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Finite Element Analysis of a Laminated Conoid Shell under Uniform Pressure

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Abstract - *A four layered rectangular laminated Conoid shell in anti-symmetrical stacking sequence with equal thickness of layer for all sides clamped, all sides simply supported and two sides clamped two sides simply supported under transverse uniform pressure is analysed using ANSYS 15.0. The main objective is to study the effect of r/a ratio varying from 0.05 to 0.5 with an increment of 0.05 on the maximum principal stresses and deflection in structure under uniform pressure of magnitude 5000 kN/m².*

Key Words: Static Analysis; Composites; Conoid; Cross-ply; Angle ply; Anti-symmetric; Rise-to-span Ratio; Orthotropic.

1. INTRODUCTION

The stability of any structure is the main concern in any engineering construction. Materials with higher strength to weight ratio are the most preferable to meet the desired requirements. Advancement in the modern technology Composite materials has been widely used now days for many purposes.

Composites are light in weight compared to traditional materials Composites exhibit very high strength in all directions. There are many properties which make them the best suited material at present such as corrosion resistant, flexible in nature, easy and time saving in construction, low thermal conductivity, durable etc.

1.1 Shell and its Classification

Shells are defined as the structures, which are essentially an expansion of plain surfaces or plates to bended plates and surfaces curved in geometry. Shells have small thickness in comparison to its other dimensions and have a curvature which differentiates it from plates.

The shape of a shell structure spreads forces uniformly throughout the whole structure which means every part of the structure supports only a small part of the load which provides strength to the structure. Membrane action in shells is primarily due to the plane stresses whereas the secondary forces also occur due to the flexural deformations.

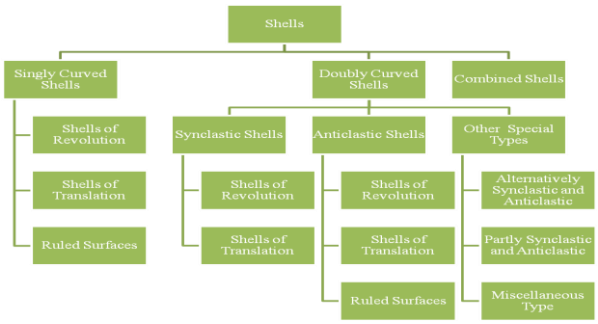

Fig - Classification of shells

1.2 Conoid Shell and its Applications

These are the doubly curved shells which are anticlastic in nature. They have negative Gauss curvature and membrane governing equation of the conoid shells is hyperbolic. These are the ruled surfaces with one edge curved and other edge straight. A **c**onoid is ruled surface, whose rulings (lines) follow these conditions:

1. All rulings are parallel to plane –the directrix plane.
2. All rulings intersect a fixed line - the axis.

2. FEM and its Importance

FEM is a numerically based approach which is utilized in solving many engineering problems such as structural analysis, heat transfer, fluid flow, mass transport and electromagnetic potential. There are basically three types of finite elements:

1. One-dimensional element
2. Two-dimensional element
3. Three-dimensional element

2.1 Clamped Conoid with CP laminate

The maximum stresses and maximum deflection with increasing rise are given in Table and discussed below

RSR	1st principal stress σ_1 (kN/m²)	2nd principal Stress σ_2 (kN/m²)	3rd principal Stress σ_3 (kN/m²)	Shear stress τ_{xy} (kN/m²)	Shear Stress τ_{yz} (kN/m²)	Shear Stress τ_{xz} (kN/m²)	Deflection U_Z(m)
0.05	.178E+08	752959	1713.55	471367	857908	.121E+07	.753753
0.1	.123E+08	460840	4414.7	339120	819532	.107E+07	.315301
0.15	.891E+07	412883	7720.5	307358	865050	.117E+07	.204405
0.2	.795E+07	351605	11698.7	279093	846708	.130E+07	.141713
0.25	.651E+07	226604	12758.5	495806	467434	.224E+07	.103094
0.3	.752E+07	350937	91487.9	661629	845788	.361E+07	.194684
0.35	.835E+07	420470	100329	727875	.114E+07	.353E+07	.233368
0.4	.916E+07	488007	103698	729870	.144E+07	.343E+07	.276657
0.45	.993E+07	572596	110890	731096	.179E+07	.345E+07	.323925
0.5	.106E+08	741668	110574	748975	.208E+07	.347E+07	.372435

Maximum transverse shear stress (τ_{yz}) and (τ_{xz})

The variation of maximum shear stresses with respect to rise to span ratio (r/a) is presented in figure 4.7 graphically. Stresses increase with increase in rise to span ratio. Increase in stresses in yz and xz is large as compared to decrease in stresses in shear stress xy. Maximum stress in shear in yz and xz direction is $0.208*10^7$ kN/m²at RSR 0.5 and $0.361*10^7$kN/m² at RSR 0.3 respectively.

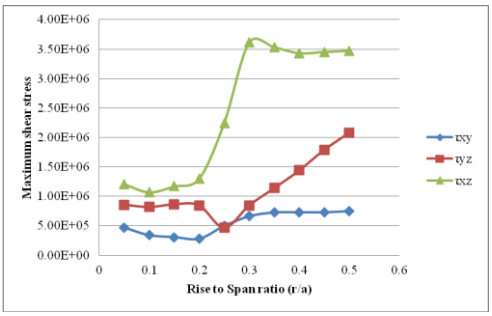

Chart -1: Maximum shear stress (τ_{xy}, τ_{yz} and τ_{xz}) for CCCCCP laminate

3. CONCLUSIONS

In the present report, conoid shell with changing rise to span ratio along with various boundary conditions is analyzed for principal stresses and deflections under uniform transverse pressure by using finite element method.

a) **Cross ply** performs better than angle ply laminates.

b) Boundary condition all sides clamped **(CCCC)**cross ply found to give better results than all other cases.

c) Rise to span ratio of **0.25-0.35**is found suitable for better performance of the Conoid shell.

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BIOGRAPHIES

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