Research on Stress State in Composite Bridge Deck System with Orthotropic Steel Deck and Thin Reactive Powder Concrete Layer

Junhui CAO
Ph.D Candidate
Hunan University
Changsha, Hunan, China
caojunhui520@yahoo.com.cn

Xudong SHAO
Professor
Hunan University
Changsha, Hunan, China
shaoxd@hnu.edu.cn

Zhe ZHANG
Ph.D Candidate
Hunan University
Changsha, Hunan, China
fengzhizi0730@126.com

Bin CHEN
Ph.D Candidate
Hunan University
Changsha, Hunan, China
abin426@163.com

Zhengyu HUANG
Professor
Hunan University
Changsha, Hunan, China
zjy246@yahoo.com.cn

Summary

To treat with fatigue cracking problem in orthotropic steel deck and damage in asphalt pavement on it comprehensively, an innovative composite deck with orthotropic steel deck and thin reactive powder concrete was presented in this paper. Study was emphasized on stress state in the new composite bridge deck system. In research, calculation based on finite element models were carried out to compare stress state in two kinds of bridge deck system, namely, the traditional steel deck with asphalt overlay and the composite deck with thin RPC layer. Calculation result shows that stress in the deck plate and the longitudinal stiffer decreases greatly when the RPC layer is adopted, with the decreasing amplitude reaching 46.44 % - 82.39 %. This is helpful to diminish the risk of fatigue cracking in the steel deck. Then a full-scale composite deck model was made for load test to reveal its static performance. In experiment, the composite deck system performed well without any crack appearing in the RPC layer even though the maximum tensile strain in it reached as large as 955 $\mu\varepsilon$. Research in this paper is meaningful for exploiting an efficient new way to extending service life of the orthotropic steel deck and its pavement.

Keywords: orthotropic steel deck (OSD); fatigue cracking; Reactive Powder Concrete (RPC); composite deck; stiffness; full-scale model experiment.

1. Introduction

Since firstly used in Germany in the 1950s, the modern Orthotropic Steel Deck (OSD) has been applied as deck system in bridges all over the world. However, there are two typical problems with it. One is that fatigue cracking in the OSD poses as a common phenomenon. For instance, fatigue cracks were founded in longitudinal rib - to cross beam welds, longitudinal rib - to deck welds in the Severn Crossing [1]. The other is that asphalt pavement on the OSD is prone to damage such as cracking, rutting, debonding, etc [2].

Generally, these typical problems with the OSD system are researched and treated respectively. On the one hand, researchers try to promote its anti fatigue performance mainly through adopting thicker deck plate, improving configuration of welded details in design and fabrication procedures in construction [3-4].

On the other hand, researchers treat problems in the asphalt pavement by developing the design method, improving the material performance and so on [5]. However, diseases with the asphalt pavement on steel bridges are reported from time to time, especially in country whose traffic volume is great. Some other researchers apply cement concrete as overlay, such as the Steel Fiber Reinforced Concrete [6] and High Performance Concrete [7], which has been tested beneficial in reducing stress in the OSD. However, due to insufficient tensile strength, crack appears in the overlay itself [8].

In this paper, authors anticipate to cope with these two typical problems in the OSD system as an integral. It is known that the OSD is flexible with relative low local stiffness. As a result, local stress and displacement in the deck are generally large under vehicle load. When large tensile stress

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