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Effect of Wind and Earthquake Force on Different Aspect Ratio of Building

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***Abstract*—The rapid increase of the urban population in developing countries such as India, has forced the revaluation of the importance of high rise buildings with different size and shape which leads to different aspect ratio of the buildings. The structural systems of high rise buildings are usually sensitive to the effects of wind& earthquake, the wind-earthquake-structure interactions and then determines the wind loads& earthquake loads as equivalent static loads. It has been proved that the aspect ratio of building affects the effect of wind and earthquake forces on building. These thesis study the different cases of aspect ratio of the building and effect of wind and earthquake forces on building.**

Key words:-Aspect ratio, , Earthquake forces, ETABS, Wind load etc.

I. INTRODUCTION

In India, in recent decades, the application of wind engineering to civil engineering structures has become popular and the state-of-the-art has improved considerably. Wind engineering requires a multifaceted approach to provide solutions to various wind-sensitive problems. It involves various fields such as (i) Fluid dynamics (ii) Probability and statistics and (iii) Structural dynamics. Wind, in general, has two main effects on tall buildings: First, it exerts forces and moments on the structure and its cladding, and second, it distributes air in and around the building, mainly termed as wind pressure. Wind pressures on buildings are influenced by the building geometry, angle of wind incidence, surroundings and wind flow characteristics. There are many situations where available database, codes/standards and analytical methods cannot be used to estimates the wind pressure coefficients and wind loads on the claddings and supporting system of buildings, for example, the aerodynamic shape of the building is uncommon.

A. Overview on earthquake effect.

Earthquakes are occasional forces on structures that may occur rarely during the lifetime of buildings. It is also likely that a structure may not be subjected to severe earthquake forces during its design lifetime. Reinforced Concrete Multi-Storied buildings (RCMS) are supposed to be of engineered construction in the sense that they might have been analyzed and designed to meet the provisions of the relevant codes of practice and building bye-laws; the construction might have been supervised by trained persons. In such cases, even if earthquake forces have not been considered precisely, the structures would have adequate in-built strength and ductility to withstand some level of earthquake intensity.

B. Types of Analysis.

1. Seismic analysis

Seismic analysis is a major tool in earthquake engineering which is used to understand the response of buildings due to seismic excitations in a simpler manner. In the past the buildings were designed just for gravity loads and seismic analysis is a recent development. It is a part of structural analysis and a part of structural design where earthquake is prevalent. There are different types of earthquake analysis methods. Some of them used in the project are-
I. Equivalent Static Analysis II. Response Spectrum Analysis

2. Equivalent static analysis

The equivalent static analysis procedure is essentially an elastic design technique. It is, however, simple to apply than the multi-model response method, with the absolute simplifying assumptions being arguably more consistent with other assumptions absolute elsewhere in the design procedure. The equivalent static analysis procedure consists of the following steps:
1. Estimate the first mode response period of the building from the design response spectra.
2. Use the specific design response spectra to determine that the lateral base shear of the complete building is consistent with the level of post-elastic (ductility) response assumed.
3. Distribute the base shear between the various lumped mass levels usually based on an inverted triangular shear distribution of 90% of the base shear commonly, with 10% of the base shear being imposed at the top level to allow for higher mode effects.

3. Response spectrum analysis

This approach permits the multiple modes of response of a building to be taken into account. This is required in many building codes for all except for very simple or very complex structures. The structural response can be defined as a combination of many modes. Computer analysis can be used to determine these modes for a structure. For each mode, a response is obtained from the design spectrum, corresponding to the modal frequency and the modal mass, and then they are combined to estimate the total response of the structure. In this the magnitude of forces in all directions is calculated and then effects on the building are observed. Following are the types of combination methods:

- Absolute - peak values are added together
- Square root of the sum of the squares (SRSS),

- Complete quadratic combination (CQC) - a method that is an improvement on SRSS for closely spaced modes

The result of a RSM analysis from the response spectrum of a ground motion is typically different from that which would be calculated directly from a linear dynamic analysis using that ground motion directly, because information of the phase is lost in the process of generating the response spectrum. In cases of structures with large irregularity, too tall or of significance to a community in disaster response, the response spectrum approach is no longer appropriate, and more complex analysis is often required, such as non-linear static or dynamic analysis.

B. Need for the present study.

- From various experimental investigations, it is observed that dimensions of buildings significantly affect the wind pressure and earthquake forces on different faces of the buildings.
- This study shows that certain shapes are prone to wind and EQ Force phenomena which can generate high dynamic loads and govern the design.
- This study will ignite an interest on the use of Aspect ratio to wind and EQ Force.
- It would be useful in showing the importance of Aspect ratio to wind and EQ Force on high rise Structure.

C. Scope of the present study.

The scope of the present work included the study of the wind load and EQ Forces on high rise Structure with Difference Aspect ratio .for wind load IS 875: part 3-1987 and the analysis of the buildings will be done by using ETAB software and the performance will have analyzed by same building with different Aspect Ratio is to be consider. Analysis will be done by ETAB software.

