Post-buckling analysis of stiffened braided cylindrical shells under combined external pressure and axial compression

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Abstract

A post-buckling analysis is presented for a stiffened braided thin shell subjected to combined loading of external pressure and axial compression. The effects of the nonlinear large deflection and the initial geometrical imperfection are considered in the formulations. The analysis uses perturbation method to determine the interactive buckling loads and the post-buckling equilibrium paths and a three-cell model are used to obtain the elastic constants of braided shell. Some effects such as imperfection parameter, stiffened and Braiding parameters on the post-buckling path are discussed in the article.
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1. Introduction

The post-buckling response of braided composite cylindrical shells subject to combined axial loads and external pressure has been of interest in recent years due to braided composite cylindrical shells being widely used in aerospace, marine and ocean engineering practice. These cylindrical shells are often reinforced by stiffeners and may have significant and unavoidable initial geometrical imperfections. Therefore, the post-buckling behavior of stiffened braided cylindrical shells under various loading conditions is very urgent.

There are a number of previous studies on the buckling and post-buckling analyses of composite cylindrical shells under single loading cases. The buckling of orthotropic cylindrical shells under external pressure and axial compression was studied by Hess [1]. A buckling study for heterogeneous anisotropic cylindrical shells subject to combined loading was performed by Cheng and Ho [2] and Ho and Cheng [3]. The influence of coupling between bending and extension on iterative buckling loads of stiffened multilayered composite cylindrical shells was analyzed by Jones [4]. The effect of initial geometrical imperfections on the interactive buckling loads was investigated by Abu-Farsakh and Lusher [5]. The influence of the nonlinear pre-buckling deformations on the interactive buckling loads was studied by Booton and Tennyson [6] for imperfect unstiffened anisotropic cylindrical shells and by Ley et al. [7] for imperfect ring stiffened anisotropic cylindrical shells. Post-buckling of stiffened laminated cylindrical shells was studied by Sheinman et al. [8] and Savoia and Reddy [9].

In shell buckling, there is a boundary layer phenomenon where pre-buckling and buckling displacements vary rapidly. Based on a boundary layer theory of shell buckling suggested by Shen and Chen [10] which includes the effects of the nonlinear pre-buckling deformation, the large deflection in the post-buckling range and the initial geometrical imperfection of shell, a post-buckling analysis of perfect and imperfect, stiffened and unstiffened isotropic cylindrical shells under various loading conditions has been presented by Shen et al. [11].

Because of the huge complexity, there are few contributions in the literature discussing buckling and post-buckling behavior of 3D braided shell. The main purpose of the article is to develop a theoretical model to investigate buckling and post-buckling behavior of stiffened braided cylindrical shells under combined external pressure and axial compression.

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