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Thermal stress intensity factor for an edge crack in orthotropic composite media

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Abstract

The purpose of this article is to determine the thermal stress intensity factor (SIF) of an edge crack situated in an orthotropic strip of finite thickness h bonded to an orthotropic half plane, under thermal and mechanical loadings. The problem is reduced to a singular integral equation of the first kind. The integral equation is converted to a pair of the singular integral equations using asymptotic expansion method. The analytical expression of the stress intensity factor at the edge crack tip is found for concentrated point loading. The numerical values of SIF are computed for different point loading for various crack lengths and different ratios of thermal conductivities for different particular cases when the composite orthotropic material is the mixture of Steel-Myler and E-Glass epoxy. The significant feature of the article is the pictorial presentations of the variations of SIF due to the effect of ratios of thermal conductivities of both the materials.

Keywords: Edge crack, Orthotropy, Composite material, Thermal loading, Stress intensity factor.

1 Introduction

The failure behavior and cracks in engineering structures generated by application of several thermal loading may be obtained due to thermal-stress effects [1, 2]. To prevent micro cracks and catastrophic failure of materials and for interpreting the service life and reliability of engineering structures, it is important to analyze the thermo-elastic behavior of cracked materials [3, 4]. One can observe that lot of works have been done for cracked material under application of the thermal loadings to analyze the thermo-elastic fields. By using Hankel transform, Olesiak and Sneddon [5] solved the problem of a penny-shaped crack situated in an isotropic material under the temperature at the crack surface. Near the tip of crack situated in an isotropic medium, the temperature field and thermal stresses are analyzed by Sih [6] whereas the same stresses and thermal effects in anisotropic bodies were studied by Sih *et al.*, Tzou, Chao and Chang [7, 8, 9]. The expression of the thermo-elastic fields under the thermal loading for the crack of type penny-shaped in an infinite solid is obtained by Florence and Goodier [10]. Under the various temperature and application of loading the analysis of thermal stresses for a penny-shaped crack inelastic material are done by Kasir and Sih [11]. Atkinson and Clements [12] suggested a mixed-mode fracture under thermal loading. The problem of plane thermoelastic under the application of uniform heat flow in crack situated in an orthotropic material was analyzed by Tsai [13]. The expressions and effects of thermal stresses induced by penny-shaped crack positioned in a semi-infinite material are analyzed by [14] whereas the crack situated at the interface of materials is obtained by [15, 16]. By considering the crack parallel to boundaries of a slab under thermal loading, the problem of generalized plane strain was studied by Thangjitam and Choi [17]. The expressions for thermal stress intensity factor for the crack embedded in an elastic material, which is parallel to an isotropic half plane, has been obtained by Liu and Kardomater [18]. Thermal stresses generated by a pair of offset parallel cracks embedded in an orthotropic infinite plane under uniform heat flow distribution are studied by Choi [19].

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