1. Height of the building considered was 90 m/30 story
2. Same floor area of the building with different aspect ratio.

D. Objectives of the present study.

- To study the behaviour of tall structures when subjected to along wind loads and Earthquake force.
- To study the effect of shape of the building in plan on the behaviour of the structure.
- To study Same floor area of the building with different Aspect ratio.
- To determine the effect of wind load and Earthquake force on various parameters like storey drifts, lateral displacements in the building.
- To define the most efficient Aspect ratio in high rise buildings which can provide sound wind loading and Earthquake force by observing the comparative studies.
- To model high rise structure in ETAB Software.

II LITRETURE REVIRE

A. ***Sadh, Pendharkar. (2016)***[2] studied the behavior of a building during earthquakes depends critically on its overall shape, size and geometry. Earthquake resistant design of buildings depends upon providing the building with strength, stiffness and inelastic deformation capacity which are great enough to withstand a given level of earthquake-generated force. This is generally accomplished through the selection of an appropriate building configuration and the careful detailing of structural members. Configuration is critical to good seismic performance of buildings. The important aspects affecting seismic configuration of buildings are overall geometry, structural systems, and load paths. The building slenderness ratio and the building core size are the key drivers for the efficient structural design. This paper focuses on the effect of both Vertical Aspect Ratio (H/B ratio i.e. Slenderness Ratio) and Horizontal or Plan Aspect Ratio (L/B ratio), where H is the total Height of the building frame, B is the Base width and L is the Length of the building frame with different Plan Configurations on the Seismic Analysis of Multistoried Regular R.C.C. Buildings. The test structures are kept regular in elevation and in plan .Here, height and the base dimension of the buildings are varied according to the Aspect Ratios. The values of Aspect Ratios are so assigned that it provides different configurations for Low, Medium and High-rise building models. In the present study, four building models having different Horizontal Aspect ratios viz. 1, 4, 6 & 8 ranging from 12m.to 96m.length of different Vertical Aspect ratios (slenderness ratios) viz. 1, 4, 6 & 8 of varying 4, 16, 24 & 32 storeys have been considered and their influence on the behavior of the RCC Multistorey buildings is demonstrated, using the parameters for the design as per the IS-1893- 2002-Part-1 for the seismic zone- 3. In this way total 16 building models are analyzed for different load combinations by Linear Elastic Dynamic Analysis (Response Spectrum analysis) with the help of ETABS-2015 software and the results obtained on seismic response of buildings have been summarized.

B. ***Abhay Guleria. (2014)***[4] ETABS stands for Extended Three dimensional Analysis of Building Systems. ETABS is commonly used to analyze: Skyscrapers, parking garages, steel & concrete structures, low and high rise buildings, and portal frame structures. The case study in this paper mainly emphasizes on structural behavior of multi-storey building for different plan configurations like rectangular, C, L and I-shape. Modelling of15- storeys R.C.C. framed building is done on the ETABS software for analysis. Post analysis of the structure, maximum shear forces, bending moments, and maximum storey displacement are computed and then compared for all the analyzed cases.

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C. ***Alireza Razavi, etol (2018)***[18] studied the influence of tornado parameters such as swirl ratio and translation speed and building's spatial parameters such as its distance from the tornado mean path and it orientation with respect to the tornado's translation direction on tornado-induced wind loads are investigated. A low-rise gable roof building with a roof angle of 35 degrees and a square plan area is chosen for this study. The 1:200-scaled building model that was used for this study was located on both sides of the simulated tornado's mean path at several locations up to the distance of several tornado-core radii. For simulated tornado with lower swirl ratio, measurements showed that peak roof uplift increases with increase in translation speed when building is located on tornado mean path, whereas peak roof uplift decreases with increase in translation speed at locations other than tornado mean path. maximum horizontal and uplift loads at building orientation angle of −45° and 0° for lower swirl tornado case and −45° and −30° for higher swirl tornado case,In this study, effects of tornado translation speed, tornado swirl ratio, building distance to tornado mean path and building orientation angle on tornado-induced loads on a low-rise building have been investigated. Results show significantly larger peak loads for simulated tornado with lower swirl ratio While increase in translation speed reduces peak uplift loads on the low-rise building for the lower swirl tornado, translation effect on peak uplift load resulted from the higher swirl tornado Maximum torsional moment coefficient was found to be significantly larger than the horizontal component with the help of remark the horizontal road(max) Corresponding to this type of tornadoes for design of tornado resistant buildings. Some Future studies of internal pressure that affects the net pressure on structural components should be considered net peak force on buildings with low porosities (0.1% opening ratio) is 40% larger than the buildings of high porosities (3.9% opening ratio). This should result in the largest peak loads for non-porous buildings, making the results of this study as the worst-case loading scenario for a low-rise gable roof building.

