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Comparison of Beam Shear Analysis between Flat Slab and Grid Slab of High Rise Buildings with Varying Geometry under Seismic and Wind Loading Condition

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Abstract
The gift goal of this work is to evaluate among behavior of flat slab with waffle or grid slab the use of in high upward push buildings in unique geometry. For this evaluation there are taken 18 models of Rectangular, Pentagonal and Octagonal geometry having one of kind flooring as eight, sixteen and 24. The parametric studies include of most nodal displacement, maximum share force, storey go with the flow most beam moment and axial forces generated within the beam and column. The modelling is carried out in STAAD.pro V8i for seismic zones IV. The Plan length of rectangle geometry 16X28 m, Octagonal geometry sixteen m in diameter, and octagonal geometry 12 m in diameter is taken into consideration. The peak of floors is taken three.2 meter. Seismic loadings are taken into consideration one by one to evaluate the overall performance of all of the 18 fashions and conclusions have drawn on the high-quality framing machine. On the basis of the seismic conduct, the overall performance of the shape is checked, and then after subsequently the additional required measures and ideas for the design of shape for the development are suggested. This observe offers various information of seismic parameters like storey drift, maximum beam second seismic, conduct, base shear and most proportion pressure based totally on current literature evaluation.

Keywords: Flat Slab, Conventional Two Way Slab, RCC Structure, Design & STAAD.pro V8i.

INTRODUCTION

Due to urbanization and increasing population in our country there is a growing demand for high-rise buildings. Earthquake and wind load are the biggest problem for such buildings. Due to its unpredictability and the huge power of destruction, earthquake is the most destructive. Earthquakes do not kill themselves, but there is a huge loss of human life and properties are caused by the destruction of structures. Building construction collapses during earthquake, and is the reason for direct harm of human life. Several researches have been directed to investigate the failure of various types of buildings under various seismic stimuli throughout the world in the last few decades. The recent destruction of high-rise and low-rise buildings in a devastating earthquake proves that the process of such kind of time is needed to develop a county like India. Therefore, seismic behaviour of asymmetric building structures has become the subject of active research across the world. Many discoveries have been made on elastic and unbalanced seismic behaviour of asymmetric systems to know the cause of seismic vulnerability of such structures. The aim of this paper is to conduct analysis of the RCC building frames under seismic loading and wind loading condition and to check the change in structural behaviour due to such loading. Earthquake loads for building structures are one of the important design loads. In the previous research project on high building structures, the study of the demands of air-pressure have been classified as follows: reactions on the cross and accompanying air pressure.

These demands are due to various mechanisms. Due to the effect of unrest caused by the wind, the direct component is related to the effect of the windstorm. On the other hand, the impact of wind load on tall structures is not only distributed on the wider surface, but also its intensity is high.

The principle objective of this paper is to analysis and compare of flat slabs and grid slabs with various geometries such as Rectangular, Pentagonal and Octagonal structure using STAAD.proV8i, to get the optimum slab system. The design involves load calculations and analysing the whole structure bySTAAD.pro V8i using Limit State Design method. Using Indian Standard Code of Practice (IS: 456-2000) STAAD.pro is a powerful analysis and state-of-the-art user interface, and design engine, used in the structural design. It offers visualization tools and advanced finite element & dynamic analysis capabilities.STAAD.pro model generation is the option of professionals for visualization and result verification from generation, analysis and design.STAAD.pro provides a very interactive user interface that allows users to draw frame sections and input load load value and dimensions. According to specified specifications, it analyzes the structure and finally designs the members with reinforcement details for the RCC frame.

II LITERATURE REVIEW

Nagaraja and Kulkarniet al. (2014) Analyzed the effects of earthquake loading on waffle and flat slab framed structures resting on different soil. For earthquake resistant design, multistory framed structures having waffle or flat slab, need to be analyzed for seismic loading. The seismic analysis in this project was carried out by ETABS 2013 software on symmetric model in shape. For Seismic evaluation of the building models, Equivalent Static Analysis (ESA) and Response Spectrum Analysis (RSA) were adopted, which are specified in IS 1893 (Part-1): 2002. These analysis were based on various parameters including modal period, base shear, maximum displacement and storey drift. As the result of analysis, it was deduced that waffle performed better against earthquake loading than that of flat slab with drop.

