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“A Parametric Study Of Skewed Parabolic Cylindrical shell at 0^0 and 45^0 By Staad Pro Software ”

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ABSTRACT:

The interior of the shell constructions is open due to the thin, reinforced concrete shell's lack of internal supports. The most widely used shells in industry are domes and flat plates, but other shapes, such as spherical, parabolic, or cylindrical sections, may also be employed. Common concrete shell buildings are storage facilities or sports facilities. The most widely used shells in industry are domes and flat plates, but other shapes, such as spherical, parabolic, or cylindrical sections, may also be employed. Common concrete shell buildings are storage facilities or sports facilities. The parametric analysis of several cylindrical shell structures with varying lengths is the primary objective of this work. For analysis, took two different cylindrical shell lengths and changed two parameters: the radius and the thickness. Based on these variations for the same chord width, length, and material of the shell, compare the shell behavior for various models.They can be challenging to design, though, because the precise shape needed for structural stability varies depending on the material, shell size, internal or external loading, and other relevant factors. The following results have been found out by three cases by staad pro software .Hence three cases are adopted in the present study. Case1:Effect of variation in skew angle: Case2:Effect of variation in rise Case3:Effect of variation in thicknesses:

Keywords: cylindrical shells, Analysis, Parameters,Rise,shear stress,moment.

I. INTRODUCTION

Thus, when the shell's parameter is changed, the shell's behavior likewise changes. In the fields of civil, mechanical, aeronautical, and marine engineering, shell structures are frequently employed. The introduction of novel materials and prefabrication systems has improved shell technology. The shell structures offer both mechanical and aesthetic benefits, but there is a large degree of relative ignorance regarding shell behavior and design.Numerous issues arise during the building of a reinforced concrete shell, including form work design and construction, reinforcement choices, etc. Shells rely more than nearly any other structural system on the engineer's ability to anticipate design flaws. The majority of the first shells constructed were cylindrical, single- or multi-barreled shells. The article offers a comparison and analysis of several cylindrical shells with different thickness and radius values.

2. OBJECTIVES OF THE PRESENT STUDY

As mentioned above the study of skewed cylindrical shell roofs with varying parameters has been under taken for present study.
The main objectives of the present work:
To study the behavior of the parabolic cylindrical shell subjected to Dynamic loading conditions.
Comparison between the behaviors of straight parabolic cylindrical shell vs skewed parabolic cylindrical shell.

3. LITERATURE REVIEW

This chapter examines prior research on superplasticizer admixtures in concrete that is already available. Also discussed are the impact of these admixtures on the mechanical characteristics of freshly laid and hardened concrete. Also, machine learning approach introduced. Based on the past researcher the following literature review can be done for present investigation.

- **Arciniega and Reddy (2006)** A geometrically nonlinear analysis of functionally graded shells is presented. The two-constituent functionally graded shell consists of ceramic and metal that are graded through the thickness, from one surface of the shell to the other. A tensor-based finite element formulation with curvilinear coordinates and first-order shear deformation theory are used to develop the functionally graded shell finite element. The first- order shell theory consists of seven parameters and exact nonlinear deformations and under the framework of the Lagrangian description. High-order Lagrangian interpolation functions are used to approximate the field variables to avoid membrane, shear, and thickness locking. Numerical results obtained using the present shell element for typical benchmark problem geometries with functionally graded material compositions are presented.

- **Sahu and Datta (2007)** This paper reviews most of the recent research done in the field of dynamic stability/ dynamic instability/parametric excitation/parametric resonance characteristics of structures with special attention to parametric excitation of plate and shell structures. The purpose of this study is to review most of the recent research on dynamic stability in terms of the geometry shells, type of loading, boundary conditions method of analysis, method of determination of dynamic instability regions, order of theory being applied, shell theory used materials of structures and the various complicating effects such as geometrical discontinuity, elastic support, added mass, fluid structure interactions, neoconservative loading and twisting, etc. The important effects on dynamic stability of structures under periodic loading have been identified and influences of various important parameters are discussed.
- **Kandasamy and Singh (2010)** Numerical studies of the free vibration analysis of open skewed circular cylindrical shells supported only on selected segments of the straightedges are presented in this paper. The uniform thickness shell geometry is defined by the radius, subtended angle and the length, all with reference to the middle surface.. The free vibration analysis of the shell structure is performed using two types of interpolating polynomials, viz. simple high order algebraic and Bezier, respectively. The number of nodal points per patch determines the order of the displacement polynomials. As a consequence considerably high- order polynomials are used in computations for the accurately converged results. Convergence studies are carried out to validate the method for cases in which the skewed cylindrical shell is supported only on the third of each of the two straight edges. Additionally, the performance of the present method is assessed and discussed by comparing frequency results with those from standard finite element methods using linear and parabolic quadrilateral elements.
- **Tripathy (2017)** Turbo-generator machines even as operation generate harmonic load on the muse which might also additionally create heavy vibration in case it’s now no longer taken into consideration within side the basis design. The gift paintings research the impact of raft,pile with raft and barrettes with raft subjected to harmonic load at the turbo-generator basis in medium dense and partly saturated sand. Detailed computational evaluation turned into done with the assist of SAP; 2000 software; the numerical version turned into analysed and in comparison with the experimental outcomes. Both experimental and numerical outcomes monitor that the displacement at pinnacle deck is decrease for barrettes in comparison to raft and pile structures, which leads to least vibration at pinnacle deck for barrette-supported turbo-generator foundations. There is likewise lower in spectra acceleration, stress, base shear and grow thin herbal frequency in barrette-supported foundations in comparison with raft-and pile-supported foundations. Hence, barrettes with raft are encouraged below dynamic loading in bad soil situations as it transfers the dynamic load thru columns to barrettes as a consequence growing the steadiness of the turbo-generator basis.
- **Yadav et al. (2022)** This article presents nonlinear vibration and dynamic stability assessments of laminated composite circular cylindrical shells with simple support that are exposed to periodic edge loading. The new mathematical model is developed using a third-order shear deformation shell theory that takes into account rotating inertia and all the nonlinear factors in all five kinematic parameters so that the model is also valid for thick cylindrical shells. The energy-based method known as Hamilton's principle is applied to derive the partial differential equations (PDEs) that regulate the cylindrical shell's motion. Furthermore, Galerkin's approach is used to reduce these equations to ordinary differential equations. The frequency-amplitude response of the system is obtained by combining the pseudo-arc-length method with the incremental harmonic balance (IHB) method. The Bolotin method is used to obtain the zones of instability. The analysis of results is extended to account for damping for the composite cylindrical shells for greater practical significance. Plotting of the phase portrait and time history response is done using the Newmark-beta method. Additionally, the effects of nonlinear vibration, instability zones, and time history responses are investigated in relation to the static load factor, dynamic load factor, modal damping coefficient, and stacking sequence.
- **Draiche et al. (2024)** For the purpose of static bending and dynamic analysis of functionally graded (FG) doubly-curved shell structures, an enhanced mathematical model based on a newly revised sinusoidal shear deformation theory with only four unknown variables is presented in this study. The suggested higher-order shell theory satisfies the tensile-free boundary conditions at the top and bottom surfaces of the shell, producing an appropriate distribution of the transverse shear strains through the thickness. Based on the volume fractions of the constituents and the power-law distribution, the mechanical characteristics should alter gradually in the thickness direction. This study's shell equilibrium equations are generated from Hamilton's variational principle and then solved using the Navier solution methodology for simply supported boundary conditions. The proposed theory's accuracy is validated by multiple numerical results regarding the mechanical behavior of FG shell structures with varying geometrical configurations. These results were compared and successfully converged with corresponding results found by alternative higher-order shear deformation models. The improved model, however, is supported by these results.

