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Optimal Design of Composite Cylindrical Shell Based on Nonlinear Finite Element Analysis

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Abstract : The present research is an attempt to figure out the best configuration of composite cylindrical shells of the sandwich type, i.e. the lightest design of such shells required to sustain a certain load over a certain area. The optimization is based on elastic-plastic geometrically nonlinear incremental-iterative finite element analysis. The nine-node degenerated curved shell element is used in which five degrees of freedom are specified at each nodal point, with a layered model. The formulation of the geometrical nonlinearity problem is carried out using the well-known total Lagrangian principle. For the structural optimization problem, which is dealt with as a constrained nonlinear optimization, the so-called Modified Hooke and Jeeves method is employed by considering the weight of the shell as the objective function with stress and geometrical constraints. It was concluded that the optimum design of composite sandwich cylindrical shell that have a rigid polyurethane foam core and steel facing occurs when the area covered by the shell becomes almost square with a ratio of core thickness to facing thickness lies between 45 and 49, while the optimum height to length ration varies from 0.03 to 0.08 depending on the aspect ratio of the shell and its boundary conditions.

Keywords : composite structure, cylindrical shell, optimization, non-linear analysis, finite element
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