Comparison of Different Design Codes on Fatigue Assessment of Typical Welded Joints in Orthotropic Steel Bridge Decks

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Abstract

Many fatigue cracks have been gradually detected in typical fatigue-prone details of orthotropic steel decks (OSDs), which will lead to the reduction of fatigue life, load-carrying capacity and operation safety to some extent. In this regard, design codes for steel structures play a significant role in ensuring the fatigue resistance with high reliability. However, small differences between design standards may have a great influence on fatigue assessment. To explore and compare the variations, a full-scale FEA model of OSDs in a real bridge was developed. The hot spot stress histories and stress amplitude spectrums of toe-deck fatigue cracking at rib-to-deck (RTD) welded joints were precisely calculated, and based on this, the fatigue life evaluation was conducted. The results indicate that the fatigue resistance of this detail can meet the design requirements, but the fatigue lives which were evaluated according to Eurocode 3 and Chinese JTG specifications respectively, have a significant difference between them. The primary cause for this is that stress concentration effects vary with the contact area of wheel load under different fatigue load models, which may have a critical influence on hot spot stress range used to predict fatigue life.

Keywords: fatigue evaluation; fatigue design codes; rib-to-deck welded details; hot-spot stress method; OSDs.

1 Introduction

As an innovative structure system of steel bridge deck, orthotropic steel decks (OSDs) have been extensively put into use in plenty of existing and newly-built highway bridges, and increasingly been adopted in high-speed railway bridges, due to the inherent advantages they display such as high load-bearing capacity, expedient construction and the cost effectiveness. However, as reported in practical engineering, a large number of fatigue cracks have been detected at welded joints and local regions with high level of stress concentration effects [1]. The major cause for this is that OSDs were directly and repeatedly suffered from locally concentrated wheel loading which may lead to a higher local stress value at welding areas, and in general, welding-induced residual stresses, welding defects and structural discontinuities are considered as the significant reasons of fatigue cracking as well. Though a number of improvements for OSDs with regard to design, fabrication, inspection and maintenance have been achieved, and subsequently the fatigue resistance of typical structural details has been significantly enhanced since such structure system was employed, the rapid increase of traffic volume and wheel load in the past decades makes the fatigue cracking of OSDs an even tougher issue.

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