of the tower, the stiffness of the beam, the number of stay cables in the side and central tower, and so on. Through the wind tunnel test research, the control measures for the buffeting performance of the double cantilever are clarified. According to the IABSE vessel collision model, the vessel collision force is determined. A double-layer collision protection structure is used to protect the bridge and reduce vessel collision damage. In order to improve the structural durability, high-performance epoxy steel bars are used in the splash zone. The cable-anchor beams of the towers are made of weathering steel. Maintenance vehicles are installed in the main beam which is 1.63 km. Through the above measures, the structural performance is guaranteed.

Keywords: three-tower cable-stayed bridge; overall stiffness; buffeting performance of double-cantilever state; double layer collision protection structure; structural durability.

1 Introduction

The Main Passageway of Ningbo-Zhoushan Port (the “Main Passageway” hereafter) is located at the Zhoushan Islands in northeast Zhejiang Province, China. The Main Passageway has a design speed of 100 km/h, a standard subgrade width of 26.0 m, and a total length of 25.659 km (which covers an overwater length of 16.734 km and is configured with an overwater interchange). The total investment in the project is CNY 12.28 billion (approximately EUR 1.59 billion).

Due to the constraints on the construction project, the main navigable bridge was designed as a three-tower cable-stayed bridge with two main spans of 550 m, as shown in Figure 1. The design of the bridge needed to resolve the following key problems:

(1) Measures for ensuring the overall structural stiffness
(2) Wind-resistance performance in the maximum double-cantilever state during construction
(3) Vessel collision design of the structure
(4) Structural durability design

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