5.METHODOLOGY

The purpose of the present work is to study, the behavior of non-skewed parabolic cylindrical shell roof and skewed parabolic cylindrical shell roof with varying parameter under dynamic loads. For this purpose following details are used:

Table 1 Parameter selected for analysis

S. No.	Description	Parameter
1	Span in x-direction	18m
2	Span in y-direction	10m
3	Live load	0.6kN/m^2
4	Grade of concrete	M-25
5	Type of steel	Fe-415
6	Column Size	0.5mx 0.3m
7	Column height	6m
8	Column longitudinal reinforcement	2%ofarea
9	Column transverse reinforcement	10d@150mmc/c
10	Beam Size	0.8mx 0.3m
11	Beam reinforcement	0.0037m^2bothside(Top &Bottom)
12	Shell reinforcement	10d@200mmc/c in both faces in both ways
13	Diaphragm thickness	0.2m,0.15m&0.1m
14	Radius of shell	10m
15	Thickness of shell	0.20m,1.5m&0.1m
16	Skewed angle	0^o,45^o
17	Roll down angle	30^o
18	Rise	2.68m

Non-skewed Parabolic Cylindrical

In order to achieve the objectives of the study, the following methodology is proposed. In this attempt, we prepared twenty seven models with variation in skew angle, rise and thickness. With those variation models are as follows:-

Shell Roof

1. Size10m*18mspan18mandchordlength10mrise1.5mRolldownangle30^0radius10m thickness of shell 200mm.
2. Size10m*18mspan18mandchordlength10mrise1.5mRolldownangle30^0radius10m thickness of shell 150mm.
3. Size10m*18mspan18mandchordlength10mrise1.5mRolldownangle30^0radius10m thickness of shell 100mm.
4. Size10m*18mspan18mandchordlength10m rise2.25mRolldownangle30^0radius10m thickness of shell 200mm.Size10m*18mspan18mandchordlength10m rise2.25mRolldownangle30^0radius 10m thickness of shell 150mm.
5. Size10m*18mspan18mandchordlength10m rise2.25mRolldownangle30^0radius 10m thickness of shell 100mm.
6. Size10m*18mspan18mandchordlength10m rise3mRolldownangle30^0radius 10m thickness of shell 200mm.
7. Size10m*18mspan18mandchordlength10mrise3mRolldownangle30^0radius10m thickness of shell 150mm.
8. Size10m*18mspan18mandchordlength10mrise3mRolldownangle30^0radius10m thickness of shell 100mm.

Skewed Parabolic Cylindrical Shell Roof(skewedby45^0)

1. Size10m*18mspan18mandchordlength10m rise1.5mRolldownangle30^0radius 10m thickness of shell 200mm.
2. Size10m*18mspan18mandchordlength10mrise1.5mRolldownangle30^0radius 10m thickness of shell 150mm.
3. Size10m*18mspan18mandchordlength10m rise1.5mRolldownangle30^0radius 10m thickness of shell 100mm.
4. Size10m*18mspan18mandchordlength10m rise2.25mRolldownangle30^0radius 10m thickness of shell 200mm.
5. Size10m*18mspan18mandchordlength10m rise2.25mRolldownangle30^0radius 10m thickness of shell 150mm.
6. Size10m*18mspan18mandchordlength10m rise2.25mRolldownangle30^0radius 10m thickness of shell 100mm.
7. Size10m*18mspan18mandchordlength10m rise3mRolldownangle30^0radius 10m thickness of shell 200mm.

8. Size10m*18mspan18mandchordlength10m rise3mRolldownangle30^0radius 10m thickness of shell 150mm.
9. Size10m*18mspan18mandchordlength10m rise3mRolldownangle30^0radius 10m thickness of shell 100mm.

