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Developing Cost-Effective Rib-to-Deck Plate Connections for Steel Orthotropic Bridge Decks

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Abstract

Cost-effective rib-to-deck plate connections is the key to economic fabrication of steel orthotropic bridge decks. A partial joint penetration (PJP) groove weld with a 70~80% penetration and a tight fit-up gap (≤0,02 in.) are often specified for this connection. Efforts for optimizing fabrication parameters and destructive or non-destructive inspections for adequate penetration often increase the cost of fabrication. Recently, a research was conducted at Lehigh University, where the effect of different fabrication parameters were investigated, and the efficacy of modern Phased Array Ultrasonic Testing (PAUT) for inspecting the weld penetrations was evaluated. The research provided valuable insight into the critical fabrication parameters for developing cost-effective rib-to-deck plate connections and identified the limits of PAUT in consistent measurement of weld penetration.

Keywords: cost-effective, rib-to-deck plate connections, PAUT, fabrication, orthotropic.

1 Introduction

Steel orthotropic decks are typically used for long span bridges because of their light weight that reduces dead load and allows increased span length. However, high initial fabrication cost for achieving desired fatigue resistance often render this deck form less cost-effective. Due to sheer length, the rib-to-deck plate welds contribute to most of the fabrication cost. A partial joint penetration weld with or without joint preparation on the rib wall is often specified for this connection. Joint preparation involves bevelling the relatively thinner ribs to the specified penetration, leaving a small landing that is too susceptible to blow through condition. Fabrication of this connection without joint preparation to prevent blow through requires larger heat input for achieving desired penetration, which may result in hot cracking if not carefully controlled. In addition, achieving a consistent penetration over the entire length of the connection requires automatic fabrication methods using either Submerged Arc Welding (SAW) or Gas Metal Arc Welding (GMAW) process with stringent control of fabrication parameters and verification of the penetration by continuous inspection. However, traditional non-destructive inspection techniques such as UT is incapable of continuous scanning along the weld. As such, the verification of weld penetration is limited to destructive evaluation of sections in mock-up panels, and at the start and end of production panels. A research was conducted at Lehigh University where the effects of different fabrication parameters were investigated in full-scale specimens with 19 mm ($^3/_4$ in.) deck plate and 8 mm ($^5/_{16}$ in.) rib, and the efficacy of the continuous scanning capabilities of modern PAUT techniques was evaluated.

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