Finite Element Model to Investigate the Dynamic Behavior of Ring-Stiffened Conical Shell Fully and Partially Filled with Fluid

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Abstract : This study uses a hybrid finite element method to predict the dynamic behavior of both fully and partially-filled truncated conical shells stiffened with ring stiffeners. The method combines classical shell theory and the finite element method, and employs displacement functions derived from exact solutions of Sanders' shell equilibrium equations for conical shells. The shell-fluid interface is analyzed by utilizing the velocity potential, Bernoulli's equation, and impermeability conditions to determine an explicit expression for fluid pressure. The equations of motion presented in this study apply to both conical and cylindrical shells. This study presents the first comparison of the method applied to ring-stiffened shells with other numerical and experimental findings. Vibration frequencies for conical shells with various boundary conditions and geometries in a vacuum and filled with water are compared with experimental and numerical investigations, achieving good agreement. The study thoroughly investigates the influence of geometric parameters, stiffener quantity, semi-vertex cone angle, level of water filled in the cone, and applied boundary conditions on the natural frequency of fluid-loaded ring-stiffened conical shells, and draws some useful conclusions. The primary advantage of the current method is its use of a minimal number of finite elements while achieving highly accurate results.

Keywords : finite element method, fluid–structure interaction, conical shell, natural frequency, ring-stiffener
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