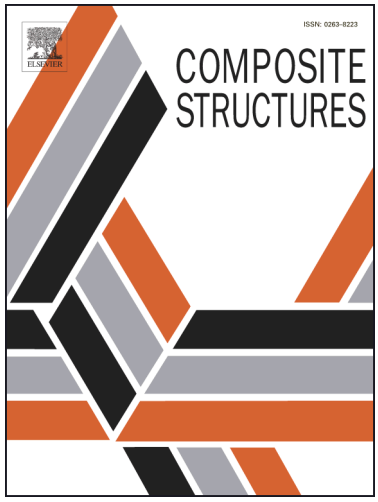

Plate assembly technique for nonlinear analysis of relatively thick functionally graded plates containing rectangular holes subjected to in-plane compressive load

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Plate assembly technique for nonlinear analysis of relatively thick functionally graded plates containing rectangular holes subjected to in-plane compressive load

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Abstract

In the present study, nonlinear behavior of relatively thick functionally graded plates containing square and rectangular cutouts has been analyzed. The effects of cutout size and location for plates with different boundary conditions under uniaxial in-plane compressive load are studied. The volume fraction of the material constituents follows a simple power law distribution. The structural model is based on first order shear deformation theory and Von-Karman's assumptions are used to incorporate geometric nonlinearity. The perforated plate is modeled by assembling eight plate-elements and the connection between these elements is provided by the Penalty method. This technique is called plate assembly technique in this paper. The fundamental equations for perforated plates are obtained by the principle of minimum of total potential energy and the response is found by solving the obtained nonlinear set of equations using the quadratic extrapolation technique. The approximation of the displacement fields in this study has been based on the Ritz method and by Chebyshev polynomials. The load-displacement responses for plates with various cutouts and with different boundary conditions are extensively provided. The accuracy of the present work is examined by comparing the results with the finite element analyses by ABAQUS program wherever possible.

Keywords

Nonlinear behavior, square/rectangular cutouts, Functionally graded plates, Plate assembly technique, Penalty method, Chebyshev polynomials

1. Introduction

Functionally graded materials (FGMs) were introduced for the first time in 1984 by a group of material scientists in Japan [1]. These materials are typically a mixture of ceramic and metal and the volume fractions of two or more constituents have been varied continuously as a function of position along certain dimension of the plate. By gradually varying the volume fraction of material constituents, their mechanical properties change smoothly and continuously from one surface to the other one. The mixture of ceramic and