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Design and Analysis of Prestressed Shell Roof Structures

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Abstract: In this paper, pre-stressed precast substantial Shell roof structures is proposed as an option in contrast to customary roof structures. plan of shell roof top utilizing supported concrete is extremely challenging. To oppose the high strain in base harmony, the substantial support should be pre-stressed. Here, the displaying of various setups of prestressed precast substantial shell roof structures is finished utilizing Staadpro v8i programming by changing its mathematical boundaries, for example, shapes, slant, length and dispersing of the support and investigation and streamlining is done to find the best and best prestressed precast substantial Shell roof structures designs fit to different circumstances feasible way of life implies reconsidering our approaches to everyday life, how we purchase and how we sort out our day to day existence. It is likewise about modifying how we mingle, trade, share, instruct and construct personalities. It implies changing our social orders and living in agreement with our common habitat. As residents, at home and at work, a large number of our decisions - on energy use, transport, food, waste, correspondence and fortitude - contribute towards building economical ways of life In India, customary practices that are feasible and climate well-disposed keep on being a piece of individuals' lives. India has a past filled with low carbon impression and way of life. These should be energized, rather than supplanted by more current yet unreasonable practices and advancements. This is likewise relevant to other non-industrial nations where there is a developing interest in elective models of advancement, and on restoring green cognizance drawing on conventional societies.
Keywords: Precast Concrete, RCC cylindrical shell roof structures, STAAD PRO V8i, Prestressed precast shell structures

I. INTRODUCTION

As we move towards a reasonable planet, the creating scene is confronted with the predicament of a requirement for quick development of lodging and foundation on one hand and the imperatives of maintainability on the other. Nonetheless, a more critical glance at neighbourhood qualities and innovation somewhere else can prompt intelligent fixes. Shells are a more proficient primary structure than the generally utilized section pillar outlines, which utilize twisting strength and henceforth underutilize the underlying limit of materials. Better underlying productivity permits shell structures than be lightweight, lessening the interest for materials. The wide scope of conceivable material arrangements - from compacted earth to concrete - takes into consideration a fitting neighbourhood material to be utilized in the acknowledgment of the underlying structure. Shell structures are in no way, shape or form an advanced creation. Proof of the earliest vaulted structures comes from Mesopotamia in 3000BC: a 5000-yearold Mesopotamian internment chamber with a barrel vault of approx. 1m range is in plain view at the Berlin Museum of Prehistory and Ancient History.

II. LITERATURE REVIEW

1) *Himayat Ullah & Sagheer Ahmad (2007)* - Fastening results gained using the Analytical shell model of be finished considering Kirchhoff-Low hypothesis. It was associated with the Semi observational to Buckle coefficients model for redressing the irregularities among speculation & test data. Numerical fastening assessment, model be analysed by both direct & non-straight strategy to anticipate catching strength. They derived mentioned straight speculation should be utilized instead concluding mode shapes aided assessment of different cylinder moulded shells see be finished using SAP 2000.
2) *Ravindra Rai & Umesh Pendharkar (2012)* – This paper. mathematical model was isolating on various cut off points changing their thickness & clear of and stream. They contemplated all model having unique reach and same thickness & piece of most over top powers lies at that segment where two shells are coexisted with one another. models having same reach without various thickness it is observed mentioned piece of most silly second, most important powers and most absurd loads is staying same anyway because reduce in thickness entire second, powers & stresses are diminished.

3) *Mahmoud Shariati (2010)* - Circulated paper on numerical and exploratory focus on fastening of barrel moulded sheets presented to centre burden. Paper deals about convincing during length, region point & different cut-off conditions on fastening weight & post catching of CK20 round & empty board. ABAQUS programming has been used for the numerical examination and the results contemplated that development long downfalls the catching weight and region point changes extends the fastening load. The precast strategies are all the more notable as a result of its uniqueness & quality. Shell structures are more appropriate for precast material on account of its light weight.
4) *Bandyopadhyay et al (2015)* - The variety of bend is the troublesome experienced in the examination of these shells. The limited component strategy is involved here for the investigation of summed up doubly bended shells and is applied to shortened and full conoids of various limit conditions. Perspectives proportions and levels of truncation. An eight hubs Isoperimetric limited component with five levels of opportunity for each hub, including three interpretations and two pivots, is used. The precision is checked by finishing the outcomes got by the current examination with those current in the writing. Results are introduced in various conoidal shells and a bunch of ends are shown up at in light of a parametric report.
5) *Koteswara Rao et al (2012)* - The restricted part showing and assessment of essentially evaluated (FG) shell structures under different stacking, for instance, warm and mechanical. Free vibration assessment of basically surveyed (FG) roundabout shell structure has also been presented. To focus on the effects of critical limits on the responses of FG shell structures, various sorts of shells have been thought of. The reactions acquired for FG shells are contrasted and the homogeneous shells of unadulterated ceramic and unadulterated metal (steel) shells and it has been seen that the reactions of the FGM shells are in between the reactions of the homogeneous shells. In light of the examination a few significant outcomes are introduced and examined for thick as well as dainty shells.
6) *Bhiimarsaddi et al (2014)* - Studied the free also, undamped vibration of an isotropic roundabout tube-shaped shell is dissected with higher request uprooting model leading to a more reasonable illustrative variety of cross over shear strains. The technique reaction of barrel shaped shells. The frequencies acquired from the current investigation shear hypothesis.
7) *Salvatore brischetto et al (2016)* - Proposes the investigation of the estimation of the arch terms in the 3D harmony shell conditions utilized for the free vibration examination of one layered and diverse composite and sandwich structures 3D balance conditions composed for round shells deteriorate into 3D conditions for tube shaped shells and plates taking into account one of the two radii of bend or both as endless, individually The guess of and flow terms has been presented in 3D balance conditions to concentrate on its belongings as far as recurrence values.

