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Punching Shear Based Design of Concrete-Filled CHS T-Joints under In-Plane Bending

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Abstract

The in-plane bending behaviour of concrete-filled circular hollow section (CHS) T-joints was examined in this paper. The main failure mode, the punching shear of the chord-wall, was observed from the test of four large-scale joints with the diameter ratio of brace to chord (β) ranging from 0.44 to 0.85. The tube-wall deformation was measured to assess the governing failure mode of the composite joints. Complementary finite element (FE) methodology was verified against the experimental findings and the validated FE models were used to further investigate the mechanical behaviour and the design methodology. The feasibility to apply a fracture criterion in the material-level to a large-scale structural simulation was evaluated. The validated FE modes could successfully capture the tube-wall fracture initiation and propagation. Based on both experimental and numerical investigations, it was shown that the capacity of composite joints was governed by the ultimate strength limit, i.e. punching shear strength, due to the infill concrete that mitigated both inward and outward deformation on the compressive and tensile sides, respectively. The analytical model was established to reveal the composite actions between the tube and the inner concrete, and to elaborate the development of the flexural section-resistance. Finally, the design equation was proposed and could well predict the moment capacity.

Keywords: *Concrete-filled steel tube; Tubular joint; In-plane bending; Fracture; Punching shear; Design.*