POSTBUCKLING OF LAMINATED CONICAL SHELLS SUBJECTED TO THERMO-MECHANICAL LOADS

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The conical shells are often used as transition elements between cylinders of different diameters and/or end closures and sometimes as stand-alone component. The loss of stability by buckling in shells is one of the most important and crucial failure phenomena. The traditional shell design approach based on the linear bifurcation buckling load reduced by a knock-down factor sometimes may result in overly conservative designs or even potentially unsafe ones. It may be more appropriate to investigate the full nonlinear response of the shells and estimate the lowest load in the postbuckling path for design purposes. The literature on the buckling/postbuckling behavior of laminated conical shells is sparse [1-3].

In this paper the nonlinear response of the laminated conical shells subjected to axial compression, external pressure, torsional load and temperature rise is studied to compare the postbuckling characteristics under different loading and boundary conditions. The analysis is carried out using semi-analytical finite element developed [2] for the postbuckling studies of shells of revolution in the neighborhood of a particular bifurcation mode. The solution of the nonlinear governing equations is obtained employing Newton-Raphson iteration technique and adaptive displacement control method to efficiently trace the equilibrium path of the shells. The solution starts with the load increments; and whenever during the marching, the tangent stiffness matrix becomes semi-positive or negative definite, the solution approach is switched to adaptive displacement control. The degree of freedom having the highest rate of change in the previous step is selected as the control parameter and is updated in each step. The step size is decided based on the increment in the previous step and the number of equilibrium iterations with suitable error norms.

It is observed that the lowest load in the postbuckling is, in general, lesser than the bifurcation load. This reduction is highest for axial compression. The shells with movable boundary conditions do not reveal buckling due to uniform temperature rise. The results for the pressure/torsional loading cases reveal that the immovable boundary conditions lead to the significant increase in the hardening nonlinearity as compared to movable ones.

References

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