Short Stud Arrangement Effect on Flexural Behavior of Steel-UHPC Composite Decks

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Abstract

To investigate the effects of short stud arrangement on flexural behavior of steel-UHPC composite decks, a static bending test was conducted on a full-scale segmental specimen and a parametric analysis was executed based on a validated finite-element model. The test results showed that when UHPC crack width reached 0,10 mm, the measured strain of UHPC was 1568 με, accounting for 47% of the material ultimate tensile strain. And the corresponding nominal stress of UHPC was largely over the material cracking stress. The parametric analysis results showed that increasing stud spacing from 200 mm to 300 mm increased the UHPC cracking load by 9,7% because of a lower composite action; compared with the normal arrangement, studs arranged in groups with the same amount could increase the UHPC cracking load by 11,1% while maintaining the combined effect. However, this was under the condition that the steel and UHPC partially interacted.

Keywords: steel-UHPC composite decks; short stud arrangement; flexural behavior; finite element simulation; parametric analysis

1 Introduction

Combining an ultra-high performance concrete (UHPC) slab with an orthotropic steel deck by shear connectors can significantly enhance the bending stiffness of the deck, reduce the cracking risk of fatigue-prone details, and ameliorate structural diseases of the pavement [1,2,3]. The cubic compressive strength and tensile strength of UHPC are normally more than 120 MPa and 7 MPa, respectively. Besides, excellent post-cracking behavior can be observed on the material under tension due to the strain-hardening feature [4].

In the last decade, application cases of the steel-UHPC composite deck increased rapidly among new projects and reconstructions of aged bridges. The shear connector is crucial to achieving a satisfying combination between the steel deck and the UHPC slab. Main structural forms of the shear connector include headed stud, section steel, reinforcement mesh, etc., among which headed stud is most commonly adopted because of constructional convenience and mechanical reliability. However, since the thickness of the UHPC slab is usually small, the headed stud used in the steel-UHPC composite deck typically has a height of 40 mm and a diameter of 13 mm, leaving

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