Ezzy and Mundhadaet al. (2015) they analysed the effect of lateral forces due to wind or earthquake or both have significance to a great extent on multi-storey buildings and they play a very important role in the structural design. Dominance and criticality of seismic and wind load changes case to case. This paper gives a concise view of the previous work done on the wind and seismic performance of high rise buildings, containing variation in reinforced concrete slab systems. It mainly focused on flat slabs and other conventional slab systems.

Utane and Dahakeet al. (2016), analysed large industrial structures with 10m and 7m panels of flat slab for square shape and rectangular shape layout with the help of Stab software with reference to IS 456:2000 code. The main objective of the work in this paper is to compare different parameters such as base shear, displacement and story drift acting on flat slab. Along with this behaviour of expansion joint, provided between existing building and industrial structure, in earthquake prone region is also checked. It was found that in industrial structure with 10m and 7m panel, displacement of rectangular flat slab is more than square flat slab. Displacement goes on increasing with the height. Story shear is more in the case of rectangular flat slab as compared to square slab. In both the cases shear is higher for 10m panel. It is maximum at base level and goes on decreasing with height of structure. Story drift is also more for rectangular.

III METHODOLOGY

In the context of the horizontal seismic coefficient of design and seismic weight structure, the total design side force or design base shear is given with any major direction. The design depends on the area factor of the horizontal seismic coefficient site, the importance of structure, the decrease in response to the lateral load

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resistance elements and the fundamental duration of the structure. The process usually used for the equivalent static analysis is explained below:

(i) Determination of fundamental natural period (Ta) of the buildings-

$T_a = 0.075h^{0.75}$ Moment to oppose RC frame construction without brick wall

$T_a = 0.085h^{0.75}$ The moment to resist building steel frame without brick infill walls

$T_a = 0.09h/\sqrt{d}$ All other buildings, including the moments resisting Infill brick walls, of RC frame building.

Where d- is the base dimension at plinth level in metre of building, and h- is the height in metre of building.

(ii) Base shear (VB) determination of the building

$$V_B = A_h \times W$$

Where $$Ah = \frac{Z}{2}\frac{I}{R}\frac{Sa}{g}$$

It is the outline flat seismic coefficient, which relies upon the seismic zone factor (Z), response reduction factor (R), importance factor (I), and the normal reaction speeding up coefficients (Sa/g). Sa/g thus establishment relies upon the idea of soil (shake, medium or delicate soil site), characteristic span and damping of the structure. Design distribution of shear-

The design obtained according to the base shear VB will be distributed with the height of the building according to the following expression:

$$Q_i = V_B \frac{W_i h_i^2}{\sum_{i=1}^{n} W_i h_i^2}$$

Where, Q_i = design lateral force, W_i = seismic weight, h_i = height of the i^{th} floor measured from base and n is the number of stories in the building.

In equivalent static force procedure, the magnitude of lateral forces is based on only the fundamental period of vibration of the building calculated using empirical formula given in the seismic code. But if the building is multi-storied it has multiple degrees of freedom, therefore many possible patterns of deformation are possible. The actual distribution of base shear over the height of building is obtained as the superposition of all the modes of vibration of the multi degree of freedom system. Response spectrum method takes into account the effect of various modes of vibration of the building to calculate the peak response. In this way, the response spectrum method is closer to the dynamic behaviour of the system. The difficulty on the other hand is the selection of the design spectrum, which is constructed for chosen set of strong motion earthquake records. This may be either conservative or under safe for the design life of a particular building depending on the seismicity of the site where the building is located. In case of essential structures time history analysis is carried out by applying the actual recorded earthquake accelerations with help of computer program. But the selection of earthquake record for the site requires expert knowledge.