Case I: Effect of skew angles

For this Study, Variation in skew angle has been done keeping rise &thickness constant.The following models are therefore selected for the study:

1. For 1.5 m rise and 200 mm thickness model no.1,10 and19.
2. For1.5mriseand150mmthicknessmodelno.2,11and 20.
3. For1.5mriseand100mmthicknessmodelno.3,12 and 21
4. For2.25mriseand200mmthicknessmodelno4,13 and 22.
5. For2.25mriseand150mmthicknessmodelno.5,14 and 23.
6. For2.25mriseand100mmthicknessmodelno.6,15 and 24.
7. For3mriseand200mmthicknessmodelno.7,16 and25.
8. For3mriseand150mmthicknessmodelno.8,17 and 26.
9. For3mriseand100mmthicknessmodelno.9,18 and27.

Case II: Effect of rises

For this Study, Variation in rise has been done keeping skew angle & thickness constant. The following models are therefore selected for the study:

1. For skew angle $0^0$and 2 00 mm thickness model no.1,4 and7.
2. Forskewangle0^0and150mmthicknessmodelno.2,5 and 8.
3. Forskewangle0^0and100mmthicknessmodelno.3,6 and9
4. Forskewangle45^0and200mmthicknessmodelno.19, 22and25.
5. Forskewangle45^0and150mmthicknessmodelno.20, 23and26.
6. Forskewangle45^0and100mmthicknessmodelno.21,24and27

Case III: Effect of thicknesses

For this Study, Variation in thickness has been done keeping skew angle and rise constant. The following models are therefore selected for the study:

1. Forskewangle0^0and1.5mrisemodelno.1,2and3.
2. Forskewangle0^0and2.25mrisemodelno.4,5 and6.
3. Forskewangle0^0and3mrisemodelno.7,8 and9.
4. Forskewangle45^0and1.5mrisemodelno.19,20 and21.
5. Forskewangle45^0and2.25mrisemodelno.22,23 and24.
6. Forskewangle45^0and3mrisemodelno.25, 26 and27.

5. RESULTS :

Graphs for stresses

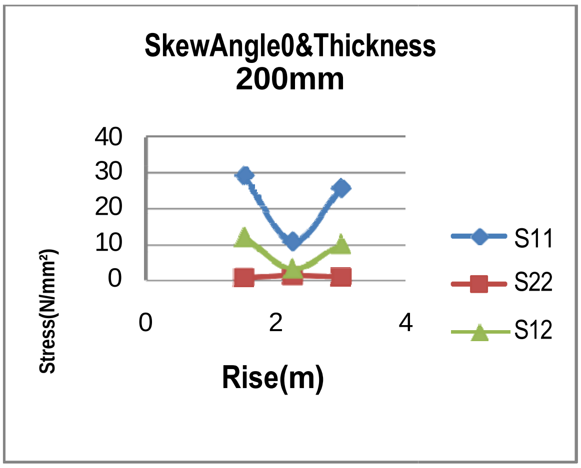
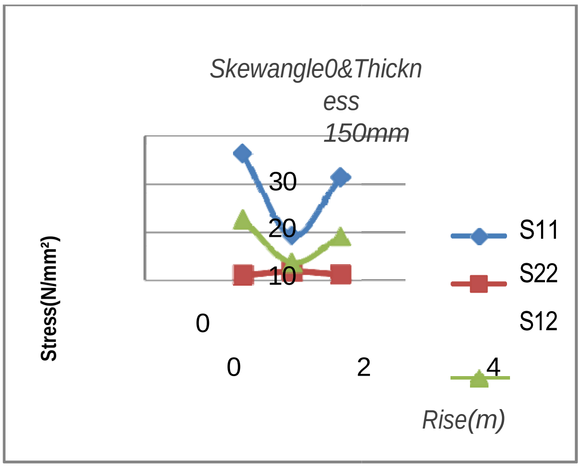


Fig.1



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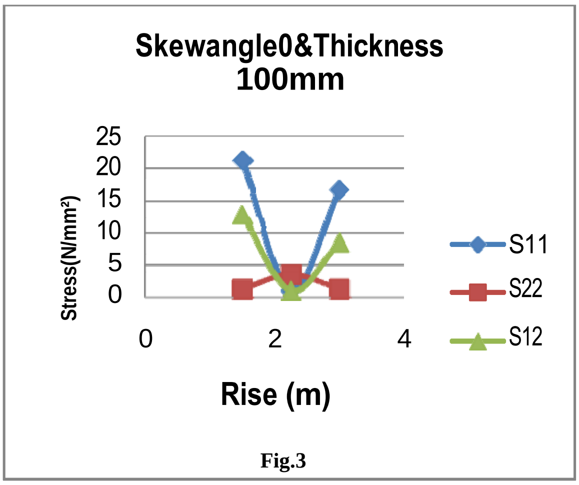

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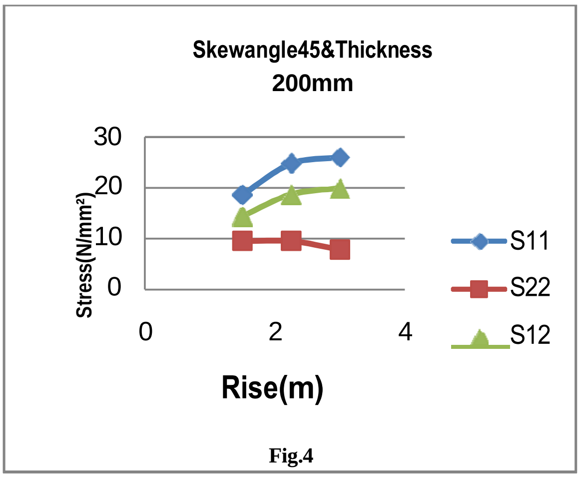

