Stresses Around Two Rigid Cylindrical Inclusions in an Infinite Elastic Body Under Tension

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Abstract

Stresses in an infinite elastic body having an infinite length cylindrical cavity with two rigid cylindrical inclusions of finite length are determined. Uniform tensile stress acts in parallel with the axis of the cavity. At the two contacting surfaces the normal and shear stresses are introduced with conditions of no axial slippage. Four simultaneous integral equations which arise are solved by using the Schmidt method. Contacting surface stresses and approximate tensile stress in the inclusion are calculated numerically.

Introduction

Recently, fiber reinforced plastics have been widely used in designing the various members of a machine or structure because they are of high strength and are not heavy. In such material, the loads are transmitted from the matrix with a low degree of stifiness to the fibers with a high degree of stifiness through the interfaces.

It is very complicated to obtain the stress field around a finite length circular cylindrical inclusion in an infinite elastic body. To bypass the difficulty, Kasano et al.[1] assumed that the cylindrical inclusion of a finite length is rigid and is sticked to an infinite length cylindrical circular cavity in an infinite elastic body. In their study, it is shown that high tensile stress occurs in the central part of the fiber. This means that the fiber may be broken in two pieces.

In this paper, to clear the mutual effect of two inclusions upon stresses around them, axisymmetric solutions are obtained for the stress field around two circular rigid inclusions of an equal size which are bonded into an infinite cylindrical cavity in an infinite elastic body under tension. Application of Fourier transform technique reduces the problem to that of solving a pair of dual integral equations. To solve the integral equations, the author expands surface stresses in a series of functions which are automatically zero outside of the contacting surfaces, and uses the Schmidt method[2].

Numerical calculations are carried out for the contacting stresses and the approximate tensile stress in the rigid cylindrical inclusion.

Formulation

A cylindrical coordinate system (r, θ, z) is defined as shown in Fig. 1 with $2r_i$ being the

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