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J-integral analysis of surface cracks in round bars under tension loadings

Abstract

This paper presents a non-linear numerical investigation of surface cracks in round bars under tension stresses by using ANSYS finite element analysis (FEA). Due to the symmetrical analysis, only quarter finite element (FE) model was constructed and special attention was given at the crack tip of the cracks. The surface cracks were characterized by the dimensionless crack aspect ratio, a/b = 0.6, 0.8, 1.0 and 1.2, while the dimensionless relative crack depth, a/D = 0.1, 0.2 and 0.3. The square-root singularity of stresses and strains were modeled by shifting the mid-point nodes to the quarter-point locations in the region around the crack front. The proposed model was validated with the existing model before any further analysis. The elastic-plastic analysis under tension loading was assumed to follow the Ramberg-Osgood relation with n = 5 and 10. J values were determined for all positions along the crack front and then, the limit load was predicted using the J values obtained from FEA through the reference stress method.

Keywords — Finite element analysis, j-integral, limit load, stress intensity factor, surface cracks