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DIFFERENTIATION, USE AND APPLICATION OF SHELL ELEMENTS, MEMBRANE ELEMENTS, THICK SHELLELEMENTS IN CASE OF HIGHRISE BUILDINGS

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ABSTRACT
This paper present the usage of shell and membrane elements are studied in high rise buildings using latest software ETABS 2013 .using this software results are compared between shell elements and membrane elements. Analysis is done using ETABS software on a high rise building with (2B+18) the building which is suited in earthquake zone IV. The study include lateral displacement , storey drift and base shear with respect to RCC section.In high rise buildings the application of shell elements and membrane elements are mostly used in shear walls, shear core which acts as lateral stiffeners in high rise buildings and membrane elements are used in slabs. In certain cases shell elements are also used in slabs because the transfer of loads from slab in membrane is more when compared to shell elements.Thus the shell elements give less moment which result in less reinforcements and makes structures economical.

KEYWORDS– Lateral displacement, Story drift, Shell & Membrane elements

INTRODUCTION
High-rise buildings in general are defined as buildings 35 meters or greater in height, which are divided at regular intervals into occupable levels. The use of innovative building materials and constraction method in early years the builders urge to rise to dizzying heights was limited by unsolved technical problems. the end of the last century, high-rise buildings were still made of solid brick masonry, which ultimately required large foundation. When steel frames are adopted from steel bridge construction, with their increased strength and lower weight, builders and architects were able to soar to greater heights. Identify the performance of the structure. The buildings are subjected to vertical loads as well as horizontal loads. The vertical loads consist of dead load and structural compounds such as beams, coloums,slabs, etc. and live loads. The horizontal loads consist of winds loads, seismic loads. Thus building is designed for a combination of dead load, live load, wind load & seismic loadSince manual computations are huge and tedious, the help of design software. The analysis and design of the super structure was done by using e tabs.

LITERATURE REVIEW
SHWETA A.WAGH (2014)- conducted a research on solution of composite location in multi storey building.There are lots of literatures available to design and analyze the composite. However, the decision about the location of composite in multi-story building is not much disscussed. In any literature In this paper main focus is to determine the solution for both the composite and rcc location in multi-story building. An earthquake load is calculated and applied to a building of G+16 located in zone II (Nagpur). It was found to be Deflection, BM, SF and cost.

D.R. PANCHAL AND P.M. MARATH- He used a comparative method of study for RCC, Composite andsteel options in a G+30 storey commercial building situated in earthquake Zone V. For this they used Equivalent static method and used the software ETABS. The comparative studyincluded size, deflections, material consumption of members in RCC and steel sections as compared to Composite sections was also studied closely and based on this study a cost comparison analysis was also performed

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CHAKRAVORTY,P.K.SINHA,J.N BANDYOPADHYAY- Explain that theApplications of FEM on free and forced vibration of laminated shell. Eng Mech, vol.124, 1998 .

S.AHMAD ,BM IRO 1970 - He give a procedureAnalysis of thick and thin shell structures by curved finite elements This paper publishes refereed contributions describing significant developments in numerical methods and their application to the solution of practical enginnering probems. It is the leading journal in the field, with a current Impact Factor of 1.335.

BILLINGTON, D.P. AND HARRIS, H.G. (1981). Test Methods for Concrete Shell Buckling representative tests used to study the buckling of thin shell concrete structures of two basic types: roof shells and shell walls. this shell walls include cylindrical tank colling tower and torroidal cylinders. The major factors described for each test series are model materials and geometry, boundary conditions, loadings, measuring devices and interpretationsof results. The goal of all such tests is to insure that shell safety is not controlled by buckling.