IV IMPLEMENTATION

Table 1 - Specifications for various Models

Sr. No.	Specifications	Type of Building Geometry		
		Rectangle (mm)	Pentagonal (mm)	Octagonal (mm)
1	Plan dimensions	20 m × 35 m (X×Z)	12 m (Radius)	14 m (Radius)
2	Length in X- direction	20 m	24 m	28 m
3	Length in Z- direction	35 m	24 m	28 m
4	Floor to floor height	3.2 m	3.2 m	3.2 m
5	No. of Stories	8, 16 & 24	8, 16 & 24	8, 16 & 24
6	Total height of Building	26,51&77 m	26,51 &77 m	26,51 &77 m
7	Slab Thickness for flat slab	200 mm	200 mm	200 mm
8	Soil Type	Hard	Hard	Hard
9	Grade of concrete	M 25	M 25	M 25
10	Grade of Steel	Fe 415	Fe 415	Fe 415
11	Beam =08Gstorey structure	0.45 m x 0.3 m	0.45 m x 0.3 m	0.45 m x 0.3 m
	=16Gstorey structure	0.5 m x 0.3 m	0.53 m x 0.3 m	0.53 m x 0.3 m
	=24G storey structure	0.6 m x 0.3 m	0.6 m x 0.3 m	0.6 m x 0.3 m
12	Column =08Gstorey structure	0.4 m x 0.23 m	0.4 m x 0.23 m	0.4 m x 0.3 m
	=08Fstorey structure	0.45 m x 0.3 m	0.45 m x 0.3 m	0.45 m x 0.4 m
	=16Gstorey structure	0.6 m x 0.4 m	0.6 m x 0.4 m	0.6 m x 0.4 m
	=16F storey structure	0.6 m x 0.45 m	0.6 m x 0.45 m	0.6 m x 0.45 m
	=24Gstorey structure	0.6 m x 0.5 m	0.7 m x 0.5 m	0.7 m x 0.6 m
	=24F storey structure	0.8 m x 0.5 m	0.9 m x 0.6 m	0.8 m x 0.6 m
13	Location	Seismic Zone IV	Seismic Zone IV	Seismic Zone IV
14	Live Load on Slabs	4.5kN/m^2	4.5kN/m^2	4.5kN/m^2

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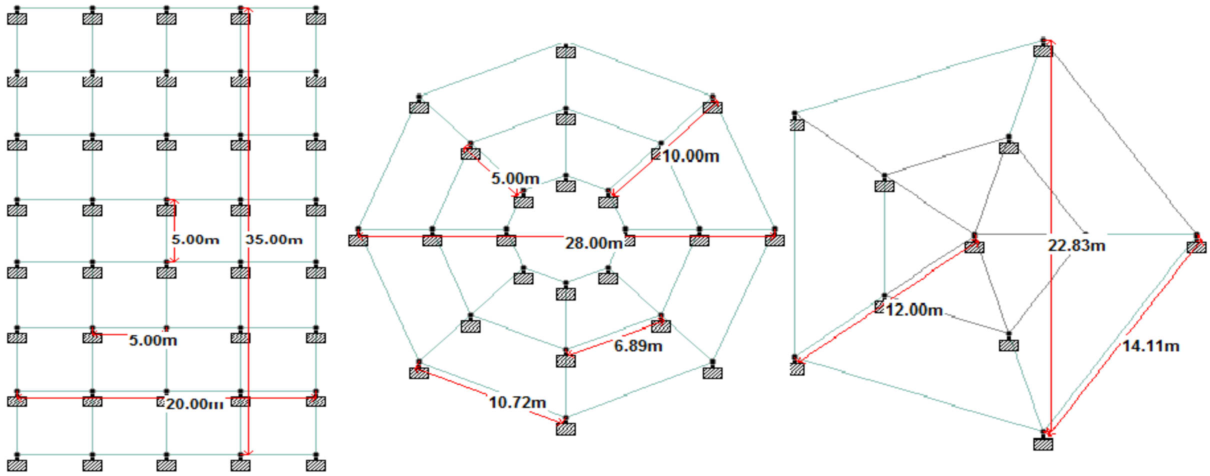


Fig 1: Basic Plan of the models of 8th storey.

