Calculation and construction study for the Novel Twin-Deck Cable-Stayed Bridge with shared pylon

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Abstract

Twin-deck cable-stayed bridge with shared pylon (TDBSP) is an innovative structural arrangement captured with complex mechanical performance and highly interaction effect between two bridges, as the deck layouts are asymmetrical and two bridges share one merged pylon leg. This paper explores the calculation and construction methods of TDBSP, based on the record-breaking Rod El Farag Axis Bridge. Single-beam model (SBM) and beam-plate model (BPM) are firstly established, and the numerical results are compared with field surveys as validations. Then, the interaction effect of two bridges during construction are studied, and a comparison of synchronous construction method (SCM) and asynchronous construction method (ASCM) are investigated during the construction of TDBSP.

Keywords: twin-deck cable-stayed bridge; shared pylon; finite element model; field survey; construction method.

1 Introduction

With the development in economics and increase in traffic volume, the bridge deck becomes wider and wider to accommodate more vehicle lanes (like eight or ten lanes) and fit ever-growing traffic demand. This results in another innovative configuration for cable-stayed bridge, twin-deck cable-stayed bridge, to extend bridge capacity and accomplish aesthetic appeal [1-3].

According to the pylon arrangement, twin-deck cable-stayed bridge can be categorized as separated pylon and united pylon. Separated pylon is the most predominant configuration for twin-deck cable-stayed bridge in practice, such as New Goethals Bridge in America [4], Bolshoy Obukhovsky Bridge in Russia [5], Jindo Bridge in Korea [6]. The two bridges with separated pylons have no connection with each other and they are actually two parallel cable-stayed bridges, so the structural mechanical responses of two bridges are pretty clear and independent. However, due to the technical advantages of large lateral rigidity and good stability, united pylon also can be a solution for twin-deck cable-stayed bridge. Based on the layout of pylon lateral connection, the united pylon can be grouped into two categories, partial united pylon and shared pylon. Table 1 and Figure 1 list twin-deck cable-stayed bridges with united pylons built in the world [7-11], wherein, the bridge numbers in Figure 1 are consistent with Table 1.

Twin-deck cable-stayed bridge with shared pylon (TDBSP) is an innovative structural arrangement, as the two pylons of twin-bridge are merged together and shared the inner pylon leg. TDBSP is favourable for the structural stability, economics and space saving, but poses challenges for the calculation and construction. TDBSP presents complex mechanical performance and highly interaction effect between two bridges as the deck layouts are asymmetrical and two bridges share one merged pylon leg. Thus, this paper studies the calculation and construction methods of TDBSP, based on the world's widest cable-stayed bridge - Rod El Farag Axis Bridge. Two kinds of finite element models are firstly established and numerical results are compared with field surveys at site as validations. Then, the interaction of two bridges during construction are

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