A. Objectives

The main objectives of the project are:
1) To find the viability of prestressed precast shell roof structures.
2) To design and its configuration for various circumstances.
3) To plan the construction against Dead load, Live load and Wind load.
4) To Analysis and Design the Load Combinations.
5) To get ideal support setup of pre-stressed precast shell roof structures.
6) To approve and check the conceivable outcomes of execution of general PC program Staadpro v8i programming for Shell roof investigation and plan**.**

B. Aim and Scope of the Project

Further degree of study is in assessment & discernment in Effectiveness of shell structure alongside logical examination of non-edged shell without edged shaft part shell. Considering calculation during weight because of self-weight, imposed weight & seismic powers & belonging mix on similar plan or edged shaft shell structure. There is prevent degree to contemplate overall economy during prestressed substantial cylinder formed shell without prestressed concrete imploded plates. There is prevent degree to contemplate overall economy of RCC fell plates & prestressed imploded plate rooftop. There is prevent degree to ponder overall economy during prestressed autonomously twisted shell without prestressed doubly twisted shell.

III. METHODOLOGY

In this review, to play analysis in pre-stressed shell roof top structure, information's like shapes, aspects, material properties, programming's which are generally utilized for investigation were gathered from the writing study and survey. Models of prestressed shell roof supports are then planned, loads are appointed and investigated and improvement is finished.

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In this review, Staadpro v8i programming has been taken on to show, upgrade and dissect the prestressed shell rooftop supports. Staadpro represents Extended Three-layered Analysis of Building System which is a plan situated programming program uniquely worked for the investigation of building structures. Results were assessed and ends were made.

A. Description Of Model And Cases

Structrural Modelling Of Rc Member

Present work done an attempt have been created theoretically to evaluate Economical directrices during prestressed cylindrical shells rooftop structures.

Length of Shell: 25meter

Width of chord: 10meter

Semi-Central Angles: 30degrees 35degrees and 40degrees Design codes IS:2204 – 1962.

Imposed weight: 0.75 KN/m2 (as per IS:875)

Shells thickness– 75mm

Grade of Concrete – M40

Reinforcement steel Bars – HTS bars

Loss ratio – 0.8

The accompanying loads are out for the investigation of the displayed roof structures

B. Initial Decision on shape

Resulting to chasing after a decision on the shape the accompanying stage is to perspective the roof. In this part the reach and sagitta of the housetop will be described. These two limits are crucial for shell plan as in the end they control its basic approach to acting.

C. Rise of the Shell

Prior to foundation of the ascent of the rooftop, the progression of powers in a rooftop, exposed to concentrated load, should be researched. Since shells are math-based structures, it is simply certain that different computations for the round housetop can achieve detached essential direct.

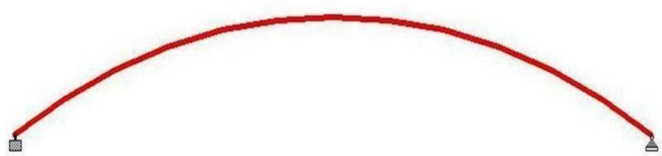

Fig 1. Shape of Curved beam showing utilized as single shell need following facts.

D. Calculation of Loads

The accompanying framework in plan is to perceive the stores circling back to the development. Load factors are resolved using Eurocodes which lead to design potential gains of a couple of kinds of weights.