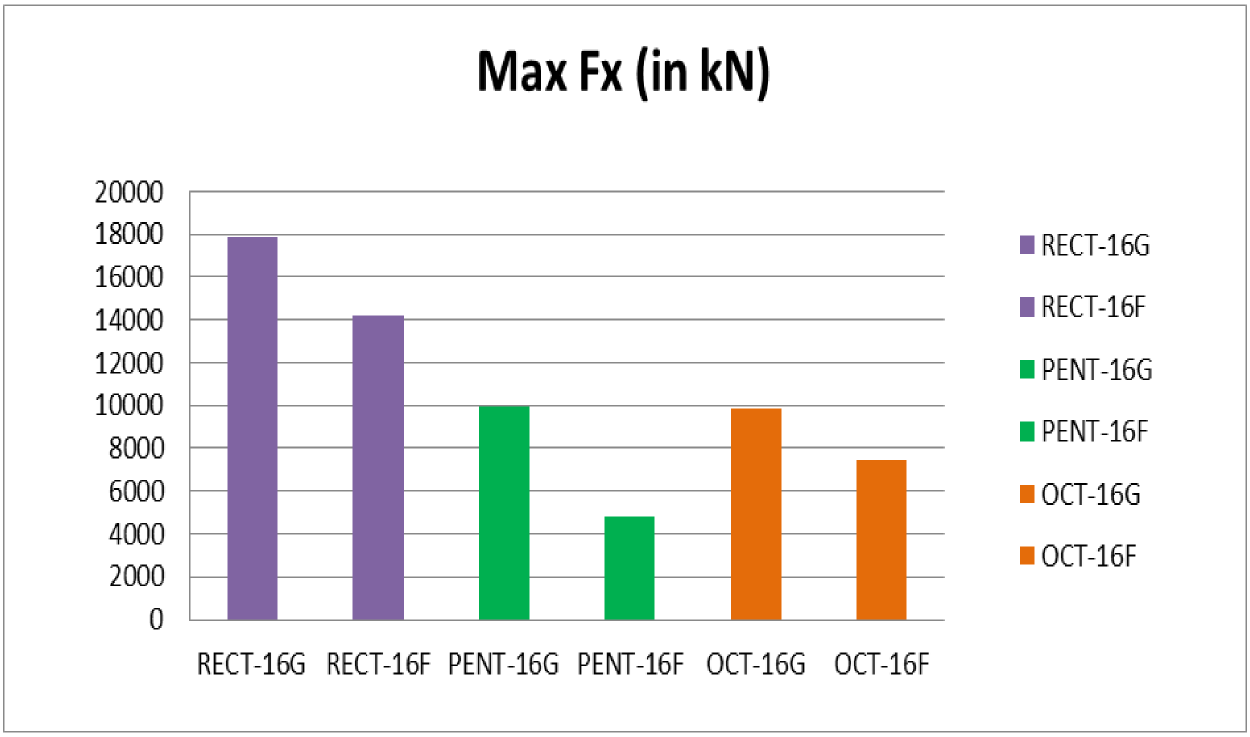
V RESULTS AND ANALYSIS

Maximum Beam stresses:- A comparison report between different geometries is given in the table

