Geometrically Nonlinear Transient Analysis of Composite Laminated Plate and Shells Subjected to Low-Velocity Impact

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Abstract

In this study, the transient responses of a composite laminated plate and cylindrical shells subjected to low-velocity impacts were investigated numerically. The shear deformation theory of a doubly curved shell and von Karman's large deflection theory were used to develop a geometrically nonlinear finite element program. It is well-known that in the case of a flat plate with fixed boundary edges, a geometrically nonlinear analysis yields larger contact forces and smaller deflections than a corresponding linear analysis. However, in the case of cylindrical shells, an opposite result was found in this study; a geometrically nonlinear analysis exhibited smaller contact forces and larger deflections than a corresponding linear analysis. The reason for this opposite result is described in this study. Conversely, with a plate and shells that have the same size, shells with a larger curvature exhibited smaller deflections and larger contact forces. The strain distribution at the bottom surface of the plate/shells using the geometrically nonlinear analysis exhibited markedly or only marginally larger tensile areas than those produced using the linear analysis.

Keywords: geometrically nonlinear analysis, composite laminates, cylindrical shell, low-velocity impact, finite element program

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