



Parametric FE Analysis for Fatigue Behavior of Rib-to-Deck Welded Joints in Orthotropic Steel Decks

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Summary

In the decades, orthotropic steel bridge decks were experienced a variety of fatigue problems from wheel load cycles and welding quality of welded joints. The crack initiation at the weld root between deck plates and U-rib was considered as one of the most serious cracks. In this study, fatigue tests and finite element analysis were conducted. In fatigue test results, the failure at the weld root shown to be easier than weld toe. Increase the penetration rate is better for reduction of stress range and stress concentration at weld root. In addition, the specimen with a changed thickness from 12mm to 16mm led to the decrease of stress range. A thicker deck plate would own a longer fatigue life before crack initiation, which was agrees with the results of tests.

Keywords: Orthotropic bridge deck; full-scale fatigue test; penetration rate; root crack; FEM

1. Introduction

Orthotropic steel decks were widely applied to the long-span bridges due to the light weight, higher durability and more rapid construction potential. However, the structures have experienced a variety of fatigue problems from wheel load cycles and welding quality of weld joints. Recently, the various fatigue cracks have been reported on the deck plate to rib and rib to floor beam welds. The crack initiation at the weld root between deck plates and U-rib was considered as one of the most serious cracks, location of fatigue crack cannot be inspected easily and might cause the deterioration of the road surface.

Until now, full-scale fatigue test of orthotropic steel deck were usually conducted to evaluate its fatigue performance at weld root. (Sim et al. [1] Kawabata et al. [2]). Some scholars had demonstrated the local stress around rib-to-deck weld joint by FE analysis. (Xiao et al. [3]) At the same time, the effect of penetration rate and the deck thickness were considered as two important parameters for this structure detail (Mori et al. [4] Murakoshi et al. [5]). However, disputes still existed about the effects on fatigue durability. Consider the different weld penetration rate and deck plate thickness, the fatigue behaviors of the root cracks were not yet been fully investigated.

In this study, fatigue tests and finite element analysis were conducted to investigate the fatigue behaviour of weld root. Different types of wheel loading, the effects of deck plate thickness and weld penetration rate were considered in the fatigue tests. In addition, elasticity FE models were conducted to calculate the structure response and verified the results in following two aspects: Firstly, deformations at mid-span were compared between different wheel loading cases. Secondly, local stress distributions near root tip were compared and parametric investigated by models with different dimension and weld penetration rates.