APPLICATIONS OF SHELL AND MEMBRANES

In more recent times the availability of reinforced concrete has stimulated interest in the use of shells for roofing purposes.Pressure vessels and associated pipework are key components in thermal and nuclear power plants, and in all branches of the chemical and petroleum industries. Steel plates were riveted together to from reinforced tubes as large as 12 ft in diametar and having a radius/thickness ratio of between 60 and 180. components, preformed into thin doubly curved shells by large power presses, and firmly connected to each other by welds along the boundaries. The introduction of fiberglass and similar lightweight composite materials has impacted the construction of vehicles ranging from boats, racing cars, fighter and stealth aircraft, and so on. The exterior skin can be used as a strong structural shell. Other examples of the impact of shell structures include water cooling towers for power stations, grain silos, armour, arch dams, tunnels, submarines, and so forth.

THE MAIN DIFFERENCE BETWEEN USING SHELL AND MEMBRANE IN ETABS

When using Etabs we may recognize that their are 3 options for a Wall/Slab section assignment. They are mainly membrane shell and plate. Each type has different features. Since Slab or Wall is main element so its section assignment will has significant effect into our model output.when we assign slab type as membrane, it only transfers forces to Beam's supporting it and does not take part in load bearing. But when we assign shell type slab element, they take part in load bearing along with the load transfer to supporting beams. This reduces the sagging moments in beams. And assigning shell element as slabs is the actual representation of on site slabs.

Membrane type - Only in plane stiffness and no outofplanestiffness

Shell type Slab - Both in plane and out of plane stiffness

membrane can take stresses in its plane only (four orthogonal components), since it has no adequate thickness to resist bending; meanwhile the shell can take stresses in its plane and perpendicular to it (six orthogonal components), because it may have adequate thickness to resist bending perpendicular to its plane. The main difference between thin and thick shell formulation. Thin plate formulation follows a kirchoffs application, which neglects transverse shear deformation, where as thick shell, which does account for shear behavior. Thick plate formulation has no effect upon membrane(in-plane)behavior, only plate bending(out-plane).

In general, the contribution of shear deformation ratio between the span of plate-bending curvature and thickness is approximately 20.1 or 10.1 the formulation formulation it self is adequate for ratio 5:1,4:1. In that this ratio is dependent upon the projected span of curvature , shell thickness may be greater than the actual plan dimension of the shell object.as a result of no contribution from membrane ,beams in membrane assignment model have bigger bending moment than in other. The thicker slab ,the lesser bending moment in shell or plate model beam.when aasigining membrane, as it only has in –plane stiffness then also cause the building global stiffness reduced as result,the displacement,story drift and period of membrane model are also largerthan the shell model .

1.1 Story Data

Table 1.1 - Story Data

Name	Height mm	Elevation mm	Master Story	Similar To	Splice Story
3RDFLR-17	3000	62000	No	3RDFLR	No
3RDFLR-16	3000	59000	No	3RDFLR	No
3RDFLR-15	3000	56000	No	3RDFLR	No
3RDFLR-14	3000	53000	No	3RDFLR	No
3RDFLR-13	3000	50000	No	3RDFLR	No
3RDFLR-12	3000	47000	No	3RDFLR	No

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Name	Height mm	Elevation mm	Master Story	Similar To	Splice Story
3RDFLR-11	3000	44000	No	3RDFLR	No
3RDFLR-10	3000	41000	No	3RDFLR	No
3RDFLR-9	3000	38000	No	3RDFLR	No
3RDFLR-8	3000	35000	No	3RDFLR	No
3RDFLR-7	3000	32000	No	3RDFLR	No
3RDFLR-6	3000	29000	No	3RDFLR	No
3RDFLR-5	3000	26000	No	3RDFLR	No
3RDFLR-4	3000	23000	No	3RDFLR	No
3RDFLR-3	3000	20000	No	3RDFLR	No
3RDFLR-2	3000	17000	No	3RDFLR	No
3RDFLR-1	3000	14000	No	3RDFLR	No
3RDFLR	3000	11000	Yes	None	No
2NDFLR	3000	8000	No	None	No
1STFLR	3000	5000	No	None	No
GFL	2000	2000	No	None	No
BASE	0	0	No	None	No

TYPES OF LOADING

Wind Load:wind load is primarily horizontal load caused by the moment of air relivent to the air. Wind load is required to be considered in design especially when the health of the building exceeds two times the dimensions transverse to the exposed wind surface. Wind load is considered to be acting horizontally on the exposed walls and roof. However pressure intensity depends mainly on the wind direction of the height of structure.