1) *Dead Load:* It is a consistent burden that follows up on the construction because of oneself load of the individuals, the upheld structure, alongside suffering connections or different embellishments. The review with dead loads is considered in the structure plan and all the while in the materials unit weight. These heaps are determined as indicated in IS 875-1987. These are conditions instead membrane hypothesis of a shell without circular directrices. The Self weight or load shell is taken as 24 kN/m3. The stresses are determined at the boundary conditions & also at semi focal point.
2) *Live Load:* For the situation of rooftop support, live burden might be the heap oppressed by dust load, disseminated, sway burden and vibration, different factors like breeze, seismic, snow alongside temperature varieties, differential settlement, creep, shrinkage, and so forth the review proposes expecting live loads in the plan of structures, with the end goal of primary wellbeing of structures. Live loads are determined according to IS 875-1987 (section II).

Wherefrom the shells are explored as the rooftop for structures, the Imposed weight of shell is taken as 0.75kN/m2 according to Bureau of Indian Standard Building Code (2005).

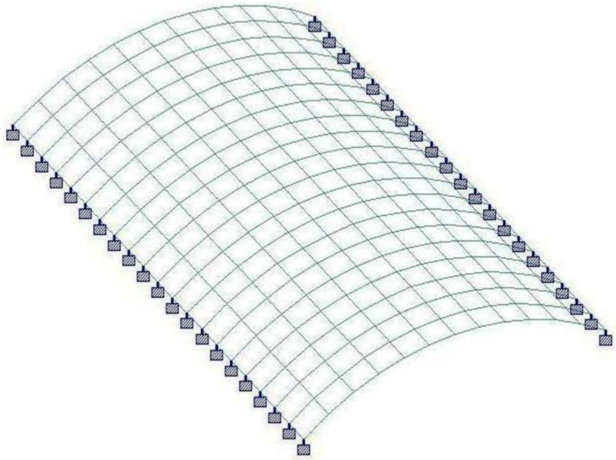

Fig 2. Shows grid covers bended slab utilized as single shell need following data.

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min X	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max Y	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Y	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max Z	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Z	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max rX	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min rX	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max rY	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min rY	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max rZ	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min rZ	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max Rs	1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 1. Shows relocation Data because of applied load cases on shell (Beam) structure.

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	21	8 GENERATE	0.977	2.097	-0.021	2.314	-0.000	-0.000	0.000
Min X	20	9 GENERATE	-0.977	2.097	-0.021	2.314	-0.000	0.000	-0.000
Max Y	21	8 GENERATE	0.977	2.097	-0.021	2.314	-0.000	-0.000	0.000
Min Y	9	8 GENERATE	0.891	-2.658	-0.030	2.803	-0.000	-0.000	0.000
Max Z	273	4 GENERATE	0.000	-1.001	0.035	1.001	0.000	0.000	0.000
Min Z	13	4 GENERATE	0.000	-1.001	-0.035	1.001	-0.000	-0.000	0.000
Max rX	272	9 GENERATE	-0.805	-2.171	0.033	2.316	0.000	-0.000	-0.001
Min rX	12	9 GENERATE	-0.805	-2.171	-0.033	2.316	-0.000	0.000	-0.001
Max rY	265	8 GENERATE	0.641	-1.596	0.017	1.720	0.000	0.000	-0.001
Min rY	5	8 GENERATE	0.641	-1.596	-0.017	1.720	-0.000	-0.000	-0.001
Max rZ	12	8 GENERATE	0.758	0.298	-0.033	0.815	-0.000	0.000	0.001
Min rZ	11	9 GENERATE	-0.758	0.298	-0.033	0.815	-0.000	-0.000	-0.001
Max Rs	9	8 GENERATE	0.891	-2.658	-0.030	2.803	-0.000	-0.000	0.000

Table 2. Shows relocation Data because of applied load cases on shell (Grid) structure.

