FLEXURE-SHEAR CAPACITY OF PERFORATED STEEL BEAMS WITH NOVEL REINFORCEMENT

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ABSTRACT

This study investigates a reinforcement method for I-section steel beams with a circular web opening; half-ring reinforcing plates were proposed for economy and structural performance. To verify the proposed method, cyclic loading tests were conducted for cantilever beams with a web opening at the plastic hinge zone. The test parameters were shear-span ratio (L/d = 4.9 or 2.9), opening diameter-to-beam depth ratio (H/d = 0.5 or 0.67), and ring-to-opening diameter ratio ($2R/H$ = 1.3, 1.5, or 1.7). The test results showed that properly designed ring plates successfully strengthened the web opening to induce the plastic hinge at the beam end. Further, the proposed ring plates were effective in assuring large inelastic deformation irrespective of design parameters. This result indicates that the proposed method can be used not only for strengthening, but also for ductility enhancement. In order to evaluate the test strengths, flexure-shear interaction capacity was assessed for the perforated sections with and without reinforcement, addressing the secondary moment in Tee-sections above and below the opening. The proposed model well predicted the strengths and failure locations of the test specimens. The predicted strengths can be used to design the required thickness of fillet weld between the web and ring plates.

Keywords: Perforated steel beam; Circular web opening; Opening reinforcement; Half-ring plates; Flexure-shear capacity; Cyclic loading test

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