For low rise building say up to four to five stories, the wind load is not critical because the moment of resistance provided by the continuity of floor sys tem to coloum connection and walls provide between coloums are sufficient to accommodate the effect of these force.future in limit state method the factor for design load reduced to 1.2 (DL+LL+WL) when wind is considered as against the factor 1.5(DL+LL) when wind is not considered The relation $p=CV^2$ gives the wind pressure. C is a constant or coefficient and V is the wind velocity. Wind load and seismic load calculations are based upon local meteorological conditions; there are six wind zones in India from 3.3 m/s to 55 m/s. The design code for wind loads is IS875 part III.

Indian IS875:1987 Auto Wind Load Calculation

This calculation presents the automatically generated lateral wind loads for load pattern WXP according to Indian IS875:1987, as calculated by ETABS.

Exposure Parameters

Exposure From = Diaphragms
Structure Class = Class B
Terrain Category = Category 2
Wind Direction = 0 degrees

Basic Wind Speed, V_b [IS Fig. 1] $\qquad V_b = 44\frac{\text{meter}}{\text{sec}}$

Windward Coefficient, $C_{p,wind}$ $\qquad C_{p,wind} = 0.8$

Leeward Coefficient, $C_{p,lee}$ $\qquad C_{p,lee} = 0.5$

Top Story = 3RDFLR-17
Bottom Story = BASE
Include Parapet = Yes, Parapet Height = 0.9

Factors and Coefficients

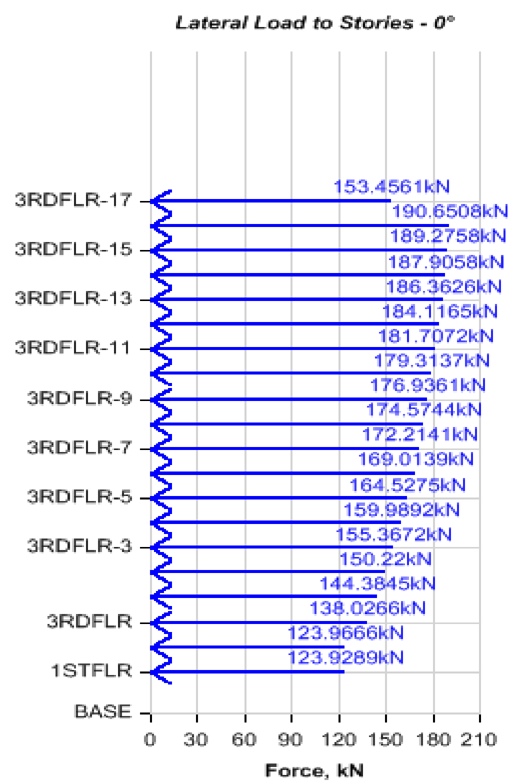
Risk Coefficient, k_1 [IS 5.3.1] $\qquad k_1 = 1$