II. METHODOLOGY

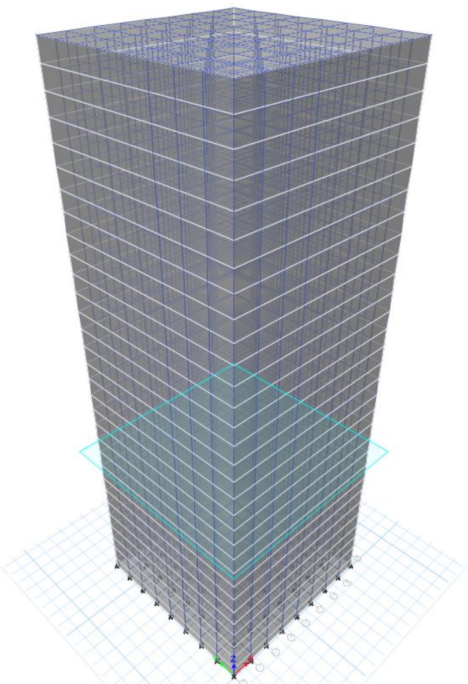
The methodology worked out to achieve the above-mentioned objectives is as follows:

- Extensive literature survey by referring books, technical papers or research papers carried out to understand basic concept of topic.
- Identification of need of research.
- Formulation of stages in analytical work which is to be carried out.
- Data collection.
- 30 storey building is considered for the analysis.
- The model has prepared on ETABS for the various Aspect ratio of the buildings.
- Wind loads and Earthquake load for the building according to IS has done by using the various parameters.
- Application of calculated wind loads and Earthquake load on the modeled buildings is to be done.
- Comparative studies done for axial loads on column, storey shear, lateral story displacement, story drift, wind intensity for the various aspect ratio of buildings and determination of structurally efficient of building is to be done. Interpretation of results and conclusion.

Description Of Modals

Modal No	Size of Building(in Meters)	Aspect Ratio	Floor area
1	31.62 X 31.62	1:1	Approx 1000 Sq.M
2	22.36 X 44.72	1:2	
3	18.25 X 54.77	1:3	
4	15.81 X 63.28	1:4	
5	14.14 X 70.70	1:5	
6	12.91 X 77.46	1:6	
7	11.95 X 83.65	1:7	
8	11.18 X 89.44	1:8	
9	10.54 X 94.86	1:9	
10	10.00 X 100.0	1:10	

ETAB Models



3D view of Model 1 (Aspect ratio 1:1)

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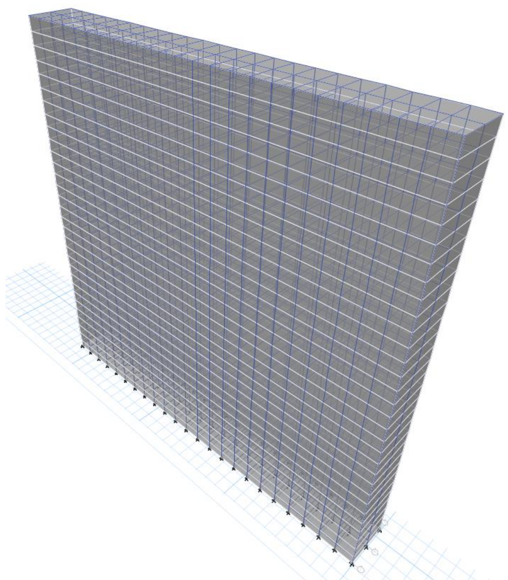
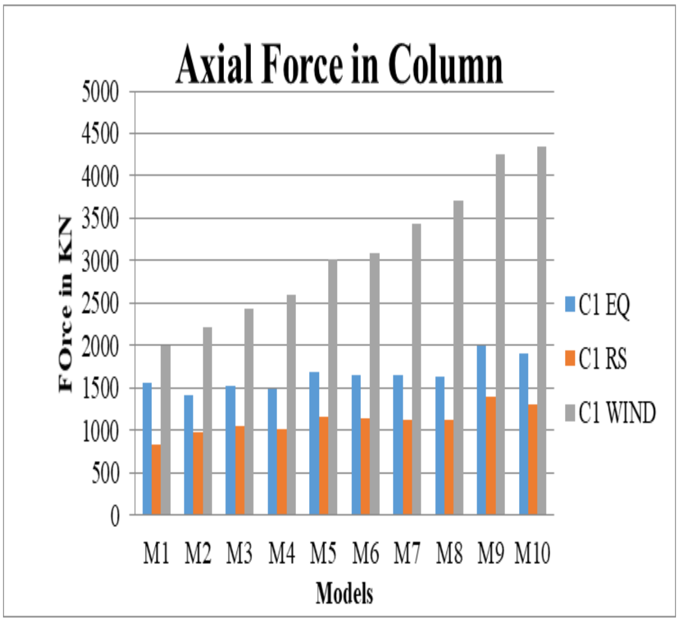


3D view of Model 9 (Aspect ratio 1:9)