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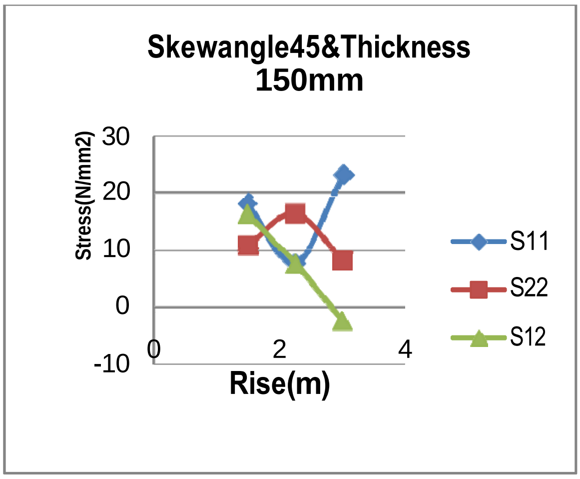

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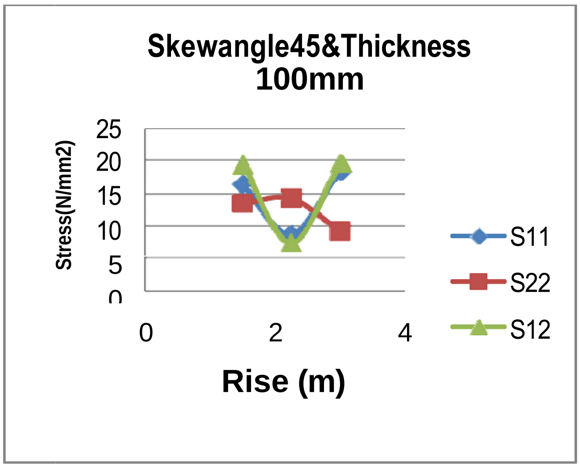

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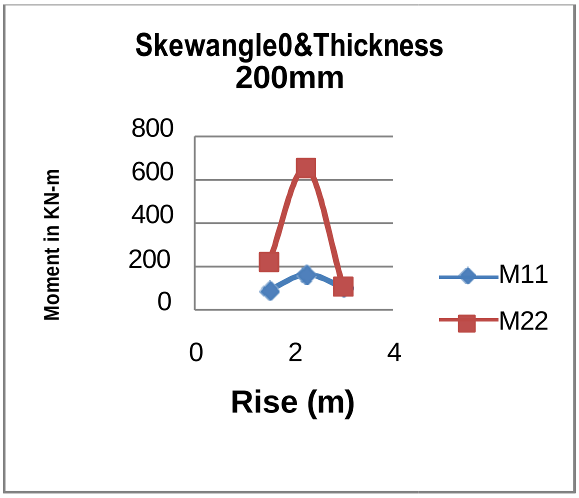


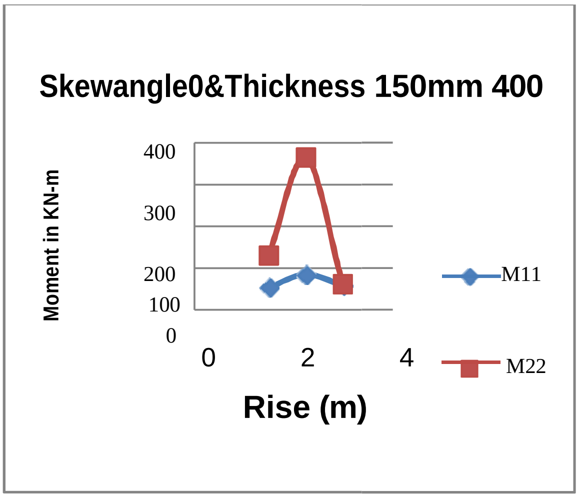
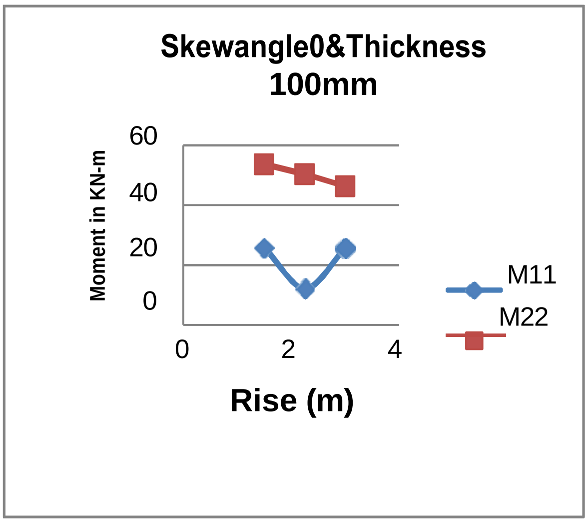


Fig.7

Fig.8



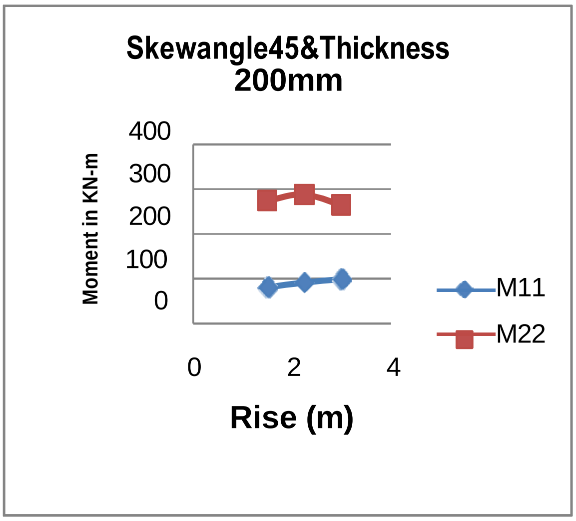
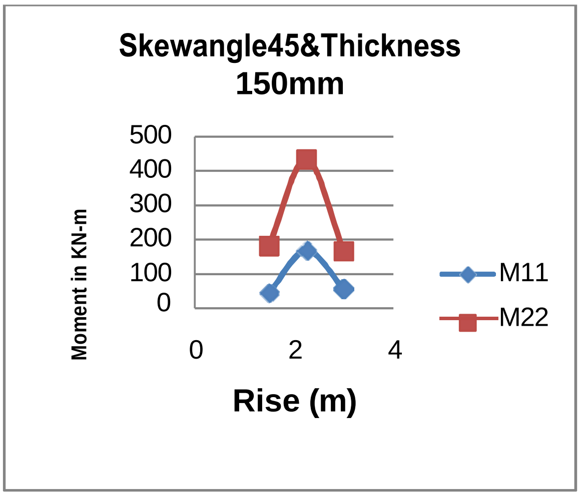