Topography Factor, k_3 [IS 5.3.3] $\qquad k_3 = 1$

Lateral Loading

Design Wind Speed, V_z [IS 5.3] $\qquad V_z = V_b k_1 k_2 k_3$

Design Wind Pressure, p_z [IS 5.4] $\qquad p_z = 0.6V_z^2$



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Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
3RDFLR-17	62	153.4561	0
3RDFLR-16	59	190.6508	0
3RDFLR-15	56	189.2758	0
3RDFLR-14	53	187.9058	0
3RDFLR-13	50	186.3626	0
3RDFLR-12	47	184.1165	0
3RDFLR-11	44	181.7072	0
3RDFLR-10	41	179.3137	0
3RDFLR-9	38	176.9361	0
3RDFLR-8	35	174.5744	0
3RDFLR-7	32	172.2141	0
3RDFLR-6	29	169.0139	0
3RDFLR-5	26	164.5275	0
3RDFLR-4	23	159.9892	0
3RDFLR-3	20	155.3672	0
3RDFLR-2	17	150.22	0
3RDFLR-1	14	144.3845	0
3RDFLR	11	138.0266	0
2NDFLR	8	123.9666	0
1STFLR	5	123.9289	0
GFL	2	0	0
BASE	0	0	0

SEISMIC LOADS are External forces applied to a building structure as a result of earthquake-generated agitation. IS1893-2002 (Part-1) gives details for earthquake resistant design of structures. By historical observations India for the first time in 1962 was divided into 5 zones (zone 1 means least and zone 5 means maximum earthquake prone area). However, the seismic ground accelerations cannot be predicted accurately either on deterministic or probabilistic basis. Tectonic movements and geological aspects are very complex in nature. Intensity, Durability etc. can never be predicted accurately

IS1893 2002 Auto Seismic Load Calculation
This calculation presents the automatically generated lateral seismic loads for load pattern EQXP according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity
Direction = X + Eccentricity Y
Eccentricity Ratio = 5% for all diaphragms

Structural Period
Period Calculation Method = Program Calculated

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 2] $Z = 0.1$

Response Reduction Factor, R [IS Table 7] $R = 5$

Importance Factor, I [IS Table 6] $I = 1$

Site Type [IS Table 1] = II

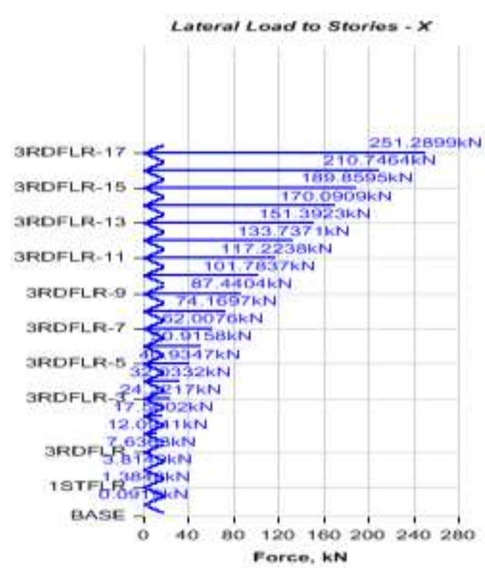
Seismic Response
Spectral Acceleration Coefficient, S_a /g [IS 6.4.5] $\frac{S_a}{g} = \frac{1.36}{T}$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2]

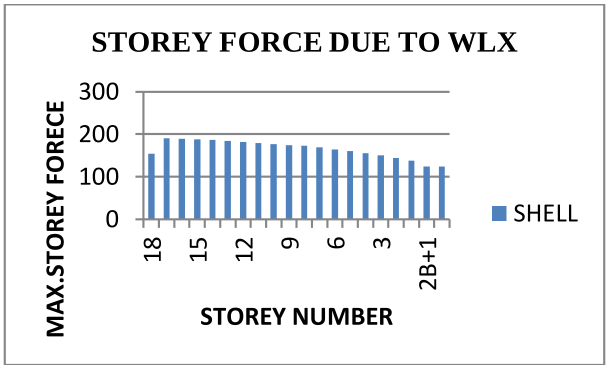
Calculated Base Shear

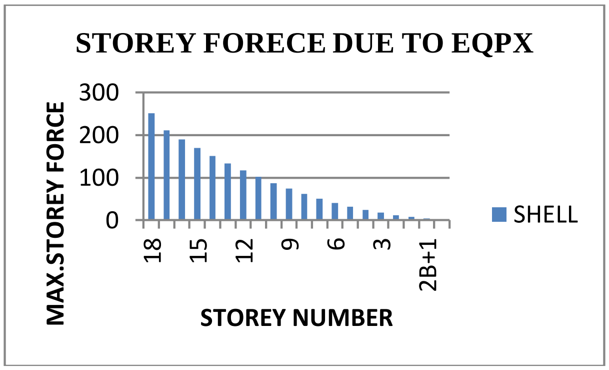
Direction	Period Used (sec)	W (kN)	V_b (kN)
X + Ecc. Y	1.58	202164.3986	1740.3689

