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Buckling load prediction of grid-stiffened composite cylindrical shells using the vibration correlation technique

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Abstract

The vibration correlation technique (VCT) is one of the most important nondestructive methods to calculate the buckling load of imperfection sensitivity in thin-walled structures. VCT is widely used for beam and plate structures, but the technique is still under development for thin-walled shells. In this paper, an experimental and numerical validation of VCT approach was presented and discussed for the prediction of the buckling load of the grid-stiffened composite cylindrical shells loaded in compression. From the experimental point of view, three specimens were fabricated using a new silicone rubber mold, and specially-designed filament winding setup. The modal behavior of the grid-stiffened composite cylindrical shells was investigated by exciting the structures using modal hammer method in different applied compression load. Then, the variation of the first natural frequency of vibration with the applied compressive load was measured up to buckling during testing. Furthermore, a series of Finite Element Models (FEMs), including nonlinear effects such as geometric and thickness imperfection, are carried out in order to characterize the variation of the natural frequencies of vibration with the applied load and also compare it with the experimental results. Finally, the buckling test was performed to validate the experimental and numerical results of VCT approach. The results showed that the difference between the predicted buckling load using the VCT approach on the experimental results and numerical results with an experimental buckling load is 3.1% and 5.0%, respectively. Also, the current VCT approach has a very good correlation for grid-stiffened composite cylindrical shells when the maximum applied load is higher than 68% of the experimental buckling load.

Keywords:

Buckling, Vibration Correlation Technique (VCT), Stiffened Cylindrical Shells, Composite Materials, FEM

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