A New Scheme for The Optimum Design of Stiffened Composite Panels with Geometric Imperfections

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(ABSTRACT)

Thin walled stiffened composite panels, which are among the most utilized structural elements in engineering, possess the unfortunate property of being highly sensitive to geometrical imperfections. Existing analysis codes are able to predict the nonlinear postbuckling behavior of a structure with specified imperfections. However, it is impossible to determine the geometric imperfection profile of a nonexistent composite panel early in the design. This is due to the variety of uncertainties that are involved in the manufacturing of these panels. As a mater of fact, due to the very nature of the manufacturing processes, it is hard to imagine that a given manufacturing process could ever produce two identical panels.

The objective of this study is to introduce a new design methodology in which a manufacturing model and a convex model for uncertainties are used in conjunction with a nonlinear design tool in order to obtain a more realistic, better performing final design. First a finite element code for the nonlinear postbuckling analysis of stiffened panels is introduced. Next, a manufacturing model for the simulation of the autoclave curing of epoxy matrix composites is presented. A convex model for the uncertainties in the imperfections is developed in order to predict the weakest panel profile among a family of panels. Finally, the previously developed tools are linked in a closed loop design scheme aimed at obtaining a final design that incorporates the manufacturing tolerances information through more realistic imperfections.