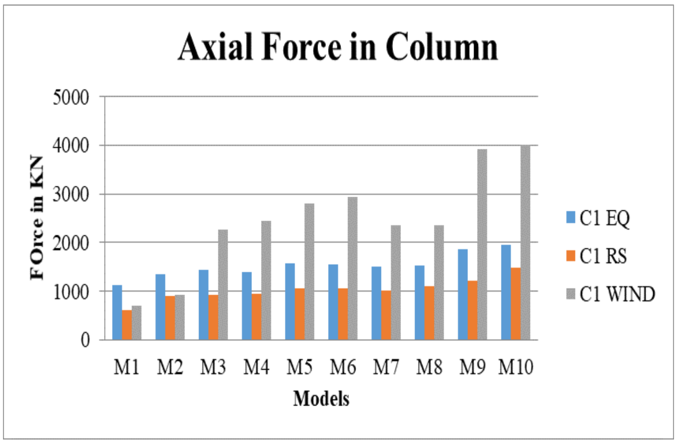
Sizes of Column

	Rectangular	Circular
B to 4	800 X 300	800 mm Dia
5 to 7	775 X 300	775 mm Dia
8 to 10	750 X 300	750 mm Dia
11 to 13	725 X 300	725 mm Dia
14 to 16	700 X 300	700 mm Dia
17 to 19	675 X 300	675 mm Dia
20 to 22	650 X 300	650 mm Dia
23 to 25	625 X 300	625 mm Dia
26 to 28	600 X 300	600 mm Dia
29 to 31	575 X 300	575 Dia

III. RESULTS AND DISCUSSIONS

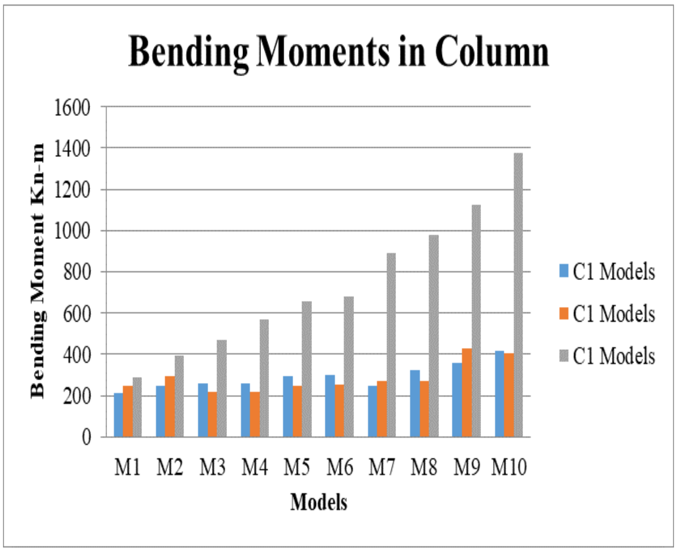


Axial Force in rectangular column C1

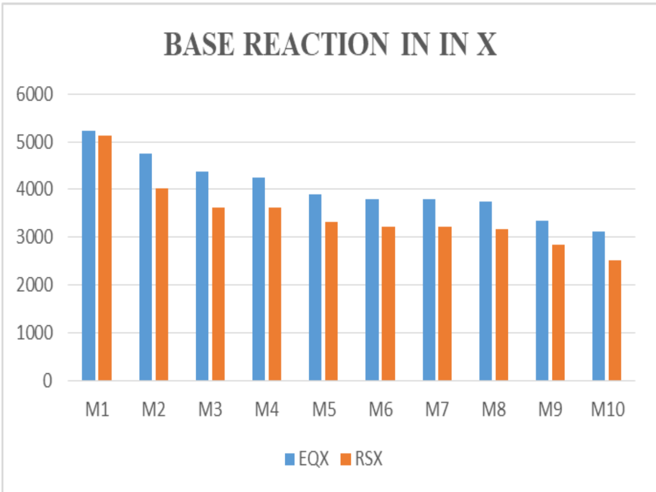


Axial Force in Circular column C1

Bending Moments in rectangular column C1



Bending Moments in circular column C1



Base Reaction In X Direction For Rectangular Column

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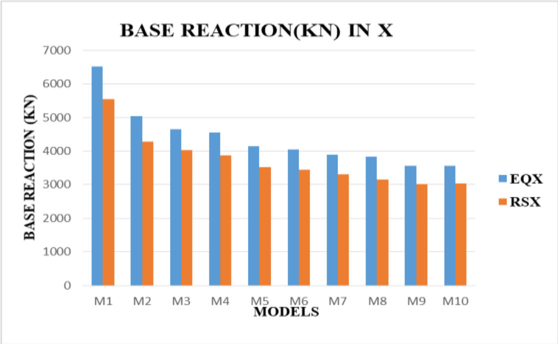
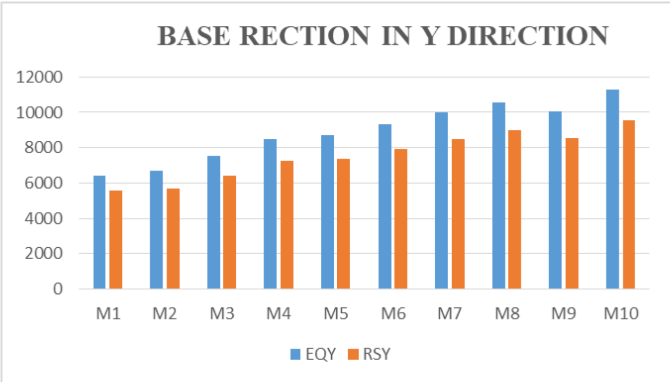
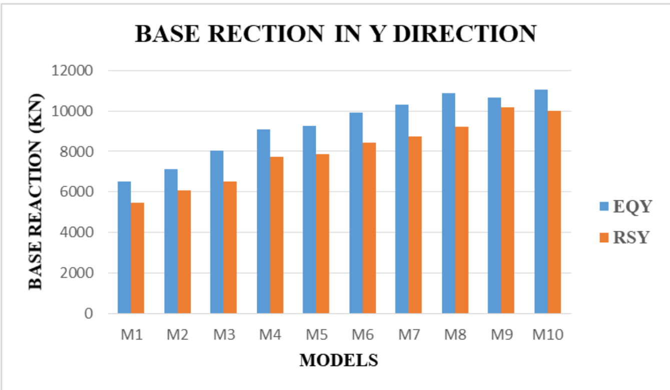


