Wang, Y.-Y., On the Two-Parameter Characterization of Elastic-Plastic Crack-Front Fields in Surface-Cracked Plates, ASTM International, STP18026S, 1993

Abstract

Plane-strain elastic-plastic crack-tip fields at a constant *J* and various elastic *T*-stress levels were obtained in a modified boundary layer (MBL) formulation similar to that of Betegón and Hancock but with a slightly different power law hardening stress-strain law. The analyses were based upon small geometry change formulation and deformation theory plasticity. To verify the two-parameter characterization of elastic-plastic crack-tip fields, three-dimensional (3-D) elastic-plastic finite element (FE) analyses were performed on plates with deep ($a/t = 0.60$) and shallow ($a/t = 0.15$) semielliptical surface cracks under both remote tension and bending. Here *t* is the plate thickness and a is the maximum penetration of the crack through the plate thickness. In topological planes perpendicular to the semielliptical crack fronts, the crack-opening stress fields, normalized by the local *J*, were compared with the plane-strain MBL predictions based upon the local *J* and *T*. In all four cases studied, better than 94% agreement between the 3-D FE solutions and the plane-strain solutions was obtained for loads up to general yielding. This remarkable agreement held throughout all crack-front locations where the stress fields could be resolved accurately. Given the vastly different distributions of *J*, *T*, and crack-opening stress profiles along the collective set of respective crack fronts, the elastic *T*-stress appears to be a tractable, predictive parameter in quantifying elastic-plastic crack-front stress constraint.

Keywords

Crack-tip constraint, *T*-stress, Two-parameter characterization, *J*-dominance, Surface cracked plates, Three-dimensional, Finite element analysis