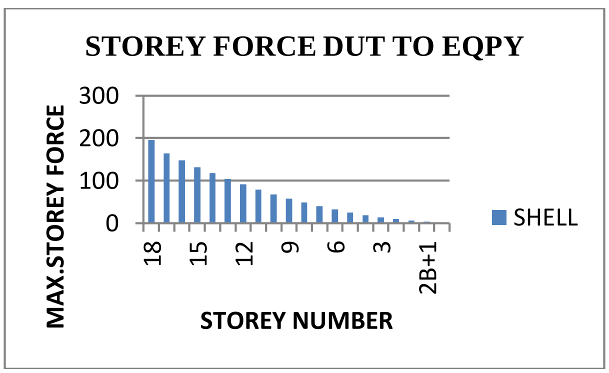


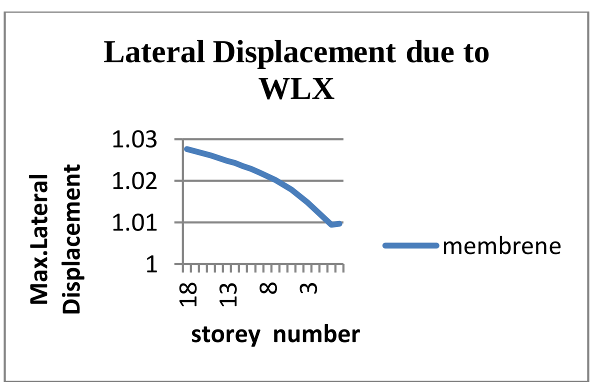
RESULTS AND DISCUSSION

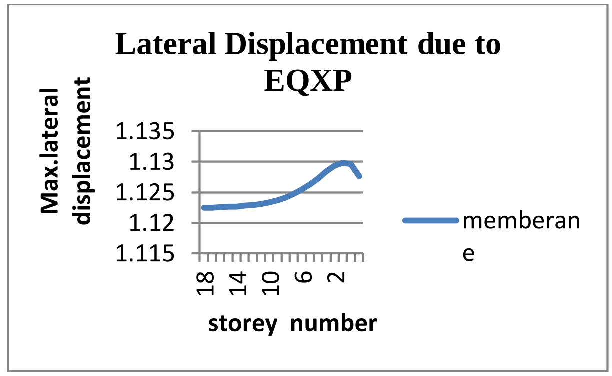
GRAPHS

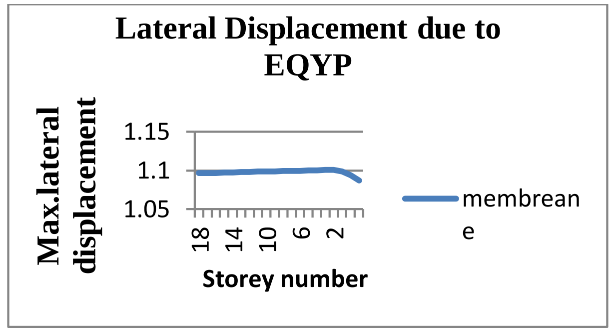












1.The Graph shear force due to WLX is observed that Base Shear for shell frame is maximum because the weight of the shell frame and the membrane frame. Base shear gets reduced by up to EQPX to EQPY 30% to 52% and 34.5% to 50 % in EQNX to EQNY directions respectively. :

2.The displacement, story drift and period of a Membrane model are also larger than Shell modelGraph It is also observed that for shell structure the lateral displacements are reduced from WLX 22.5% in longitudinal direction and WLY 46% transversedirection than the membrane in static analysis. Because of less stiffness.

