39th IABSE Symposium – *Engineering the Future*
September 21-23 2017, Vancouver, Canada

Optimal Design and Fatigue Performances of Innovative Corrugated Orthotropic Steel Deck Plate-RPC Layer Composite Deck Structure

Zhang Qinghua, Cheng Zhenyu, Liu Yiming, Bu Yizhi, Li Qiao

Southwest Jiaotong University, Chengdu, China

Contact: swjtuzqh@126.com

Abstract

Fatigue problem of orthotropic steel deck posed great challenges to the sustainable development of bridges all over the world. Improving mechanical performance, increasing local rigidity, and decreasing stress concentration at the fatigue-prone details were the foundation to solve fatigue problem. Developing innovative composite deck structure was one of the promising solutions. An innovative composite deck structure was investigated, which composed of corrugated orthotropic steel deck plate, reactive powder concrete (RPC) layer and stud shear connectors. To explore the mechanical performance of the composite deck structure under different parameter combinations, an optimal design method was presented based on the BP (Back Propagation) artificial neural network. And a multi-object design optimal model was established to achieve the optimal structure design. The fatigue performance of the presented deck system under the typical fatigue vehicle load was analyzed by finite-element model. The fatigue stress amplitudes of the fatigue-prone details of the steel deck were decreased obviously. The results indicate that the presented optimal design method is feasible in determining the optimal structure design. The controlling fatigue-prone detail of steel structure is the cross weld between the corrugated deck plate and diaphragm. The innovative composite deck structure possesses excellent mechanical properties and fatigue performance.

Keywords: composite bridge deck; orthotropic steel deck; reactive powder concrete (RPC); optimal design; fatigue performance.

1 Introduction

Conventional orthotropic steel deck has been widely used in long span bridges due to its high load-carrying capacity, light weight, convenient construction, etc. However the cases of fatigue crack and bridge pavement damage appear continuously, which posed challenges to the sustainable development of bridge as investigated by Wolchuk[1] and Connor[2]. New type bridge deck structure system has been proven to be as one of the most promising way to address the difficult problems confronted by conventional orthotropic steel deck. Large-scale longitudinal rib orthotropic deck structure was adopted to improve the fatigue performance of orthotropic steel deck by decreasing the amount of weld joints significantly. But the weld joints between bridge deck and longitudinal rib and between diaphragm and longitudinal rib were still the controlling fatigue-prone details of orthotropic deck as discussed at the conference[3] and as studied by Wolchuk[4]. The

https://doi.org/10.2749/vancouver.2017.2043
Distributed by structurae