# Fatigue Features and Optimal Design of Orthotropic Steel Deck with a New-type of Rolled U-ribs

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## Abstract

Fatigue crack at rib-to-deck welded joints of orthotropic steel deck is one of the most important issues that pose great challenge to the durability of steel bridges. The main reason for these kinds of fatigue cracks located in the detail is the high local stress concentration in the connection joint. A new-type of rolled U-rib with a thickening rib wall adjacent to the rib-to-deck joint was proposed to reduce the local stress by enhancing local stiffness. The mechanical characteristics of orthotropic steel deck with the presented ribs under wheel loads were investigated by three-dimensional finite element method. Besides, optimal design for the local geometry of the rolled edge was carried out. And the fatigue performance of orthotropic steel deck composed of the presented ribs was evaluated by two assessment methods. The results indicate that the local stress concentration in the adjacent region of welded joint between deck plate and rib wall is alleviated notably and the structural fatigue performance is significantly improved compared to conventional orthotropic steel deck with constant thickness U-rib walls. The new-type of rolled U-rib is suitable for the enhancement of the structural durability of the orthotropic steel deck.

**Keywords:** orthotropic steel deck; new-type of rolled U-rib; fatigue; finite element analysis; optimal design

## 1 Introduction

Orthotropic steel deck (OSD) has been widely employed and become an essential component for long-span bridges for its notable advantages such as light self-weight, high capacities and convenience to construction, etc [1]. However, OSD is prone to fatigue because of the influences of unfavourable factors from structural system, fabrication, construction and maintenance. Theoretical and experimental investigations reveal that most fatigue cracks in orthotropic steel deck bridges are located at partial penetration fillet welded connections as a result of the cyclic local stress induced by a large amount of heavy vehicles. It is worth noting that fatigue cracks in rib-to-deck connections account for 18,9% of the total damage types in orthotropic steel deck bridges according to the investigation by Japan Society of Civil Engineers (JSCE) [2]. Four types of fatigue cracks have been observed in rib-to-deck weld joints [3], as shown in Figure 1. These cracks



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