			Shear		Membrane			Bending Moment		
	Plate	L/C	SQX (local) N/mm2	SQY (local) N/mm2	SX (local) N/mm2	SY (local) N/mm2	SXY (local) N/mm2	Mx kNm/m	My kNm/m	Mxy kNm/m
Max Qx	228	8 GENERATE	0.024	-0.000	-0.564	-0.072	-0.053	1.006	0.169	-0.008
Min Qx	13	9 GENERATE	-0.024	0.000	-0.564	-0.072	-0.053	1.006	0.169	-0.008
Max Qy	4	8 GENERATE	0.002	0.003	-0.435	0.001	0.001	0.584	-0.138	0.015
Min Qy	232	8 GENERATE	0.002	-0.003	-0.435	0.001	-0.001	0.584	-0.138	-0.015
Max Sx	1	3 LOAD CAS	0.010	-0.000	0.057	0.008	0.006	-0.592	-0.088	-0.004
Min Sx	12	8 GENERATE	0.024	0.001	-0.638	-0.065	0.051	0.991	0.079	-0.030
Max Sy	109	3 LOAD CAS	0.010	0.000	0.056	0.009	0.000	-0.595	-0.101	0.000
Min Sy	120	8 GENERATE	0.021	-0.000	-0.554	-0.089	0.002	0.950	0.162	0.000
Max Sx	24	8 GENERATE	0.024	0.000	-0.564	-0.072	0.053	1.006	0.169	0.008
Min Sx	13	9 GENERATE	-0.024	0.000	-0.564	-0.072	-0.053	1.006	0.169	-0.008
Max Mx	24	8 GENERATE	0.024	0.000	-0.564	-0.072	0.053	1.006	0.169	0.008
Min Mx	109	8 GENERATE	0.010	-0.000	-0.387	-0.061	-0.002	-0.835	-0.142	-0.000
Max My	36	8 GENERATE	0.022	-0.000	-0.559	-0.081	0.041	0.995	0.173	0.009
Min My	237	8 GENERATE	-0.003	-0.001	-0.492	-0.001	0.003	-0.811	-0.214	0.017
Max Mx	2	8 GENERATE	0.009	0.002	-0.434	-0.003	-0.000	-0.121	-0.175	0.032
Min Mx	230	8 GENERATE	0.009	-0.002	-0.434	-0.003	0.000	-0.121	-0.175	-0.032

Table 3. Shows Normal stress, circumferential & longitudinal stresses because of applied weight.

Geometry | Property Constants | Center Stresses | Princ Stress and Disp | Corner Stresses

Plate No : 89

Load List : 9:GENERATED INDIAN C

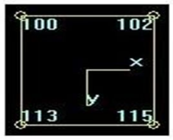

Plate Corner Displacements

Node	X mm	Y mm	Z mm
100	-0.875	1.603	-0.007
102	-0.763	0.507	-0.009
115	-0.763	0.514	-0.006
113	-0.874	1.605	-0.005

Plate Principal Stresses

	SMAX N/mm2	SMIN N/mm2	TMAX N/mm2	Angle
Top	-0.0792384	-0.799799	0.36028	-0.0976234
Bottom	0.0407302	-0.117378	0.0790539	2.56949

Table 4. Shows major stress & displacement on shell element because of applied weight.

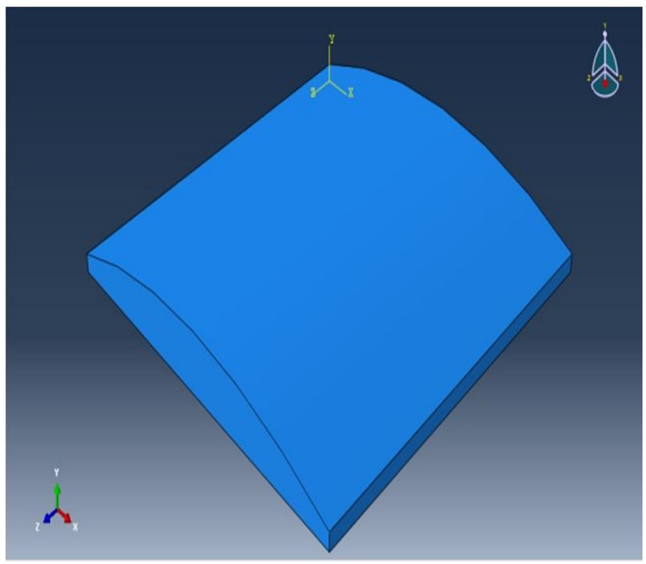

Fig 3. Model shell roof cylindrical tube structure

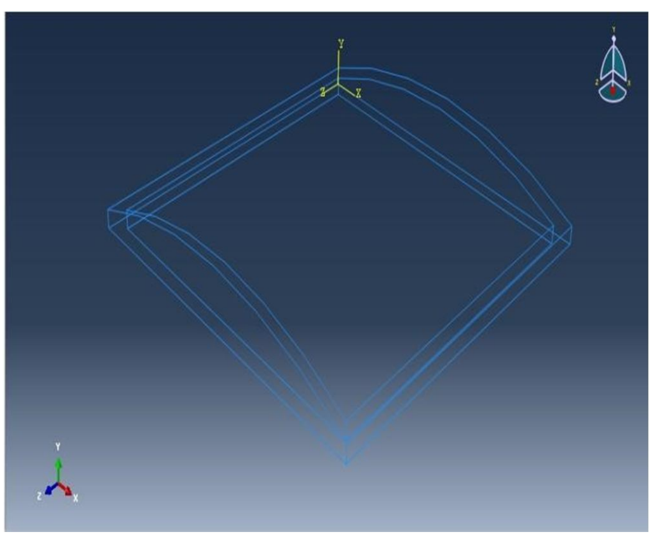

Fig 4. Model during Wire cylindrical tube-shaped shell without support.

