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"STRUCTURAL ANALYSIS OF CONOIDAL SHELL UNDER UNIFORMLY DISTRIBUTED LOAD"

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ABSTRACT :

Engineering is manner of usage of technology for the society. There are various engineering field based totally on the vicinity of application. Civil engineering is subject which is used to constructed roads, bridges, dams, canals, building, and so on and also used for protection, but civil engineering performs essential role in growing infrastructure. On this challenge it is used for "Bending analysis of conoidal shell under uniformly distributed load".Conoidal shell papers focus on the structural analysis, behavior, and performance of conoidal shells, which are structures with a curved, single-surface roof, often used in architecture and engineering.

Keywords: *:* Bending, conoidal shell, delaminated composite, Finite element method.

INTRODUCTION :

Shell structures are widely used in all industrial applications, especially those related to automobile, marine, nuclear, civil, aerospace and petrochemical engineering. In civil engineering construction cylindrical, conoid, hyperbolic and elliptic shells are commonly used as roofing units to cover large column-free areas. Conoidal shells provide ease of fabrication and allow sun light to come in. They are most suitable when greater rise is needed at one end. Depending upon the curve used as the directrix, a parabolic, circular or catenary, conoid is generated by a straight line moving parallel to a vertical plane with one of its ends on a plane curve and the other on a straight line as shown in figure 1.1.

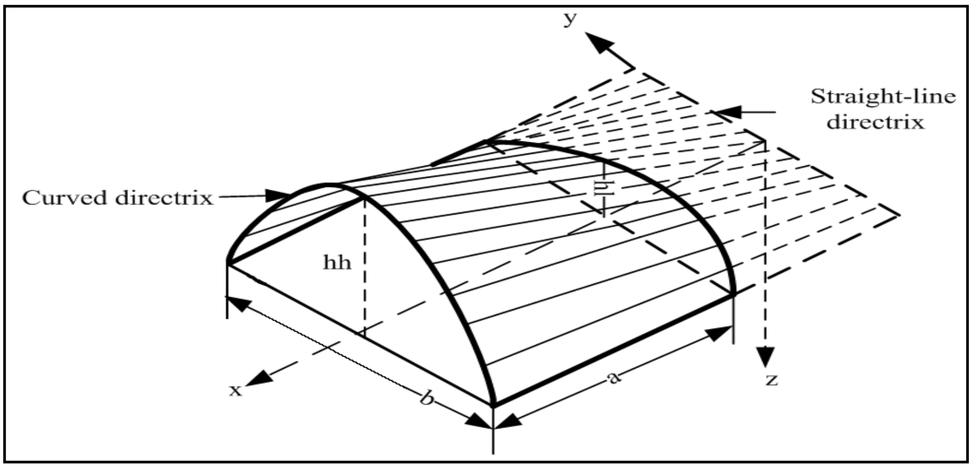


Figure 1.1 Geometry of conoidal shell

1.1 Conoidal Shells

A conoid surface is generated by a straight line moving parallel to a fixed plane. The moving line always intersects two different lines, one straight and one curved one. The curved directrix can be a parabola (or) catenary (or) part of a circle. It is assumed that both the straight line directrix and the plane containing the curved directrix are at right angles to the director plane, the curved directrix being moreover symmetric about its vertical axis, such conoids are called square conoids. A part of a conoid, known as a truncated conoid, is preferred to a full conoid, as otherwise large compressive and tensile stresses accompanied by bending and torsion will occur near the flat edge. Quite frequently, only a part of the surface that is truncated conoids is used for purpose of roofing. One of the greatest advantages in the use of conoidal shells is that a considerable amount of natural lighting is achieved at a minimum structural cost. Also the formwork for this ruled surface can be easily made from straight planks.