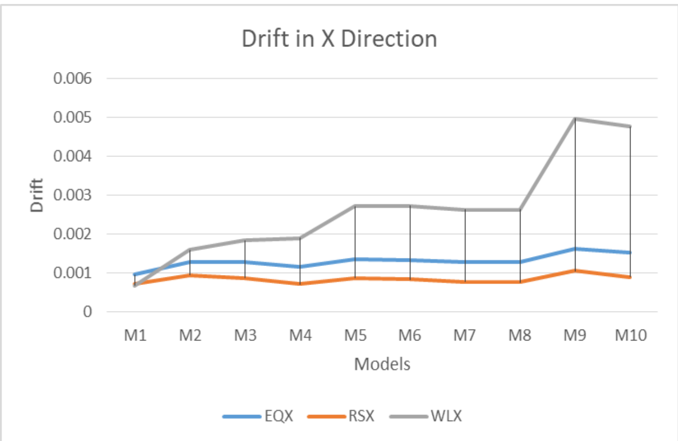
Base Reaction In X Direction For Circular Column



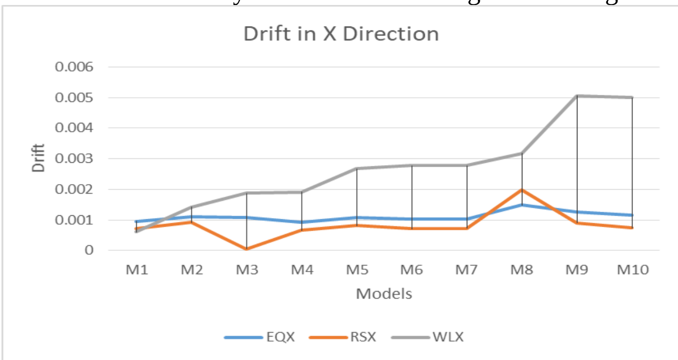
Base Reaction In Y Direction For Rectangular Column.



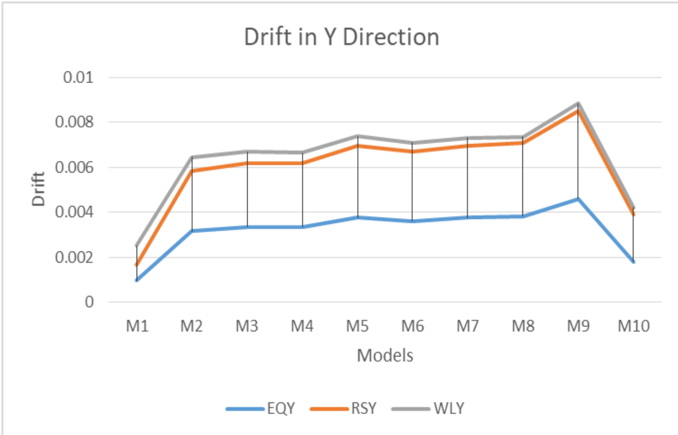
Base Reaction In Y Direction For Circular Column.



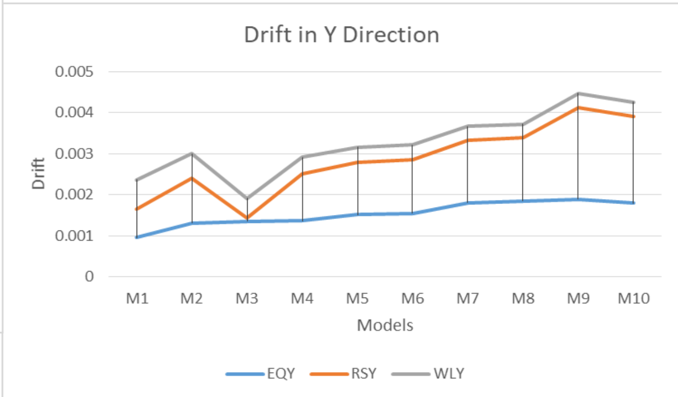
Maximum Storey Drift in X for rectangular building



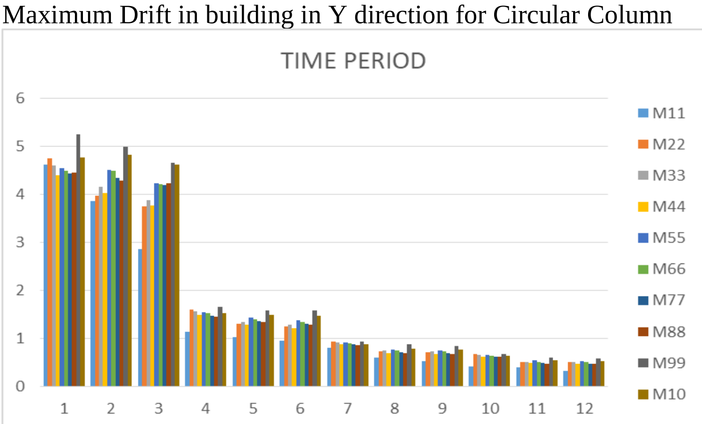
Maximum Storey Drift in X for Circular Building



