ABSTRACT

In this investigation, the stability and the failure of laminated composite plates, cylindrical panels, cylindrical panels with cutouts and stiffened cylindrical panels when subjected to in-plane pulse loads is presented in the finite element method framework.

The investigation is carried out in the finite element code -Abaqus. The plates and panels are modeled using shell elements with six degrees of freedom at each node. The Static Buckling load, First Natural Period, Dynamic Buckling Load and the First Ply Failure Load are calculated. The First Ply Failure Load is calculated to check the precedence of the Dynamic Buckling Load and the First Ply Failure Load. Four failure criteria are considered: Maximum Stress criterion, Azzi-Tsai-Hill criterion, Tsai-Hill criterion and Tsai-Wu criterion. The stability of the plates and the panels subjected to suddenly applied in-plane load are evaluated using Vol'mir's criterion, where, the Dynamic Buckling Load is the load at which the maximum transverse displacement in the panel equals the thickness of the panel. This criterion is easy to use, and the results obtained from this criterion are comparable with the results from other criteria. The pulse loading functions considered are: rectangular, sinusoidal and triangular. The panel is subjected to pulse load for a certain duration and the Displacement/Failure Index are calculated after the removal of load as well. Cross-ply and Angle-ply laminates are considered. The material properties are taken from the literature. First, the results of the present work are validated with the results from the literature. Then the results of the Dynamic Buckling analysis are presented.

The influence of various parameters such as loading duration, pulse loading function, aspect ratio, curvature, stacking scheme, boundary conditions, cutout area, cutout geometry and aspect ratio of the stiffener on the dynamic buckling behavior of laminated composite plate and cylindrical panels are investigated.

In the present investigation, the strength and the stiffness of thin laminated composite plate and cylindrical panels are evaluated when subjected to in-plane pulse loads; which change when the duration of loading is varied. With this investigation, it is shown that in certain cases, a sharp increase in displacement in the case of composite plates and cylindrical panels when subjected to in-plane pulse loads is not observed. In such cases, Vol'mir's criterion can be used

to evaluate their dynamic buckling loads. It is also shown that for designing of thin laminated composite cylindrical panels subjected to in-plane loads, their dynamic buckling loads also should be considered. In the case of laminated composite cylindrical panels, balanced and symmetric angle-ply laminates have higher static buckling loads. However, when subjected to in-plane pulse loads, the cross-ply laminates exhibit better dynamic performance in a sense that their dynamic buckling loads and first ply failure load for certain cases are higher than the respective static buckling loads. Stiffened cylindrical panels have higher strength and stiffness than unstiffened panels. But, for the stiffened panel to have dynamic buckling load and first pyl failure load to be higher than its static buckling load, a certain stiffener aspect ratio is essential when the panel is subjected to in-plane pulse loads.

Keywords: Laminated composite plates, cylindrical panels, cylindrical panels with cutout, stiffened cylindrical panel, pulse loading, in-plane loading, finite element method, dynamic buckling