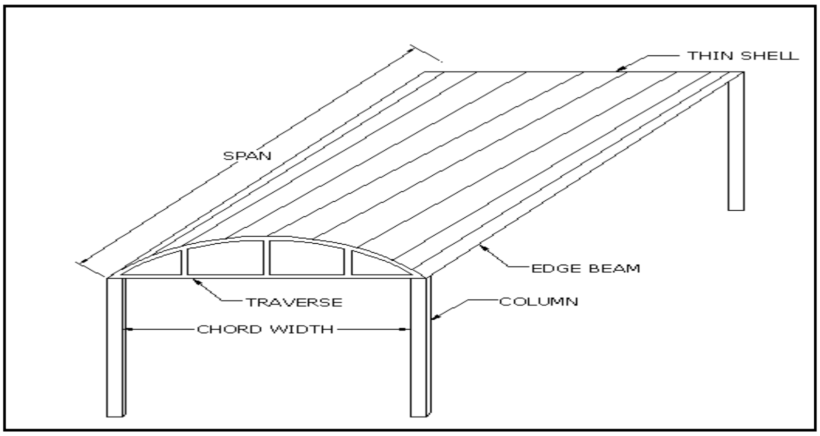


Figure1.3 Conoidal shell

1.2Objectives

1. Study the bending behaviour of conoidal shell for different aspect ratio, degree of truncation and different boundary condition under uniformly distributed load.
2. Study the bending behaviour of conoidal shell for different material under uniformly distributed load.
3. Study the stress behaviour of conoidal shell for different material under uniformly distributed load.

2.LITERATURE REVIEW :

2.1 Introduction

The conoidal shell, usually in a truncated form, is most commonly used for factory type buildings, cantilevered canopies and dams. A conoid is a shell of complicated shape, singly ruled, anticlastic, non-developable conoidal shell configurations are aesthetically appealing, structurally stiff, and they may be used for covering large column free spaces. Naturally, these forms received importance from the engineers and research on conoidal shells.

2.2 Review of Literature

V. D. Nawale and M.R. Wakchaure [21] discussed bending analysis behaviour of laminated composite conoidal shell roof using classical plate theory. The Conoidal shell configurations are aesthetically appealing, structurally stiff and they may be used for covering large column free spaces. But the variation of curvature is the major difficulty encountered in the analysis of these shells. The greatest advantage of conoids from the construction point is that they are easy to cast as the surfaces are ruled. These shells are very important industrial roofing units used extensively in the industry. These shells provide uniform lighting to the covered area and are more suitable when greater rise is needed at one end. Aspect ratio and degree of truncation is the major factor leading to variation of curvature which might affect the bending stiffness of such shells. Hence, in this paper, a study of the bending behaviour of laminated composite conoidal shells is carried out under uniformly distributed pressure with having different stacking sequences by varying aspect ratio and degree of truncation. A finite element analysis is carried out using an eight noded isoparametric element with five degrees of freedom based on the classical plate theory.

K. Bakshi, D. Chakravorty [10] studied delamination and first ply failure study of composite conoidal shells using the finite element method. Interlaminar and Interlaminar failure modes of simply supported conoidal shells are investigated which are considered to be loaded by concentrated load at the centre. Eight noded curved quadratic isoparametric elements are used to develop a computer program which is validated through solution of benchmark problems. While obtaining the failure loads, each lamina of the laminate is considered to be under plane stress condition which implies that no transverse stresses are considered act on any lamina. Comparisons between failures loads correspond to each failure mode are also presented to obtain the minimum failure load which will govern design of the shell. It is important to note that failure study of the laminated conoidal shells under different circumstances is needed for their confident application in the industry. A laminated shell may fail in two ways i.e. interlaminar or interlaminar failure. Interlaminar failure mode is termed as delamination where the interlaminar stresses exceed their permissible limits and individual lamina are separated from each other. As the lamina interfaces are devoid of fibers and the interlaminar integrity is attributed to matrix stresses only, there is every chance of a delamination failure before first ply failure. The tensile strength of fibers is significantly higher than that of the matrix, which enables the composite lamina to carry higher tensile load then the epoxy adhesive. Compressive load sustainability of a lamina is also enriched due to the presence of the fibers as their buckling tendency under compression is resisted by the matrix.

