Elastic-Plastic Interaction of a Griffith Crack with a Circular Inclusion and Nearby Edge Dislocation

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Abstract

The problem of a Griffith crack interacting with a circular inclusion by considering the influence of a nearby edge dislocation is studied in this work. The cracks are modelled by distributed dislocation method, which results in a set of singular integral equations with Cauchy kernels and can be solved numerically. It is noted that fracture behavior studies based on the linear elastic fracture mechanic theories are not accurate enough when yielding occurs around crack tips. The Irwin plastic zone correction method is employed in the present work to analysis the yielding behavior in the crack tip area. Two parameters including the plastic zone size and crack tip opening displacement (CTOD) of the yielding zone are evaluated by connecting them to the stress intensity factors. The von Mises yield criterion is used to differentiate the elastic and plastic deformation at the crack tips. To analyze the elastic-plastic fracture behavior of a Griffith crack interacting with a nearby edge dislocation and a circular inclusion, we emphasized the influence of the inclusion/matrix material properties, dislocation position parameters and burgers vectors of the edge dislocation. Numerical results have found that the normalized stress intensity factor, normalized plastic zone size and normalized CTOD are very sensitive to the change of edge dislocation position against the target crack tip. When the distance between the edge dislocation and crack tip are fixed and only the angle varies, the maximum value of the normalized stress intensity factor can be achieve at $\pm 60^{\circ}$. When the edge dislocation is located along the crack line or vertical to the crack line, the normalized SIF, PZS and CTOD are smaller than the rest. The mixed-mode loading condition also contribute to the SIF, PZS and CTOD a lot and influences the effect of other parameters.

Keywords: Nearby dislocation, Griffith crack, Plastic zone, CTOD, Stress intensity factor.