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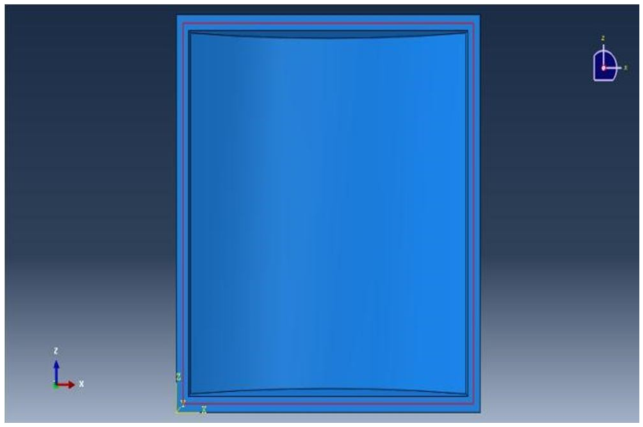

Fig 5. Cylindrical shell tube shaped structure model with support.

E. Loading Conditions for the Model

Three various loading combinations are utilized for the analysis. Since buckling is being considered we determined load factors for extreme breaking point model was made by showing outer inward elements of shell & cutting them. shell have been fit using a 3D strain part of C3D4 which is a 4noded tetrahedron part. Reduced size of overall part has been given 50. fit model of construction is shown in figure 4. For expected of round & empty shell without reinforcement, two events see be made without first being shell alone & second being support alone. implanted necessity was utilized to introduce steel into substantial shell. Surface of shell during be given as latitude strain along top surface of shell as shown in figure 5 & besides pile not entirely settled presence instead layer examination. heap was given as displayed in figure.

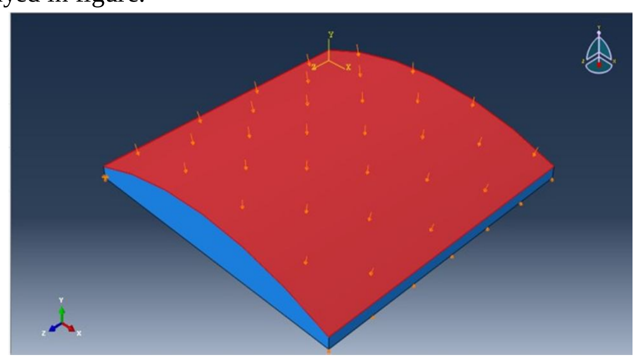

Fig 7. Shell structure loading

F. Wire mesh details

The edge shafts, ribs and stiffeners are corresponded, including the Auto-Mesh capacity for edges, while the shell sheets are harmonized, using the Face Map-Mesh ability. In the two cases network sizes rely upon 10 divisions of each subsurface (which make up the entire shell). Mid-side center points are made during the cross segment, things being what they are. While grid the most noteworthy mark of the vault, care is removed to remain from time of quadrilaterals with extraordinary corners.

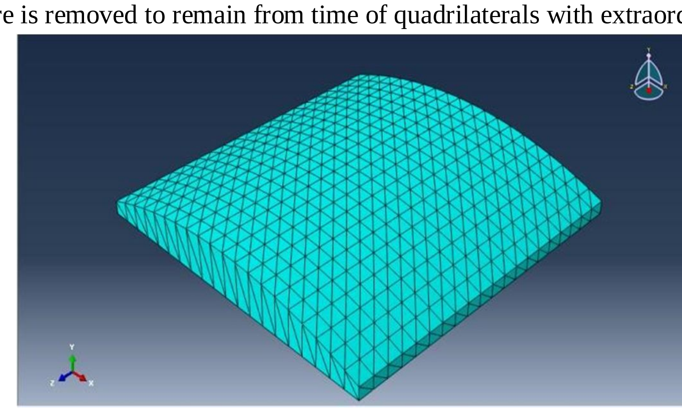

Fig 6. shows Meshed model of Cylindrical shell roof structure.

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G. Boundary Edge Conditions

Fixed or cinched limit conditions are decided to be applied as line support on the edge of the shell. Showed that the proper help is better for locking contemplations in the event of consistently disseminated stacking. This is a direct result of firmness of the shell is expanded close to the edge shaft.

The breaking point conditions of shell are assuming converse edges of edge people as tracked down in figure 6. Along one side vertical migration is caught and on contrary side both vertical & level movements are caught. static gamble procedure for examination is finished to vanquish the precariousness occurring in the static general system.