D Chakravorty, P. K. Sinha, and J. N. Bandyopadhyay [6] applied the concept of the finite element method has been applied to solve free and forced vibration problems of isotropic and laminated composite shells with and without cutouts employing the eight-node isoparametric finite element formulation. Specific numerical problems of earlier investigators are solved to compare their results. It is seen that free vibration of isotropic and composite shells with cutouts requires in-depth study for proper understanding of the mechanical behaviour. Moreover a practical boundary condition of comer point supported edges needs a thorough investigation. He was comparative study of composite corner point supported hyper and conoidal shells reveals that the conoidal shell exhibiting higher fundamental frequency has a lower bending stiffness and hence is subjected to higher deflection and stresses under a particular transient load case. The conoidal shell, in spite of having a higher fundamental frequency than the hyper, exhibits lower stiffness under static and transient loads.

2.3 Summary of Literature Review and Research Gap

From the available research reports it is clear that, limited work on laminated and delaminated composite structures has been taken up by some researchers. But no work has been found on effect of aspect ratios and degree of truncations on isotropic conoidal shells. Hence, in this project, a study of the bending and stress behaviour analysis of conoidal shells is carried out for different aspect ratios, degree of truncations, boundary conditions and different material under uniformly distributed load.

3.METHODOLOGY AND MATHEMATICAL FORMULATION :

In this chapter material property and problems to be analyzed by finite element method using SAP 2000NL software are given. Problems are divided into three parts for different aspect ratio and case I consist of numerical problem for clamped shells, case II consist of numerical problem simply supported shells.

3.1 Material Properties

a) Aluminum: i) weight density = 26 kN/m^3
ii) poissons ratio = 0.33
iii) Modulus of elasticity = $7x10^7$ kN/m^2

b) Glass: i) weight density = 24 kN/m^3
ii) poissons ratio = 0.26
iii) Modulus of elasticity = $6x10^7$ kN/m^2

3.1.1 Various Boundary Conditions

Case I: Clamped Conoidal Shell

a) (a) Maximum downward deflections ($\overline{w}$) clamped conoidal shells with aspect ratio = 1 under uniformly distributed load with different degree of truncation.
b) (b) Maximum downward deflections ($\overline{w}$) clamped conoidal shells with aspect ratio = 1.5 under uniformly distributed load with different degree of truncation.
c) (c) Maximum downward deflections ($\overline{w}$) clamped conoidal shells with aspect ratio = 2 under uniformly distributed load with different degree of truncation.

Methodology

In this chapter different methodology used in the project are explained.

1. Mathematical formulation using classical plate theory for analysis of plates using Navier's method is explained.
2. Finite element mathematical formulation for composite laminated conoidal shell using eight nodded isoperimetric curved quadratic shell elements with five degrees of freedom at each node.

Finite Element Using SAP2000NL Software

Clough was the first to use the terminology 'Finite Element'. Since then, tremendous advances have been made in the last 25 years both on the mathematical foundations and generalization of method to solve field problems in various areas of engineering analysis. During the same period rapid development in computer technology, large number of package programs has been developed such as ABAQUS, ANSYS, SAP, ETAB etc. for finite element analysis which made it possible for wider use of this technique in practice.

4.RESULTS AND DISCUSSION :

4.1Introduction

As we know that aspect ratio and degree of truncation are the major factors leading to variation of the curvature of conoidal shells which might affect bending stiffness. Hence in this project we have consider the shell with three aspect ratio (a/b) = 1, 1.5, 2 and different degree of truncation (hl/hh) is considered varying from 0 to 0.75. Deflection of the shell also depends upon boundary conditions hence two boundary conditions like clamped and simply supported are considered.

4.2 Deflection Results of Conoidal Shell

Deflection Results of Conoidal Shell For Aspect Ratio = 1

In this the results of conoidal shell with 1 aspect ratio and different degree of truncation as shown in Table 5.1 & 5.2 and graphical representation of deflection for conoidal shell with different boundary condition as shown in Graph 5.1 & 5.2. And the conoidal shell with aspect ratio and degree of truncation are shown in Figure 5.1

