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An elasticity solution for functionally graded thick-walled tube subjected to internal pressure

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Abstract

An elasticity solution for the functionally graded thick-walled tube subjected to internal pressure is given in terms of volume fractions of constituents. We assume that the tube consists of two linear elastic constituents and the volume fraction for one phase is a power function $c(r)=c_0\left[1-k\left(r/b\right)^n\right]$ varied in the radial direction. By using the rule of mixture and the assumption of a uniform strain field within the two linear elastic constituents, this paper obtains the hypergeometric differential equation of the radial displacement. The closed form solution of the hypergeometric differential equation is given and the corresponding radial displacement and the stresses are presented. The present method is valid for the materials with different Poisson's ratios rather than constant Poisson's ratios usually used in the existing references to obtain the effective Young's modulus. The effects of the volume fraction and Poisson's ratio as well as the ratio of two Young's moduli on the radial displacement and the stresses are studied. To reduce the stress concentration in the FGM tube, the difference between the circumferential and radial stresses is discussed and the optimal ratio of two Young's moduli is presented.

Key words: Elasticity solution, Functionally graded material, Thick-walled tube.

1. Introduction

Functionally graded materials (FGMs) are composite materials formed of two or more constituent phases with a continuously variable composition. FGMs have a lot of advantages that make them attractive in potential applications, including a potential reduction of in-plane and transverse through-the-thickness stresses, an improved residual stress distribution, enhanced thermal properties,

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