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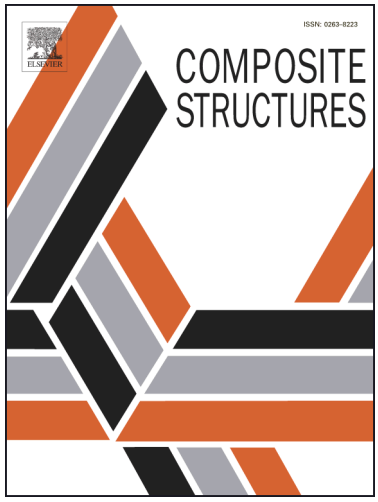

A semi-analytical investigation on geometric nonlinear and progressive damage behavior of relatively thick laminated plates under lateral pressure and end-shortening

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ACCEPTED MANUSCRIPT

A semi-analytical investigation on geometric nonlinear and progressive damage behavior of relatively thick laminated plates under lateral pressure and end-shortening

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Abstract

Because of applications of composites in aircraft structures such as skin panels in the wings subjected to lift forces, ultimate strength estimation of these structures is of great importance. In order to more realistically simulate these structures, relatively thick composite plates are analyzed under both end-shortening and lateral pressure loadings using a new simplified and reliable approach. Ultimate strength, progressive damage and geometric nonlinear analyses of such laminates under these loading conditions have not been done yet. Therefore, in the present study, first order shear deformation plate theory is considered with the assumptions of large deflections to perform the geometrically nonlinear and progressive failure analysis of moderately thick composite plates. In order to simulate the lift loads, two different types of lateral pressure distribution have been assumed to be applied on the plates; uniform and sinusoidal lateral pressure loads. The initial failure loads are calculated by means of elastic stress analyses. In this investigation, Hashin failure criteria have been selected for predicting failures. To modify the material properties, two geometric models have been considered to estimate the degradation zone around the failure location; degrading the material in regions of the plies or degrading the entire plies. The load is then increased step by step and for each given load, the stresses are reevaluated to inspect for possible failure. This procedure is repeated for each load increment until the final failure occurs and then ultimate strength is determined. To verify the proposed formulation, obtained results are compared with those calculated by finite element analyses. Plates having a range of thicknesses and with different intensities of pressure load have been analyzed extensively.

Keywords:

Ultimate strength, Geometric nonlinearity, lateral pressure, Progressive damage, Hashin criteria

1. Introduction

Thin-walled structures have widely used in various structural components. Plates made of fiber reinforced composite materials are one of these structures. They have been widely used in various industries such as spacecraft, high speed aircraft and automobiles because of their advantages of weight and mechanical properties with regard to metallic materials. For moderately thick composite plates, post-buckling and geometric nonlinear analyses without taking account of damage and material

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