Laminated Composite Stiffened Cylindrical Shell Panels with Cutouts under Free Vibration

Sarmila Sahoo, Heritage Institute of Technology, Kolkata, India

ABSTRACT

The free vibration of laminated composite stiffened cylindrical shell panels in the presence of cutout is investigated. A finite element code is developed using eight-noded curved quadratic isoparametric element for shell with a three noded beam element for stiffener and the formulation is validated through solution of benchmark problems which were earlier solved by other researchers. Parametric study is carried out varying the size of the cutouts and their positions with respect to the shell centre for different edge constraints. The results are presented in the form of figures and tables. The results are further analyzed to suggest guidelines to select optimum size and position of the cutout with respect to shell centre considering the different practical constraints.

Keywords: *Cutout, Finite Element, Free Vibration, Laminated Composites, Stiffened Cylindrical Shell,*

NOTATIONS

a, b: Length and width of shell in plan
$a^{/}, b^{/}$: Length and width of cutout in plan
b_{st}: Width of stiffener in general
b_{sx}, b_{sy}: Width of X and Y stiffeners respectively
d_{st}: Depth of stiffener in general
d_{sx}, d_{sy}: Depth of X and Y stiffeners respectively
$\{d_e\}$: Element displacement
E_{11}, E_{22}: Elastic moduli
G_{12}, G_{13}, G_{23}: Shear moduli of a lamina with respect to 1, 2 and 3 axes of fibre
h: Shell thickness
M_x, M_y: Moment resultants
M_{xy}: Torsion resultant
np: Number of plies in a laminate
N_1-N_8: Shape functions
N_x, N_y: Inplane force resultants
N_{xy}: Inplane shear resultant
Q_x, Q_y: Transverse shear resultant
R_y: Radii of curvature of shell
u, v, w: Translational degrees of freedom
x, y, z: Local co-ordinate axes
X, Y, Z: Global co-ordinate axes
z_k: Distance of bottom of the kth ply from mid-surface of a laminate
α, β: Rotational degrees of freedom
ε_x, ε_y: Inplane strain component
γ_{xy}, γ_{xz}, γ_{yz}: Shearing strain components
ν_{12}, ν_{21}: Poisson's ratios
ξ, η, τ: Isoperimetric co-ordinates
ρ: Density of material
σ_x, σ_y: Inplane stress components
τ_{xy}, τ_{xz}, τ_{yz}: Shearing stress components
ω: Natural frequency
$\bar{\omega}$: Non-dimensional natural frequency $= \omega a^2 \left(\rho / E_{22} h^2\right)^{1/2}$

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