3. The lateral displacement in shell structure is reduced up to EQPX to EQPY in longitudinal direction to transverse direction is reduced up to 41% to 56% and EQPX to EQNY in longitudinal direction to transverse direction is reduced up to 43.56% to 59% .This reduction is observed due to higher stiffness and reduction in seismic.

CONCLUSION

1. In etabs when assigning Membrane, as it only has in-plane stiffness then also cause the Building global stiffness reduced. As a result the displacement ,story drift and period of membrane model are also larger than the shell model

2. Beams in membrane assignment model have bigger bending moment than in others. The thicker slab, the lesser bending moment in Shell or Plate model beams
3. In e tabs The shell model will give lesser design forces for beams as the slab is dragged-in, to contribute in beam section
4. Shell structures are very light from of constraction.to span30.0mm thickness required is 60mm.dead load can be reduced economizing foundation and supporting system.
5. Beam design Get a conservative value of beam moment and similar to hand calculation method.Can utilize Etabs Design Function for a faster design.Take into account the contribution of Slab then has a smaller bending moment, not conservative. Can be used to assign for one-way slab. Can easily view and check how loading transferred to surrounding beams

RECOMMENDATION

1. Easily understanding that there is noout plan stiffness thenMembrane conot be resist bending moment as told since it is out plan stiffness
2. Etabs is the most important so that the modeler can ensure that his model is under controlled.” 1. Membrane is used to transfer the load to the beams Without considering the strength contributed by the slab.It distributed the load in a yield like manner i.e. trapezoidal and triangular loads to the beams..one thing to note is that membrane will only work if there are 4 surrounding beams..
3. Defining slab as membrane sometime generate a lot of errors, especially when the model is not orthogonal. Membrane element may not transfer loading to the beams accurately if it has more than 4 sides.
4. In e tabs to check the arrangement of membrane and beams so that loading can be transferred to the correct column and correct quantity similar to load take down by loading area method.A shell with a reduced out of plane bending stiffness at locations where the membrane assumption connot be met.

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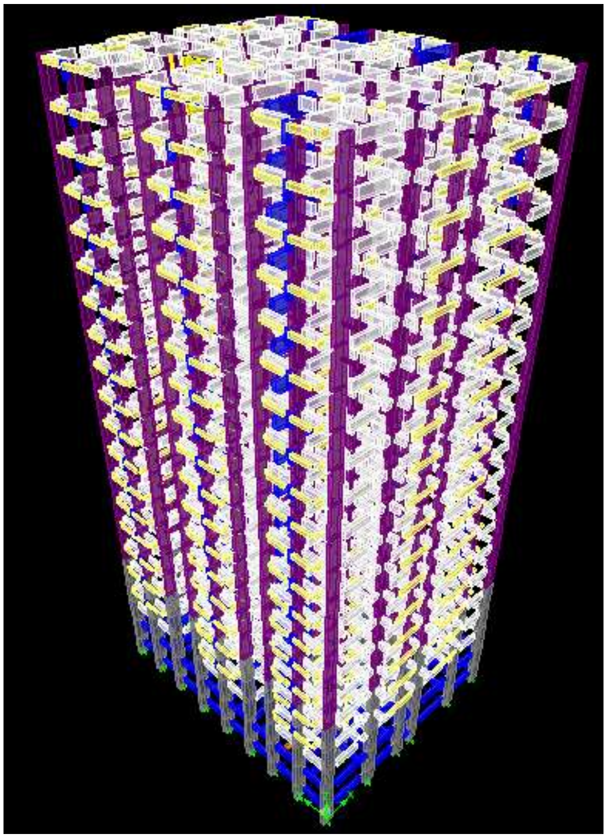

3D modeling of a building