Effect of Concrete Thickness on Fatigue Performance for rib-to-diaphragm in steel-concrete orthotropic composite decks

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Abstract

In order to study the effect of thickness of rigid pavement on the fatigue performance of orthotropic deck, the shell-solid finite-element model was established to analyze the stress on the opening area of diaphragms in orthotropic deck under different concrete thickness. The results show that with or without rigid pavement, the stress distribution of the bridge deck and the hot-spot stress at the opening area of the diapragm are significantly different. The stess amplitude at the diaphragm-opening area of the orthotropic steel bridge deck with rigid pavement is only half of that in orthotropic steel bridge deck without rigid pavement. The thickness of the concrete has a great influence on the fatigue strength of the opening area of the diaphragm in orthotropic steel bridge deck when the concrete thickness is no more than 100 mm.

Keywords: Steel-concrete orthotropic decks; Finite-element method; rib-to diaphragm; Fatigue strength assessment approach.

1 Introduction

Orthotropic steel bridge decks have been widely used in long-span bridges due to their overall light weight, convenient construction, high strength and easy transportation. A typical tranditional orthotropic steel deck usually consists of a bridge deck plate、longitudinal and transverse stiffeners[1]. Despite inherently possessing excellent structural properties, orthotropic steel decks are prone to initiate cracks as a consequence of high cyclic stresses by wheel loads in conjunction with inevitable fabrication defects. Meanwhile, Orthotropic steel bridge decks usually use asphalt concrete as the pacements. Because of the insufficient stiffness in the deck and severe overloading, the pavements are always found damaged in long-term operation, which seriously limits the application and development of orthotropic steel bridge decks[2].

Relevent data shows that fatigue cracks of orthotropic steel bridge decks are mostly discovered in the conjunction of longitudinal ribs and transverse diaphragms. It has been found that when the opening height of the diaphragm is 1/3~1/2 of the height of the longitudinal rib, and the opening position is treated by a smooth transition, the diaphragm has better mechanical properties[3]. While Zhang[4] obtained the relationship between the thickness of the longitudinal rib and the shape of the opening by finite element analysis. In the fatigue tests of the welding forms of longitudinal ribs and transverse diaphragms conducted by Tsakopoulos[5], the test results indicated that the

https://doi.org/10.2749/nanjing.2022.0637
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