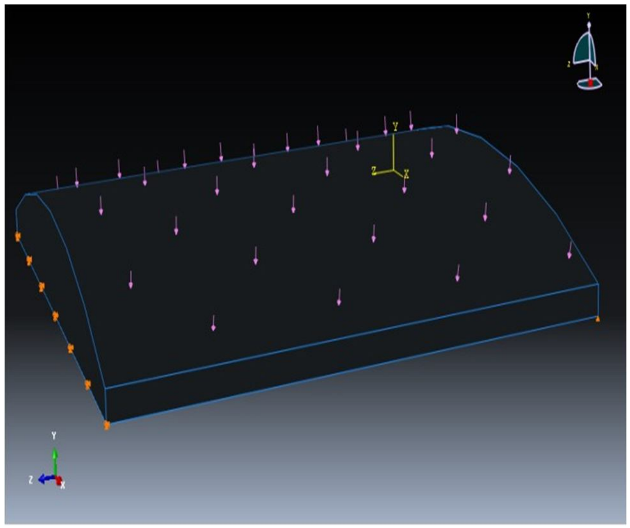


Fig 8. Boundary edge situations of the cylindrical shell roof structure.

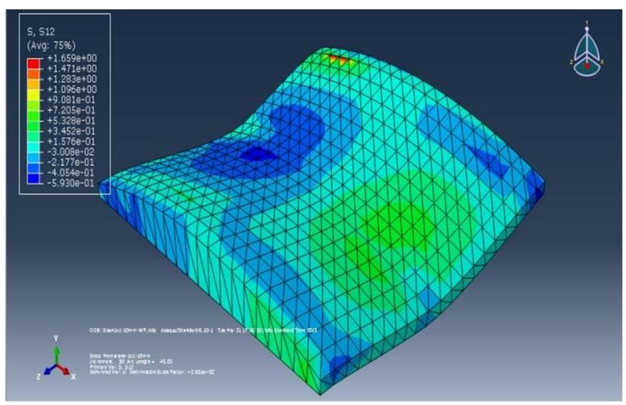
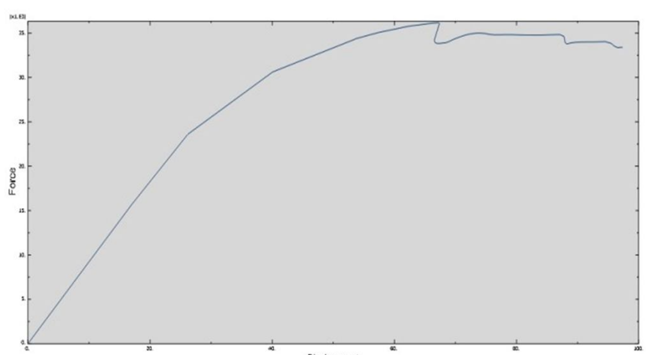


Fig 9. Stresses of round and hollow shell with reinforcement



Graph 1. Loading deformity graph of structure with reinforcement

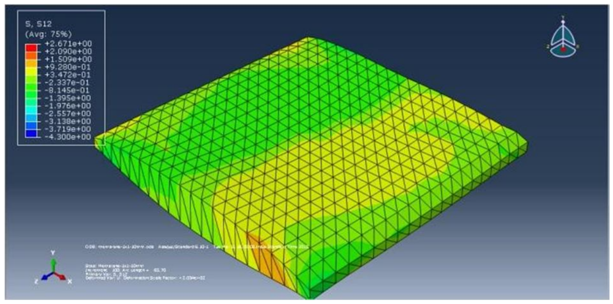
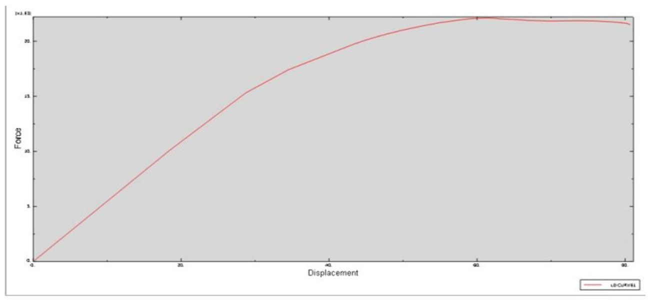