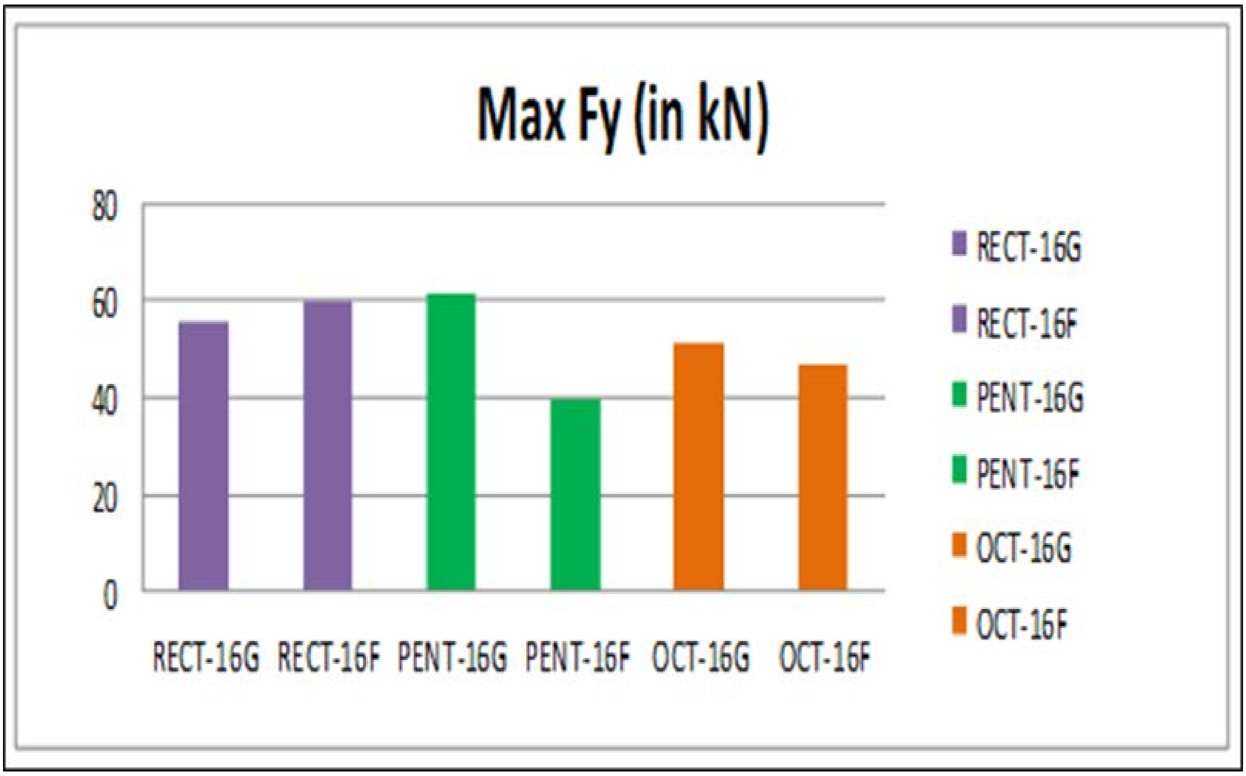
Table 2– Comparison of Beam Shear

No. of Stories	Geometry	Model No.	Type of Slab	Max Fx (in KN)	Max Fy (in KN)	Max Fz (in KN)
8	Rectangle	RECT-08G	Waffle Slab	3848.942	39. 192	37.768
		RECT-08F	Flat Slab	3447.066	29.484	23.703
	Pentagonal	PENT -08G	Waffle Slab	5372.840	49.960	39.393
		PENT -08F	Flat Slab	4582.180	40.312	29.899
	Octagonal	OCT-08G	Waffle Slab	5092.030	38.169	29.127
		OCT-08F	Flat Slab	3658.951	29.901	25.671
16	Rectangle	RECT-16G	Waffle Slab	17863.095	55.845	37.958
		RECT-16F	Flat Slab	14175.429	60.329	21.245
	Pentagonal	PENT -16G	Waffle Slab	9978.805	61.109	55.920

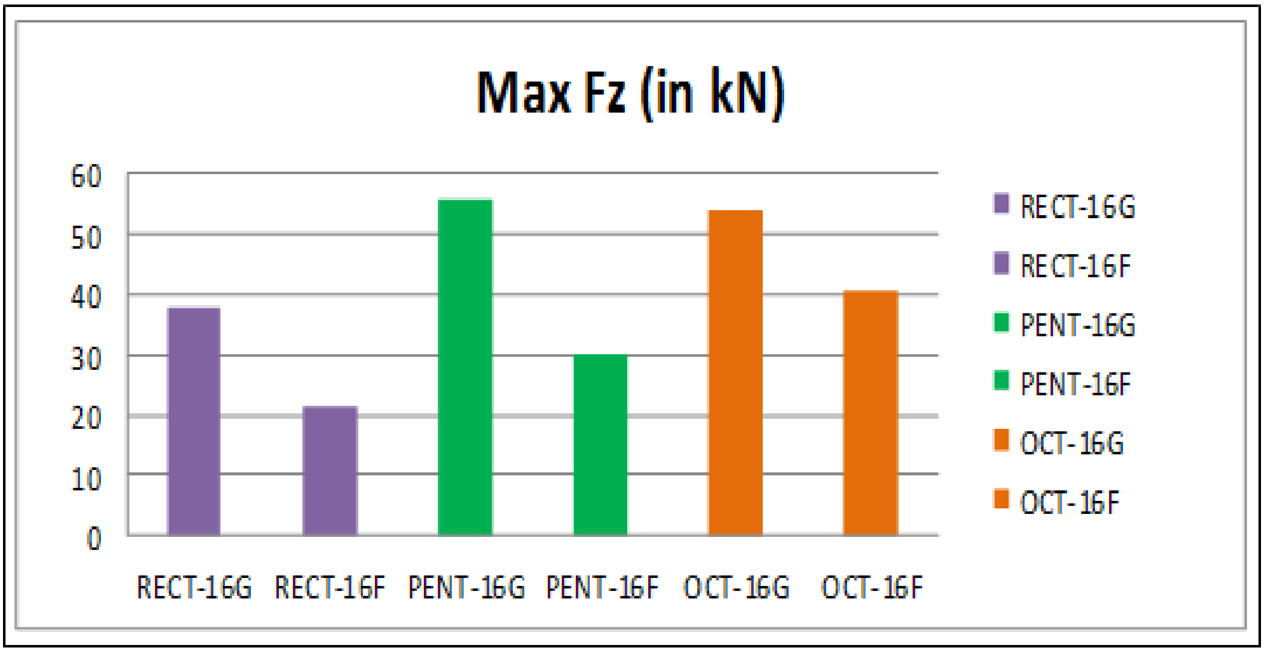
		PENT -16F	Flat Slab	4811.309	39.740	30.308
	Octagonal	OCT-16G	Waffle Slab	9871.608	51.510	54.159
		OCT-16F	Flat Slab	7421.209	47.198	40.860
24	Rectangle	RECT-24G	Waffle Slab	18246.522	91.290	75.970
		RECT-24F	Flat Slab	16789.119	95.479	56.907
	Pentagonal	PENT -24G	Waffle Slab	14548.416	134.779	70.506
		PENT -24F	Flat Slab	13867.307	81.609	71.019
	Octagonal	OCT-24G	Waffle Slab	15358.602	79.776	61.805
		OCT-24F	Flat Slab	14624.978	67.209	59.608



