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Laminated composite stiffened elliptic paraboloid shell with cutout under clamped condition

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A B S T R A C T

Clamped elliptic paraboloid shells made of laminated composite materials in presence of stiffeners and cutouts are analyzed employing the eight-noded curved quadratic isoparametric element for shell with a three noded beam element for stiffener formulation. Free vibration problem of stiffened shells with different size and position of the cutouts with respect to the shell centre are examined to find natural frequency and mode shapes of stiffened shells and arrive at some conclusions useful to the designers. The results are further analyzed to suggest guidelines to select optimum size and position of the cutout with respect to shell centre.

Introduction

Aerospace, civil, marine and other related weight-sensitive engineering applications requiring high strength-to-weight and stiffness-to weight ratios use laminated composite materials to a great extent. Shells of double curvature, particularly elliptic paraboloids, have the ability to span over relatively large distances without the need of intermediate supports in comparison with flat plates and cylindrical panels of the same general proportions. This aspect in particular attracts the designers to use such shell forms in places of large column free areas. Moreover, elliptic paraboloidal shells are both architecturally acceptable and structurally stiff due to their surface geometry. These special types of shells are found in many applications in the aerospace and naval construction industries. Of course, the shells used in those applications are designed with stiffeners to provide better strength, stiffness and buckling characteristics. Cutouts are provided in shell panels to save weight and also to provide a facility for inspection. In practice the margin of the cutouts are stiffened to take account of stress concentration effects. Also, there can be

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