Fig.9

Fig.10



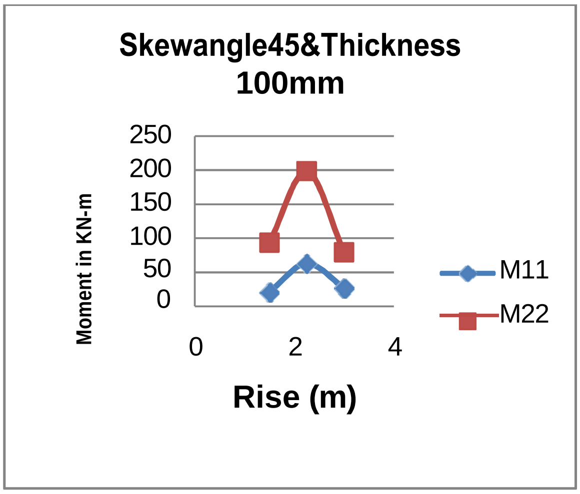
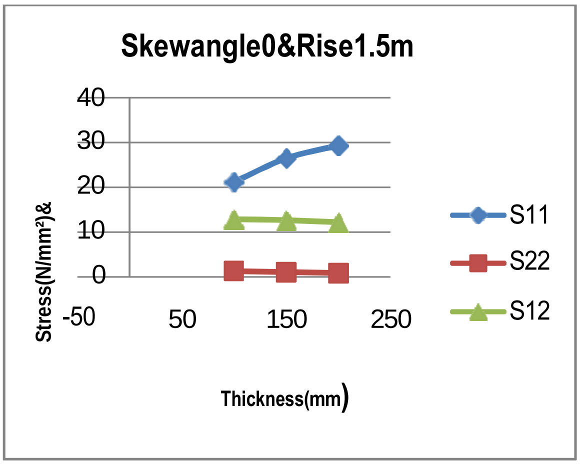


Fig. 11

Fig.12

Graph for Stresses



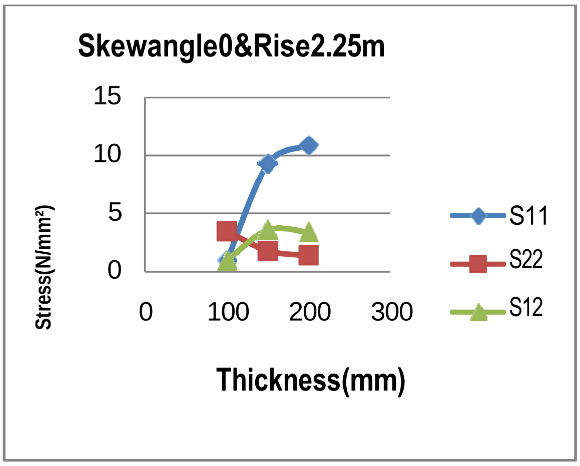
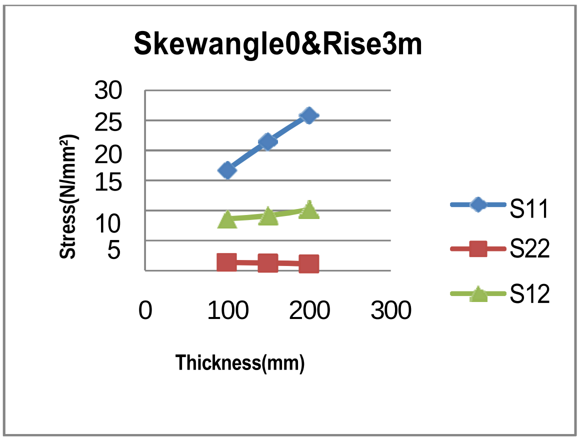


Fig.13

Fig.14



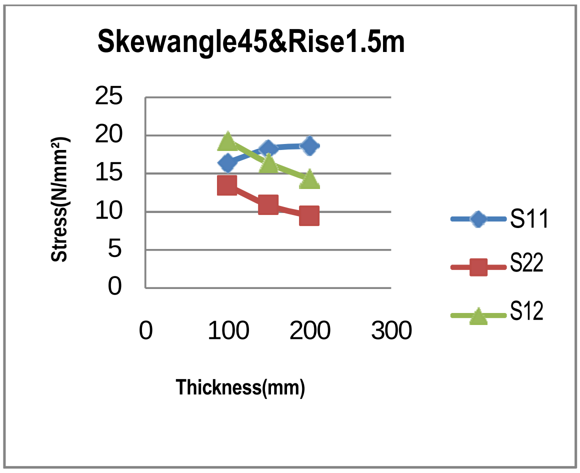
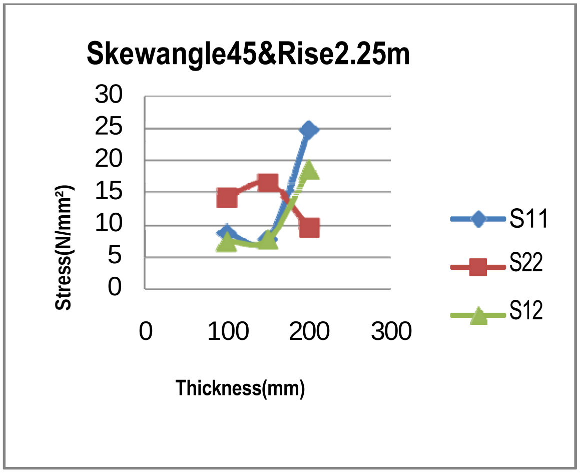