Fig 10. Stresses values of round & hollow shell without reinforcement

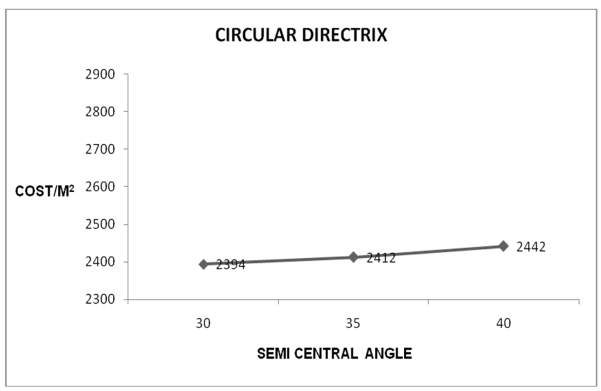


Graph 2. Loading deformation graph of the structure without reinforcement

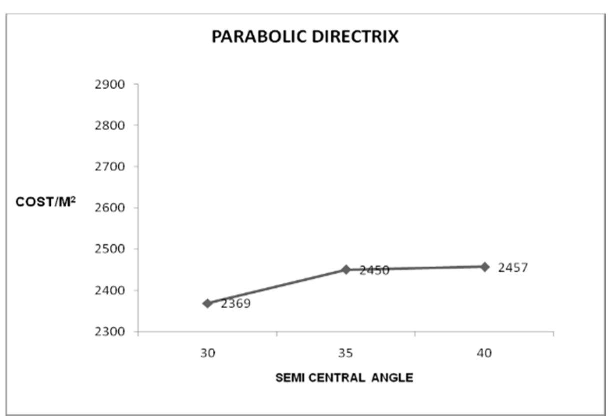
IV. RESULTS AND DISCUSSIONS

A. Design Procedure And Analysis

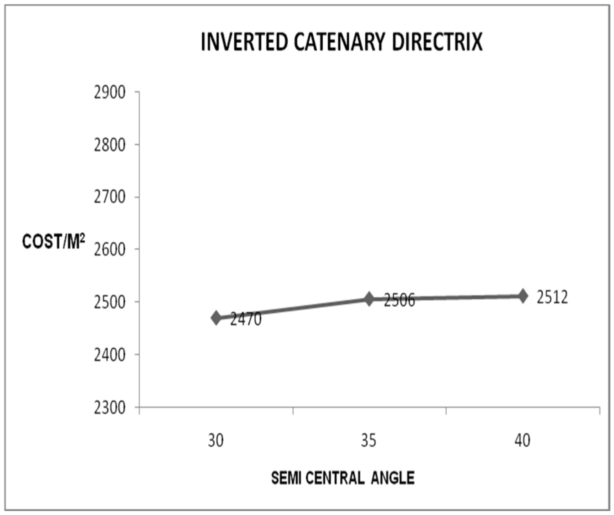
Graph 3. Comparative analysis of cost for circular directrices



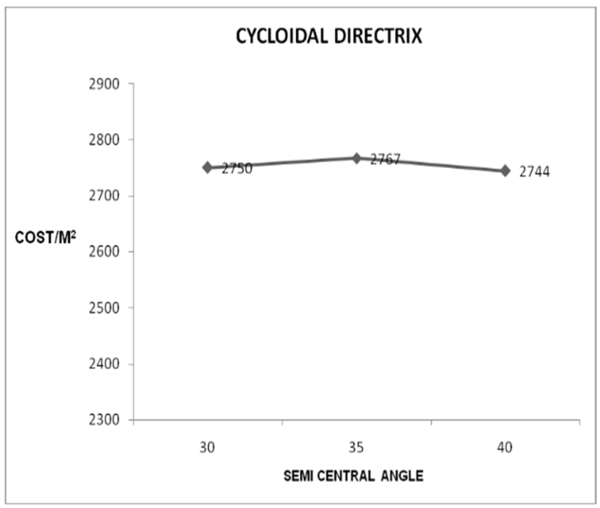
Graph No.3 Comparative analysis of cost for parabolic directrices



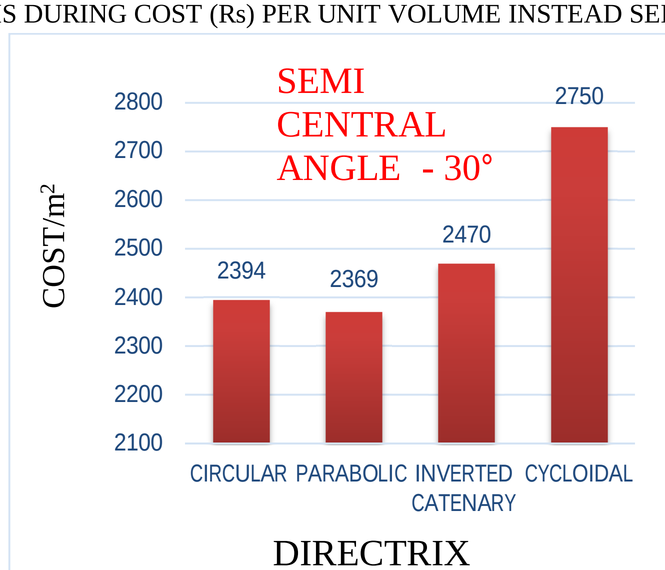
Graph 4. Comparative analysis of cost for inverted catenary directrices