Maximum Drift in building in Y direction for Rectangular Column



Maximum Drift in building in Y direction for Circular Column



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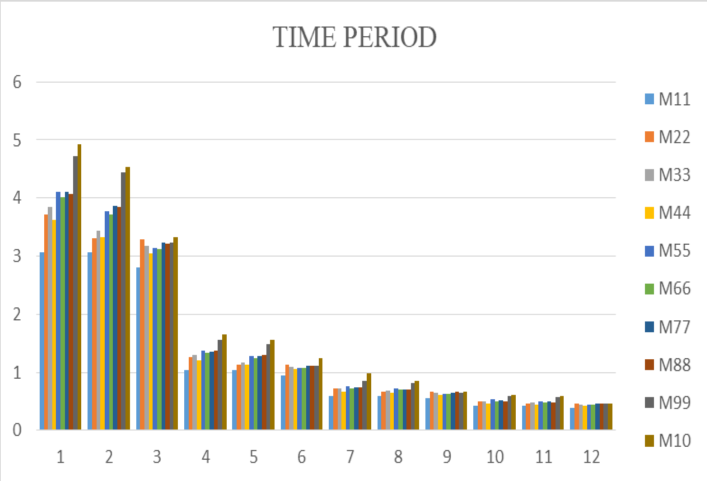
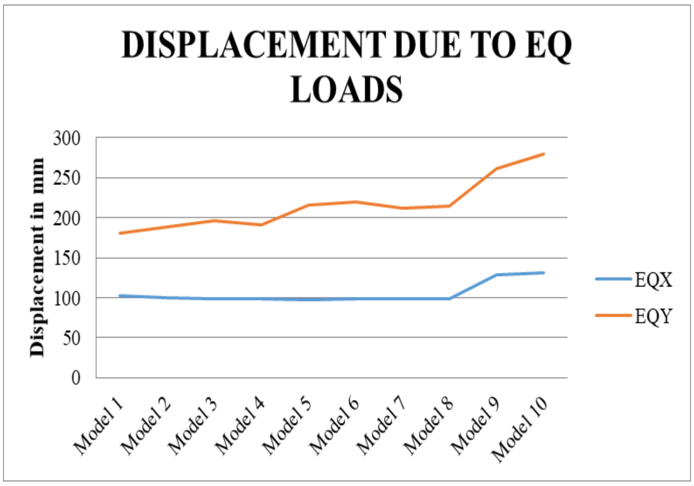
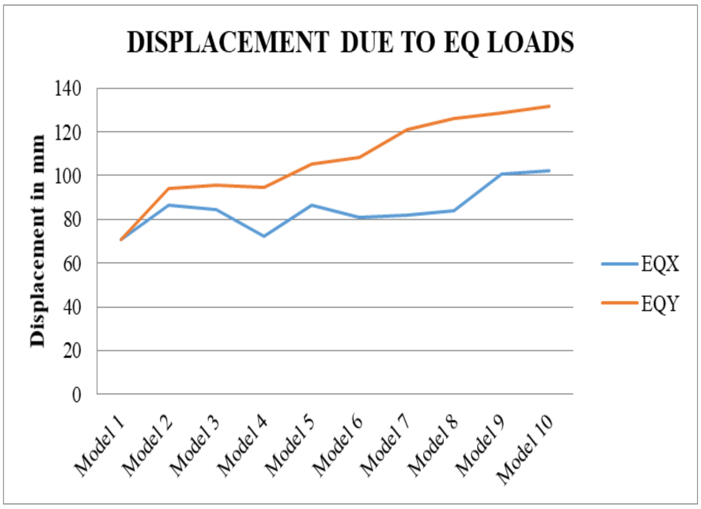
Time Period For Rectangular Column



