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Axisymmetric thermo-elastic field in an infinite space containing a penny-shaped crack under a pair of symmetric uniform heat fluxes and its applications

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Abstract

This paper deals with the problem of an infinite isotropic solid weakened by a penny-shaped crack, which is subjected to a pair of uniform heat flux loadings symmetrically exerted on the upper and lower crack surfaces. Three-dimensional thermo-elastic field variables are obtained by means of potential theory method in company with the newly developed general solution. Some physical quantities on the cracked plane, such as temperature, radial displacement, crack surface displacement, normal stress at the crack front and stress intensity factor, which are important parameters in fracture mechanics, are presented in closed-forms. In the framework of ideal thermo-elasto-plasticity, the extent of the plastic zone at the crack front is determined by the Dugdale crack model, which linearizes the original non-linear problem. The refined crack surface displacement and normal stress outside the crack are also obtained via the principle of superposition. Numerical calculations are carried out to validate the present solutions and to show the distributions of the axisymmetric thermo-mechanical fields. The present solution could be served as a reference for the infrared-thermography technique.

Keywords: Penny-shaped crack, Heat flux loading, Thermo-elastic fields, Dugdale model, Plastic zone

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