Optimization of shapes of weld access holes at the end of I-section beams based on the prediction approach for brittle fracture – Part II. Effect of propagation direction of ductile cracks

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ABSTRACT

The 1995 Kobe earthquake caused significant damage for steel buildings in Japan. Brittle fracture caused by cracks initiating from the toe of the weld access hole or weld tab regions in the beam flanges. Authors focused on the improved profile of weld access hole using the partial cutting fillet welds (PCFW) that can be used on field-welding and avoid stress concentration. Experimental results in 2018, 2019, 2020 revealed that the improved composite circular beam cope shape procedure and improved AISC procedure were the most effective shape against brittle fracture. This paper describes effect of propagation of ductile cracks at the toe of improved AISC profile on deformation capacity of welded joints as Part II. This paper aims to optimize the correlation of the web thickness and leg length of submerged arc welding.

KEY WORDS: Brittle fracture; Plastic constraint; Toughness scaling model; Weld access hole; Field-welding

NOMENCLATURE

\[ J_e \] Critical J-Integral of material obtained through SENB testing
\[ J_{app} \] Apparent \( J_e \)
\[ M_{prc} \] Predicted maximum moment of the cantilever area
\[ M_{max} \] Measured maximum moment of the cantilever

INTRODUCTION

The 1995 Kobe earthquake caused significant damage for steel buildings in Japan. Brittle fractures caused by cracks initiating from the toes of the weld access holes or weld tab regions in the beam bottom flanges. The stress concentration due to the configuration of the weld access hole considered to be a major problem since the fractures were reported to initiate at the toes of the weld access hole (AIJ, 1995). Therefore, experiments were conducted using specimens with various weld access hole shapes. As a result, the composite circular beam cope shape and no weld access hole procedure were recommended (AIJ, 1996). The no weld access hole procedure could not be used on site. The composite circular beam cope shape could not effectively suppress stress concentration. Therefore, the connection with horizontal haunches at the beam end was proposed (Tanaka et.al., 1998). However, using horizontal haunches may increase manufacturing cost. For the reasons, a procedure that can be used for on-site and does not use the no weld access hole procedure or horizontal haunches is required. On the other hand, the partial cutting fillet welds (PCFW) procedure (Nakagomi et.al., 2016) was developed to improve the deformation capacities in the beam end. Finally, using combined the PCFW procedure and the modified weld access hole proposed. In the previous cyclic loading test using simplified models of welded I-section beam-to-diaphragm connection, it was found that the details recommended by AISC significantly contributed to improve the plastic rotation capacity of the beam (AISC, 2016, FEMA, 2000). However, the test results demonstrated that the intersection point of the tapered part and arc of radius 10mm in the weld access hole must be