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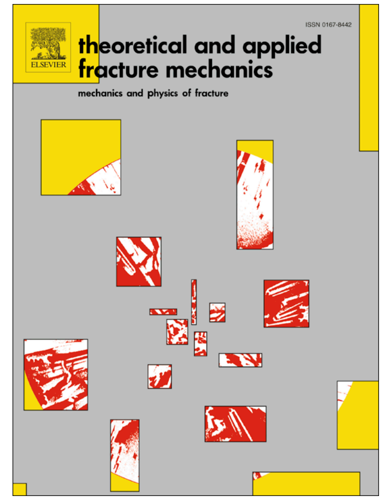

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Torsion Analysis of Infinite Hollow Cylinders of Functionally Graded Materials Weakened by Multiple Axisymmetric Cracks

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Abstract

In this paper, mode III stress intensity factor for the multiple axisymmetric cracks in the infinite hollow cylinder made by functionally graded materials base on the dislocation technique is formulated. The shear modulus of the material of the cylinder is assumed to vary with the radial coordinate by a power law. It is assumed that the outer surface of the hollow cylinder is under the action of two distributed self-equilibrating lateral shear tractions and inner surface of the cylinder is free of stress. The solution of an axisymmetric rotational Somigliana ring dislocation in a functionally graded materials infinite hollow cylinder is obtained by means of a separation of variables technique. Next, the distributed dislocation method is used to formulate integral equations for a system of coaxial axisymmetric cracks, including annular, inner edge and outer edge cracks. The ensuing equations are of the Cauchy singular type and have been solved numerically to determine stress intensity factor. Numerical examples are provided to show the effects of material properties and crack type and location on the stress intensity factors and also to study the interaction of multiple cracks.

Keywords: Torsion, Infinite hollow FGM cylinder, Axisymmetric cracks, Dislocation density.

1. Introduction

Solid or hollow cylinders have extensively practical applications in engineering. Torsion problem of a cracked cylinder is one of the favorite subjects for researchers in the science of fracture mechanics, so that the problem of a cracked cylinder with an axisymmetric crack [1-11] or multiple axisymmetric cracks[12-14] has been treated by many researchers. However, these researches mainly concentrated on homogeneous materials. In recent years, functionally graded materials (FGMs) have widely been applied in extremely high temperature environments such as turbine system, nuclear and chemical industries and in other applications. The spatial variation of the elastic and physical properties of the material makes FGMs an attractive alternative to composite solids. With the application of functionally graded materials in engineering structures, significant efforts including analytical, numerical and experimental investigations have been made in the study of the fracture behavior of FGMs. The analytical and computational solution of cracked FGMs cylinders is a challenging problem due to the complexity of the problem, singularity at crack tips, interaction between multiple cracks, and their interaction with the cylinder free surface. Due to these challenges, the number of research articles dealing with this problem is limited. In what follows we review these papers [15-20]. In these papers is assumed that the shear modulus of the FGMs cylinder was varied as a power form in the radial direction [16-20], except for reference [15] in which a power-form variation of the shear modulus of the cylinder was considered in the axial direction. Kassir [15] obtained a closed form solution for