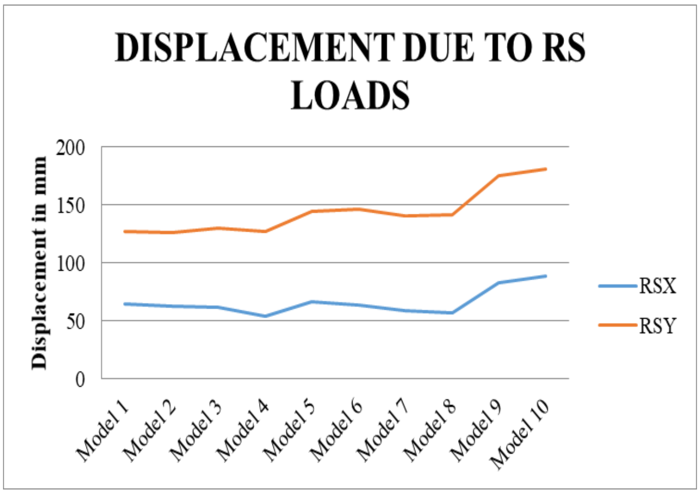
Time Period For Circular Column



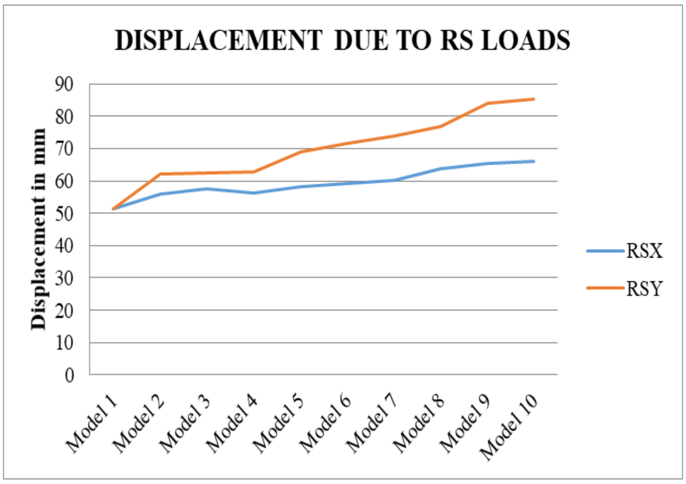
Displacement due to EQ loads



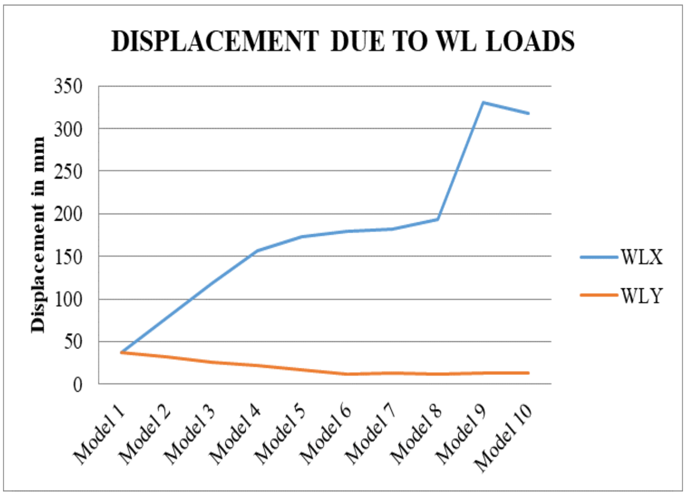
Displacement due to EQ loads for circular column



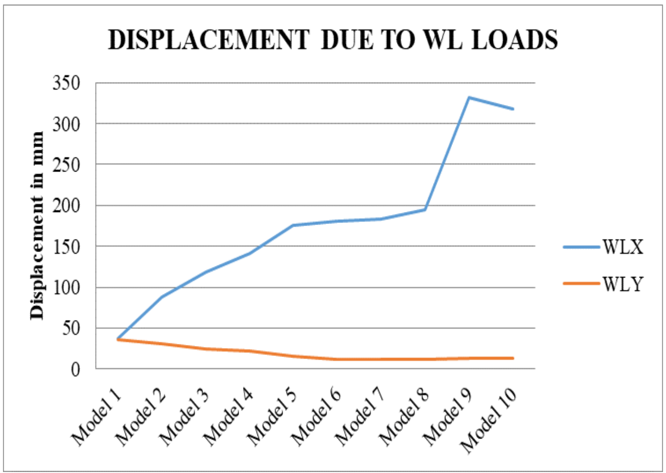
Maximum Displacement due to RS loads for rectangular column.



Maximum Displacement due to RS loads for circular column.



Maximum Displacement due to Wind loads for Rectangular column.



Displacement due to Wind loads for Circular column.

IV. CONCLUSION

- This chapter deals with the concluding remarks drawn from the results of all the analysis and design made for the G+30 storey building with the different type of aspect ratio having same floor area (1000 Sq. m) is considered for analysis. The results have been presented in tabular form along with the graphical mode in previous chapter. This chapter contains only the conclusions drawn on the basis of results drawn in previous chapter. The conclusions are valid under the consideration of different aspect ratio of building and analysis is static.
- As the aspect ratio increases, the storey displacement also increases. The displacement in x-direction is much more than than displacement in y- direction. From the results we can say that the displacement in model 10 is much more than model 1with respect to EQ loads, RS loads& Wind loads.
- The axial forces in the columns increases as the aspect ratio increases as well as the bending moment in columns also increases. The base reactions in x- direction is comparatively less than in y-directions.
- Same effect has observed for circular column, no major changes have been seen.

REFERENCES

[1] Shilong Zhang, Qinfu Liu, Yongjie Yang, Ding Wang, Junkai He, Luyi Sun,"Preparation, morphology, and structure of kaolinites with various aspect ratios" Applied clay science (2017).