Graph 1: Maximum Shear in X directions for 16storey models.



Graph 2: Maximum Shear in Y directions for 16storey models.



Graph 3: Maximum Shear in Z directions for 16storey models.

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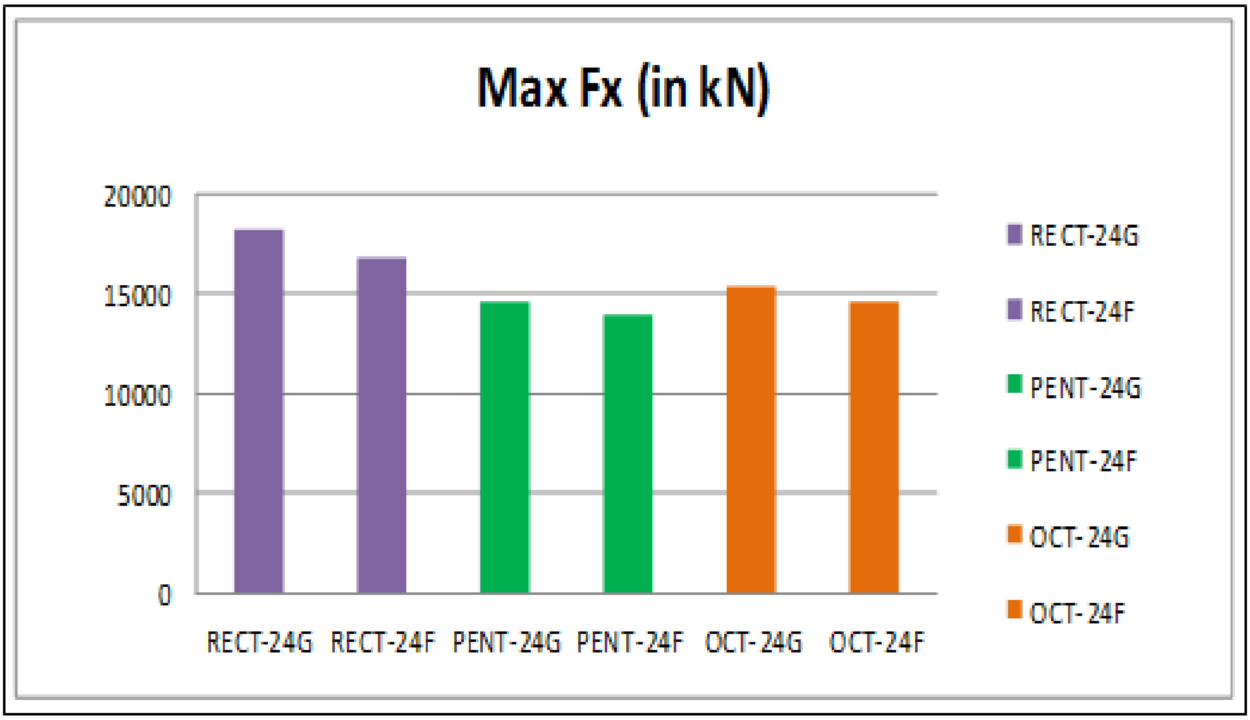
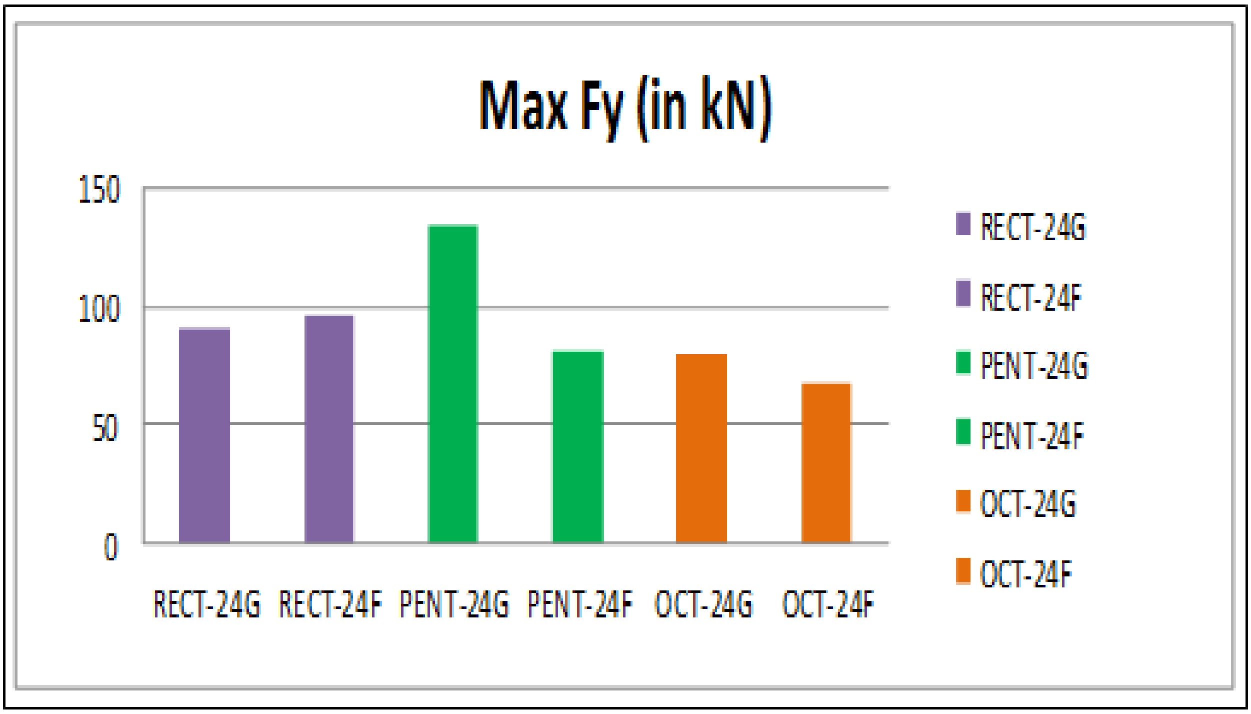
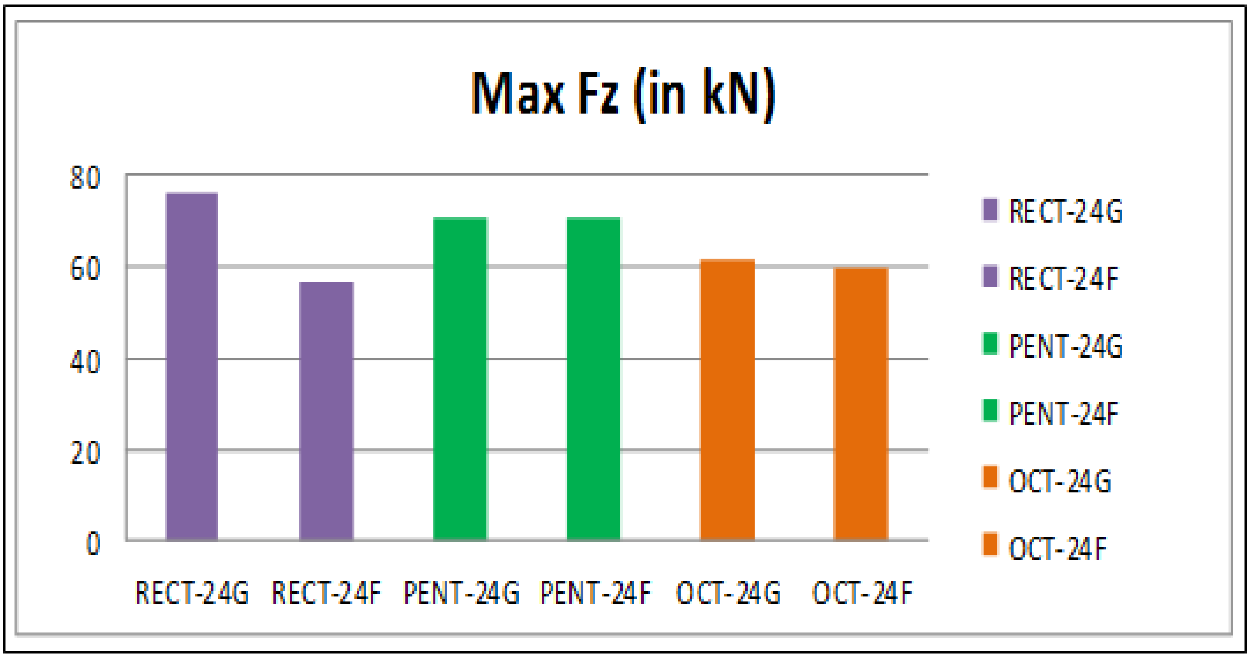