Fig.15

Fig.16



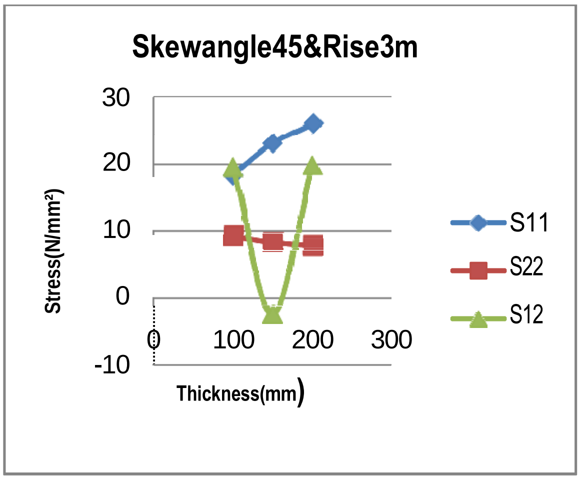
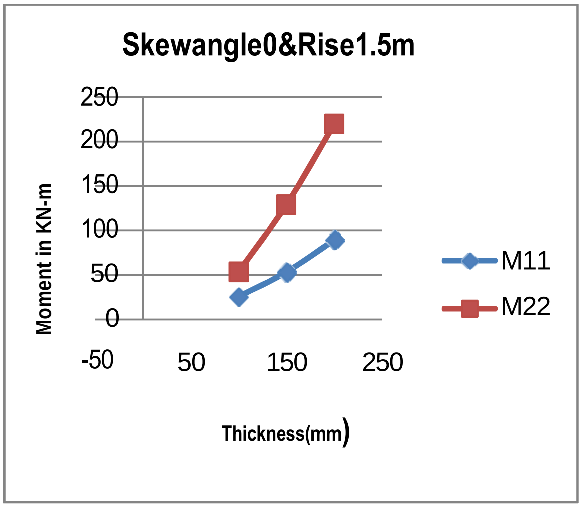


Fig.17

Fig.18

Graphs for Moments



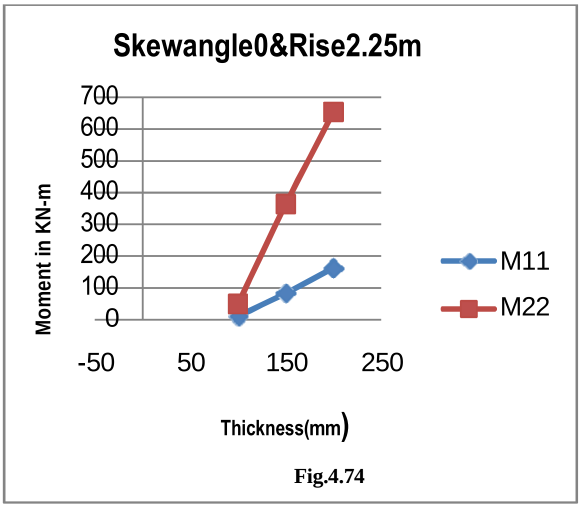


Fig.4.74

Fig.19

Fig.20

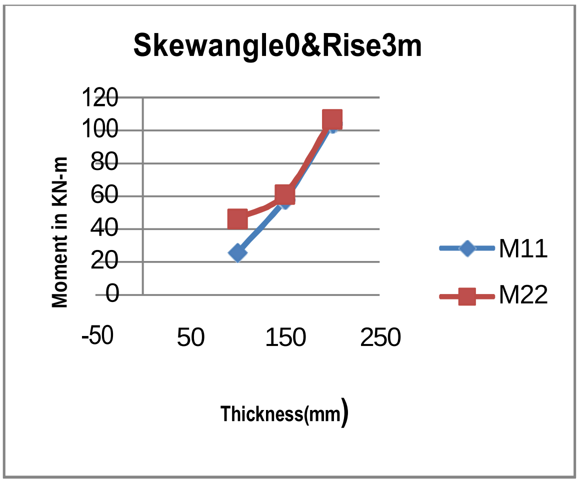
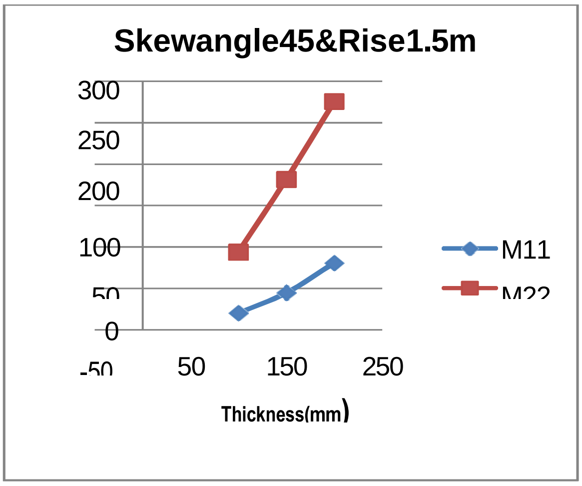