[2] Sanjay Kumar Sadh, Dr.Umesh Pendharkar, "Influence of Aspect Ratio & Plan Confriguration on Seismic Performance of Multistoreyed Regular R.C.C. Buildings: An Evaluation by Response Spectrum Analysis" IRJET vol 03,Issue 01 jan 2016

[3] Anupam Rajmani, Prof. PriyabrataGuha, "Analysis of Wind & Earthquake Load for Different Shapes of High Rise Building", IJCIET vol 6, Issue 2, feb 2015 pp. 38-45

[4] Abhay Guleria, "Structural Analysis of a Multi-Storeyed Building using ETABS for different Plan Configurations", IJERT vol. 3 Issuse 5, may 2014.

[5] Md NazmulHaq, Wahid Hassan, Md. Arman Chowdhury, "Evaluation of the Impact of Dynamic Analysis on Different Building Height" IJSR ISSN:2319-7064 vol 2 Issue 8, august 2013.

[6] Justin Talbot, John Gerth, and Pat Hanrahan"An Empirical Model of Slope Ratio Comparisons" IEEE Transactions On Visualization And Computer Graphics, Vol. 18, No. 12, December 2012.

[7] Q.S. Li, Y.Q. Xiao, J.R. Wu, J.Y. Fu, Z.N. Li"Typhoon effects on super-tall buildings" , Journal of Sound and Vibration 313 (2008) 581–602.

[8] An-pei Wang and Yung-Hing Lin, "Vibration Control Of A Tall Building Subjected To Earthquake Excitation" Journal of Sound and Vibration 299(2007) 757-773 .

[9] Fazia Ali-Toudert, and Helmut Mayer, "Numerical study on the effects of aspect ratio and orientation of an urban street canyon on outdoor thermal comfort in hot and dry climate" Building and Environment 41 (2006) 94-108.

[10] Q.S. Li, Y.Q. Xiao, C.K. Wong," Full-scale monitoring of typhoon effects on super tall buildings"Journal of Fluids and Structures 20 (2005) 697–717

[11] Philip McKeen, Alan S. Fung, "The Effect of Building Aspect Ratio on Energy Efficiency: A Case Study for Multi-Unit Residential Building in Canada", ISSN 2075-5309.

[12] ShmuelWimer, Israel Koren and Israel Cederbaum"Optimal. Aspect Ratios OfBlxlding Blocks In VLSI" 25th ACM/IEEE Design Automation Conference".

[13] M.S.Medhekar, and D.J.L. Kennedy "Displacement-based seismic design of buildings—theory"Engineering Structures 22 (2000)201-209.

[14] Stavros A. Anagnostopoulos, and Konstantinos V. Spiliopoulos,"An Investigation Of Earthquake Induced Pounding Between Adjacent Buildings" Earthquake Engineering and Structural Dynamics, vol. 21, 289-302(1992)

[15] M. Doblare, E. Alarcon and F. G Benitez, "A comparison among Different spectrum compatible earthquake simulation methods" Appl. Math Modelling, 1981, vol 5, October 1981.

[16] Alfredo I., Aguilar-Morales, SabriAlamri, Andres Fabian Lasagni,"Micro-fabrication of high aspect ratio periodic structure on stainless steel by picoseconds direct laser interference patterning" Journal of Material Processing Tech.

[17] Xuelin Zhang, K.T. Tse, A.U. Weerasuriya, S.W.Li, K.C.S. Kwok, Cheuk Ming Mak, JianleiNiu, and Zhang Lin. "Evaluation of pedestrian wind comfort near 'lift-up' buildings with different aspect ratios and central core modifications" Journal of Building and Environment.

[18] Alireza Razavi, Partha P. Sarkar,"Tornado-induced wind loads on a low-rise building: Influence of swirl ratio, translation speed and building parameters" Journal of Engineering Structure.

[19] Gennaro Magliulo, Marianna Ercolino, CrescenzoPetrone, Orsola Coppola And Gaetano Manfredi, "Emilia Earthquake: The Seismic Performance Of Precast RC Buildings", Department For Engineering And Architecture, University Of Naples Federico,Italy

[20] Eduardo Miranda, "Approximate Seismic Lateral Deformation Demands InMultistory Buildings" Journal of Structural Engineering/ April 1999/417-425.

[21] Anil K. Chopra, and Jorge A. Gutierrez "Earthquake Response Analysis Of Multistorey Buildings Including Foundation Interaction" Earthquake engineering and Structural Dynamics, vol. 3 65-77(1974)

[22] Marco D. Boscardin and Edward J. Cording, Members, ASCE, "Building Response to Excavation – Induced Settlement"University of Virginia

[23] Kathleen M. Eisenhardt, "Building Theories from Case Study Research", Academy of Management Review, 1989, vol.14, no 4, 532-550 .

[24] IS 875 : 1987 (Part 1) , Dead Loads- Unit Weight of Building Materials and Stored Materials

[25] IS 875 : 1987 (Part 2) , Imposed Loads.

[26] IS 875 : 1987 (Part 3) , wind Loads.

[27] IS 875 : 1987 (Part 5) , Special Loads and Combinations.

[28] IS 1893 : 2002 (Part 1),Criteria for Earthquake Resistant Design of Structures, General Provisions and Building.

[29] IS 456 : 2000 ,Plain and Reinforced Concrete – Code of Practice.

[30] ETABS Software- 2015, Computer and Strucutres Incorporation (CSI), University Avenue , Berkeley, California, USA.