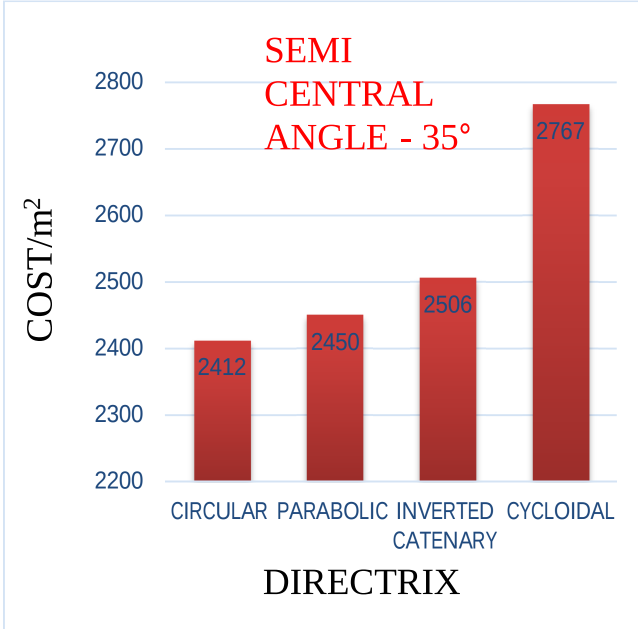
Graph 5. Comparative analysis of cost for cycloidal directrices



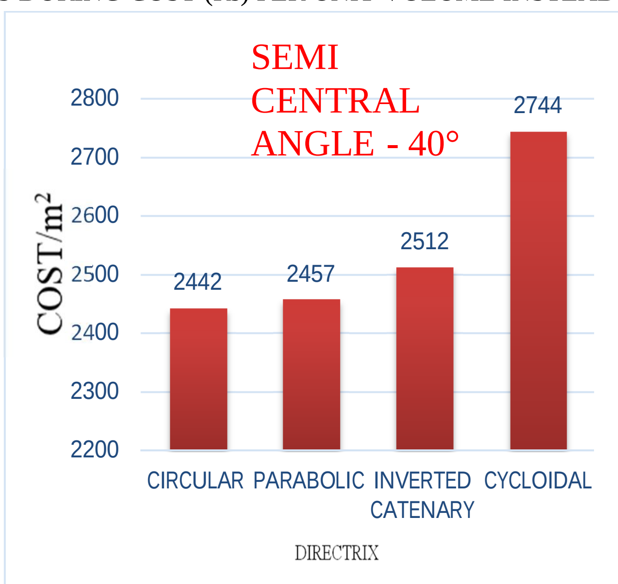
COMPARATIVE ANALYSIS DURING COST (Rs) PER UNIT VOLUME INSTEAD SEMI CENTREL ANGLE 30^0



COMPARATIVE ANALYSIS DURING COST (Rs) PER UNIT VOLUME INSTEAD SEMI CENTREL ANGLE 35^0



COMPARATIVE ANALYSIS DURING COST (Rs) PER UNIT VOLUME INSTEAD SEMI CENTREL ANGLE 40^0



Prestressed substantial cylinder molded shell roofs:

Figures Showing it is seen understood Parabolic Directrices gives most negligible cost for semi point of convergence 30 degrees & Circular Directrices gives most insignificant cost instead semi points of convergence 35 degrees 40degrees by virtue of prestressed round & empty shells presented to gravitational weights.

As semi point of convergence extends 30degrees to 40degrees cost per unit locale covered exceed.

Cylinder molded shell between shell with help & without substantial support have been inspected & nitty gritty. strain values acting along edges of plan still up in air & found out. going without closes see be procured:

There were 85% addition in the strain values between conventional course of action & shell without help.

135% extension in tension qualities between plan & shell model made through Finite Element Methods.

Blunders in tension part potential gains of the thin barrel molded shell are principally a result of the technique for assessment.

V. CONCLUSION

The shell structure arranged as a shaft part miss the mark for picked plan detail however shell as a system outlined part passes for likewise express condition.

Arranged bar shell structure get moreover thickness (0.1 m) as differentiation with 0.08 meter gave later use during wind load case as indicated by stack applied. bar shell structure has no redirection aside from system shell grants aversion instead flexibility & reasonability clarification for this mistake to be flexural disillusionment & development in pressure support in shaft shell part. strain delivered because of applied weight causes versatility twisting impact of this plan is that shell arranged as point of support construction breakdown under load while the shell arranged as system outlined structure really go against pressure additionally, safely act to counter distorting.

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