Fig.21



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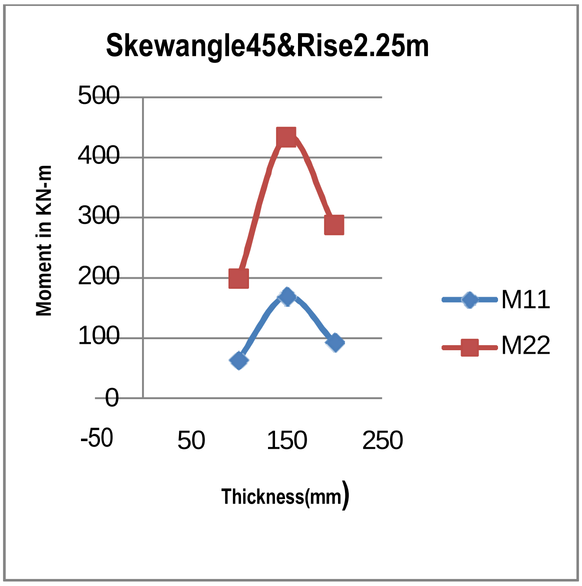

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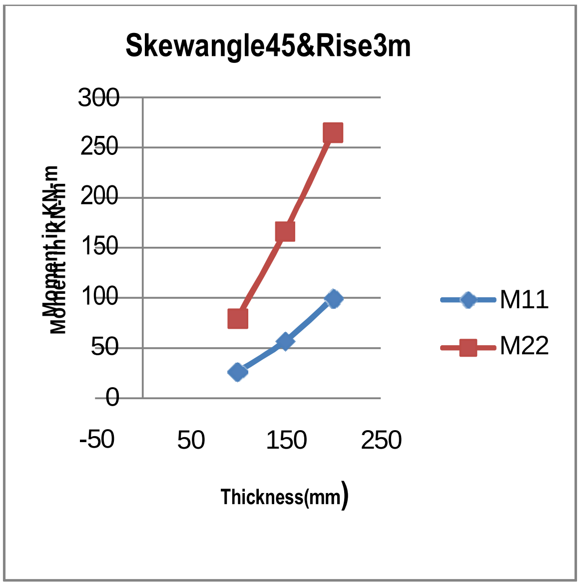

Fig.24

6 . DISCUSSION ON RESULTS:

- **Case1:effect of variation in skew angle:** Effect on longitudinal stress S_{11} (Nx): for rise1.5 meter longitudinal stress decreases in first mode by 40% and for 45° skew angle, it increases in first mode by 44% and decreases in second mode by 16%. The value of stress in third mode at 45° skew angle decreases by 6%. In fourth mode the value of stress is high as compared to first mode. The value of the stress at 45°skew angle increases by 20%. for rise 2.25 meter longitudinal stress increase in first mode by two times and increment at 45° skew angle in first mode by 50% and two time in second mode. The value of stress in third mode at decreases by 88% at 45° skew angle. In fourth mode the value of stress is high as compare to first mode, the value of the stress at increase by 91% at 45° skew angle. For rise 3.0 meter longitudinal stress 80% at 45°skew angle in second model decreases by 3% at 45° skew angle. In third mode stress is high as compare to first and second mode, stress increase by 7% at 45° in fourth mode stress is very high as compare to first and second mode at 40% at 45° skew angle.
- **Effect on transverse stress S_{22} (Nx):** for rise 1.5 meter transverse stress at 45°skew angle increases by 60%. In second mode stress at 45° skew angle increase by three times. In third mode stress is high as compared to first and second mode, stress increases at 45°skew angle ten times. In fourth mode stress is very high as compare to first and at 45° skew angle it increases by two times. for rise 2.25 meter transverse stress increase at 45° skew angle two time . In second mode stress increment at 45° skews angle increase by two times. In third mode stress is high as compare to first and second mode, stress increase by three times at 45° six times .In fourth mode stress is very high as compare to first and second mode at 45° skew angle increases by five times .For rise 3.0 meter transverse stress increases by one and half time in first mode at 45° skew angle five times. In second mode stress at 45° skew angle increase by 70%. In third mode stress is high as compare to first and second mode, stress increase at 45° skew angle increases by six time in fourth mode. Stress is very high as compared to first and second mode. In forth mode at 45° skew angle increases by two times .

- **Effect on shear stress S_{12} (Nx):** for rise 1.5 meter shear stress decreases by 11% in first mode at 45° skew angle increases by 69% . In second mode stress increases at 45° skew angle increase by two times. In third mode, stress is high as compare to first and second mode, stress at 45° skew angle it increases by 19.3%. In fourth mode, stress is very high as compared to first and second mode, at 45° skew angle two and half times .For rise2.25 meter shear stress increase by80% in first mode at 45° skew angle by 90%. In second mode stress increases increase at 45° skew angle by two times. In third mode, stress is high as compared to first and second mode, stress increase by 69% at 45° skew angle by two times. In fourth mode, stress is very high as compared to first and second mode at 45° skew angle by two times. For rise 3.0 meter shear stress increase by two times in first mode three times at45° skew angle. In second mode stress increases at 45° skew angle increase by 9%. In third mode, stress is high as compare to first and second mode, stress at 45° skew angle it decreases by 19%. In fourth mode at 45° skew angle it decreases by 22% .
- **Effect on longitudinal moment M_{11} (Mx):** for rise 1.5 meter moment stress decreases by 34% in first mode 45° skew angle increase by 6% . In second mode stress decreases at 45° skew angle increase by 2%. In third mode stress decreases at 45° skew angle by 16%. In fourth mode, stress is very high as compare to first and second mode, at 30° skew angle stress decreases at 45° skew angle by 22%.For rise 2.25 meter moment stress increase by 28% in first mode at 45° skew angle increase by 29%. In second mode stress decrement at 45° skew angleby10%. In third mode stress increase at 45° skew angle two times. In fourth mode at 45° skew angle stress increase by two times.For rise 3.0 meter moment stress decreases by 4% in first mode at 45° skew angle by 3% at. In second mode stress decreases at 45° skew angle by 9%. In third mode stress increases by 3% at 45° in fourth mode stress is very high as compare to first and second mode at 45° skew angle stress increase by 2%.
- **Effect on transverse moment M_{22} (Mx):** for rise 1.5 meter transverse moment decreases by 46% in first mode at 45° skew angle increases by 4%. In second mode stress increases at 45° skew angle increase by three times. In third mode stress is high as compare to first and second mode, stress increase at 45°skew angle by 40%. In fourth mode stress is very high as compare to first and second mode at 45° skew angle stress decreases by 29% .for rise 2.25 meter transverse moment increase by at 45° skew angle increases by 22% . In second mode stress increases at 45° skew angle increase by 82%. In third mode stress increase by three times at 45°skew angle by three times. In fourth mode, stress is very high as compare to first and second mode, at 45° skew angle stress increase by 67% .for rise 3.0 meter transverse moment increases by 7% in first mode at 45° skew angle decreases by 7%. In second mode stress increases 45° skew angle increases by two and halftimes. In third mode stress increase by at 45°skew angle by three times. In fourth mode stress is very high as compare to first and second mode and 55% at 45° skew angle .