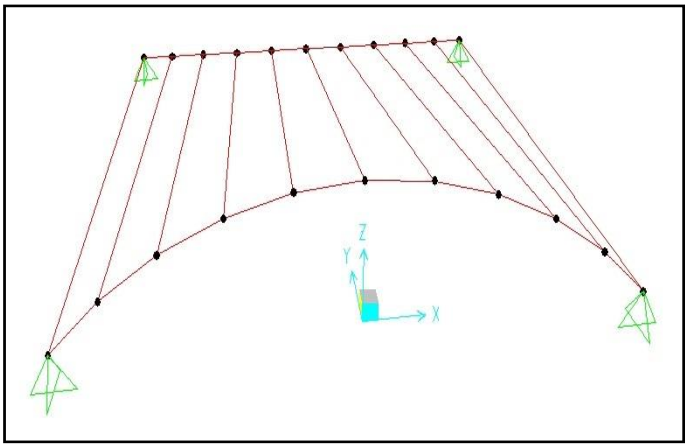
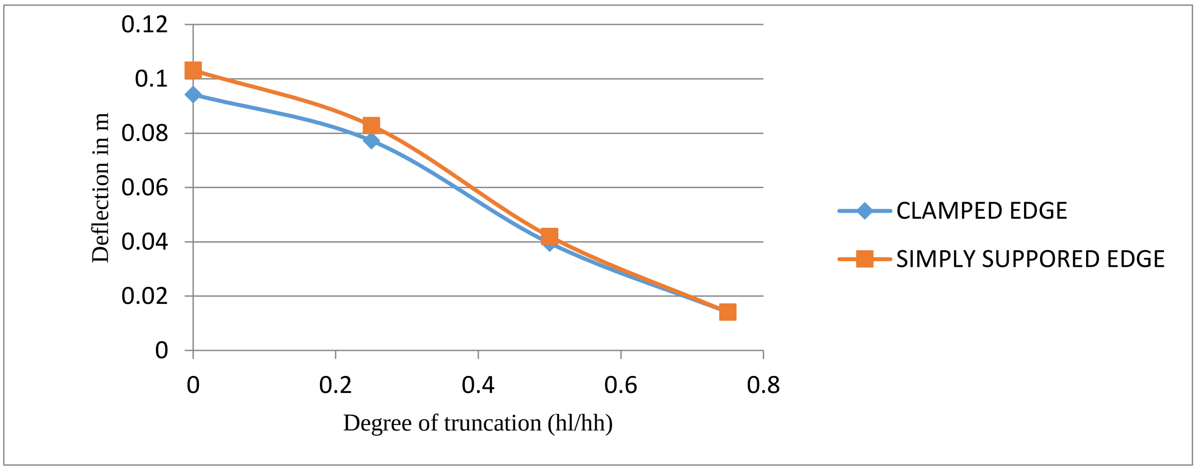


Figure 5.1 SAP2000NL Model for Aspect Ratio =1 & Degree of Truncation = 0.00

Table 5.1 -Maximum downward deflections for conoidal shell with aspect ratio = 1 of Glass materials

Sr.No.	Material	Boundary Condition	Degree of truncation	Deflection in m
1	Glass	Clamped edge	0.00	0.09424
2			0.25	0.07724
3			0.50	0.03953
4			0.75	0.01409
5		Simply supported edge	0.00	0.10318
6			0.25	0.08279
7			0.50	0.04198
8			0.75	0.01408

Note- a/b=1, a/h=500, h=0.02m, a/hh=5, hh= 2 m.



Graph 1.1 Graphical representation of deflection for conoidal shell with aspect ratio = 1 for aluminum material

5..FUTURE SCOPE :

i. There is scope of carrying out similar investigations on laminated composite conoidal shell roofs for different aspect ratios, stacking sequences, boundary conditions & various loading.

ii. There is scope of carrying out similar investigations on delaminated composite conoidal shell roofs for different aspect ratios, stacking sequences, Boundary conditions & various loading conditions.

6.CONCLUSION :

Following concluding points are drawn from the present study,

i. There is scope of carrying out comparison on laminated & delaminated composite conoidal shell roofs for different aspect ratios, stacking sequences, boundary conditions (clamped & simply supported) & various loading conditions (concentrated point load , uniformly distributed load & sinusoidal load)

ii. Ii. Buckling and stability analysis of stiffened composite laminated & delaminated shells with vibration response of such shells.The results of bending stiffness of clamped shells are more than the simply supported shells.

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