Case2:effect of variation in rise:

- **Effect in non-skew parabolic cylindrical shell:** In non skew shells the longitudinal stress S11 (Nx) decreases by 64% at 2.25 meter rise and at 3 meter rise it decreases by 18%. The transversestressS22(Nx)increasesat2.25meterriseby72%andat3meterby14%.Further the in plane shear stress decreases at 2.25 meter by 71% and at 3 meter rise by 23%.The longitudinal moment M11 (Mx), increases with the increase in rise, at 2.25 meter rise increase by 83% and at 3 meter rise it increase by 17%.The transverse moment M22 (M□) is increasesat2.25meterrisebytwotimesand at3 meter rise it decreases by51% .
- **Effect in skewed parabolic cylindrical shell(30°):** In 30° skewed shell the longitudinal stress S11 (Nx) decreases by 56% at 2.25 meter rise and at 3 meter rise it decreases by 3%. The transverse stress S22(Nx) increases at 2.25 meter rise by 53% and at3 meter it decreases by 24%.Further the in plane shear stress decreases at 2.25 meter by 65% and at 3 meter rise by 15%.The longitudinal moment M11 (Mx), increases with the increase in rise, at 2.25 meter rise increase by three times and at3 meter rise It increase by20%.ThetransversemomentM22 (Mx) is increases at 2.25 meter rise by two times and at 3 meter rise it decreases by 29% .
- **Effect in skewed parabolic cylindrical shell (45°):** In 45° skewed shells the longitudinal stressS11(Nx) decreases by 47% at 2.25 meter rise and at 3meter rise increases by12%.The transverse stress S22 (Nx) increases at 2.25 meter rise by 6% and at 3 meter by 31%. Further the in plane shear stress decreases at 2.25meterby62%and at3meterriseby 2% .The longitudinal moment M11 (Mx), increases with the increase in rise, at 2.25 meter rise increase by three times and at3 meter rise it increase by 27%. The transverse momentM22 (Mx) is increases at 2.25 meter rise by three times and at 3 meter rise it decreases by 8% .

Case3:Effect of variation in thicknesses:

- **Effect in non-skew parabolic cylindrical shell:** In non skew shells the longitudinal stress S11 (Nx) decreases by 14% at 150 mm thickness and at 100 mm thickness it decreases by 90%. The transverse stress S22 (Nx) increases at 150 mm thickness by 27% and at 100 mm by two and half times. Further the in plane shears stress increases at150 mm thickness by 5% and at 100mm thickness it decreases by 71% .The longitudinal moment M11(Mx), decreases with the decrease in thickness,at150mm thickness decrease by 40% and at 100 mm thickness it decrease by71%.The transverse moment M22 (Mx) is decreases at 150 mm thickness by 41%and at 100 mm thickness it decreases by 75% .
- **Effect in skewed parabolic cylindrical shell (45°):** In 45° skewed shells the longitudinal stress S11 (Nx) decreases by2% at 150 mm thickness and at 100 mm thickness it decreases by 11%. The transverse stress S22 (N□) increases at 150 mm thickness by 14% and at 100 mm by 41%. Further the in plane shears stress decreases at150 mm thickness by59% and at 100mm thickness by 60%.

The longitudinal moment M11 (Mx), decreases with the decrease in thickness, at150mm thickness decrease by 45% and at 100 mm thickness it decrease by75%.The transverse moment M22 (Mx) is decreases at 150 mm thickness by 32%and at 100 mm thickness it decreases by 1% .

CONCLUSION :

Effect of skewed angle

The longitudinal stress(Nx) decreases as the skew angle increases, transversestress (Nx) increases as the skew angle increases .The in plane shear stress (Nx) almost remained constant, therefore it can be concluded that the role of resistance to load shifts from longitudinal stress(Nx) to transverse stress (Nx) as skew angle increases.

Longitudinal Moment (Mx) does not vary much with skew angle, but the transverse moment (Mx) increases with skew angle but more for 45°.Further the transverse moment (Mx) is more than double than Longitudinal Moment (Mx) in all cases, which shows transverse moment (Mx) plays the major role in resisting the load.

Effect of rise:

The stresses are minimum for 2.25m rise as compared to other two rise. Thus for shallow and deep shell, the loads are resisted by stresses as compared to intermediate rise, which is reflected by their higher values. In shells with intermediate rise, the moment plays major role. In plane shear stress (Nx) played negligible part in loads resistance.

Effect of thickness:

The longitudinal stress (Nx) increases with increase in thickness, while transverse stress (Nx) either decreases or remains constant. Further the value of longitudinal stress (Nx) is much larger ascompared to transverse stress (N□). The magnitude of in plane shear (Nx) lies in between the other two stresses and it is observed to decrease with thickness. Thus it appears that longitudinal stress (Nx) plays major role in resisting the loads as compared to other two stresses. Both the moments, longitudinal Moment (Mx) and transverse moment (Mx), are increasing with thickness. Transverse moment (Mx) increases more in comparison of longitudinal Moment (Mx).

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