Graph 4: Maximum Shear in X directions for 24storey models.



Graph 5: Maximum Shear in Y directions for 24storey models.



Graph 6: Maximum Shear in Z directions for 24storey models.

VI CONCLUSION

According to the above study of Rectangular, Pentagonal and Octagonal geometry models with different floors using Waffle Slab and Flat Slab it is clear that the seismic hazard of important and high-rise structures has to be carefully evaluated before the construction. According to model analysis and results obtained from the design perform by STAAD, Pro V8i the following deductions are made:-

- Flat slabs in octagonal geometry give better results to other different models.
- The Flat Slabs resists more lateral loads in Pentagonal geometry. Thus the service life will be increases for Flat System.
- In Flat slab system there is more clearance height between two floors due to avoid of beams. Hence overall height of the structure will be reduces.
- The waffle slabs in Rectangular geometry sustain much load and moment in compared to other models.
- The deflection is increases as height of the structure is increases and hence maximum deflection occurs in case of octagonal geometry.
- If we compare models according to geometry, then Rectangular geometry shows better results and obtains minimum values.
- From economics point of view flat slab is adopted, but waffle slabs with rectangular geometry shows better results to resist the loads applied on them.

REFERENCES

[1] Dande P. S., Kodag P. B., Influence of Providing of Soft Storey in RC Frame Building for Earthquake Resistance Design (IJERA) Vol. 3, Issue 2, March-April 2013, pp.461-468.

[2] Halkude and Mahamuni (2014) “Comparison of various methods of analysis of grid floor frame” International Journal of Engineering Science Invention ISSN (Online): 2319 – 6734, Volume 3 Issue 2ǁ February 2014 ǁ PP.01-07.

[3] Mohamed A. A. El-shaer (2013),Seismic Load Analysis of different R.C. Slab Systems for Tall Building Inpressco Vol.3, No.5.

[4] Navyashree K, Sahana T. S (2014), Use of flat slabs in multi-storey commercial building situated in high seismic zone, IJRET: International Journal of Research in Engineering and Technology, Volume: 03 Issue: 08 | Aug-2014.

[5] Salman I. Khan & Ashok R Mundhada, Comparative study of seismic performance of multistoried RCC Building with Flat Slab & Grid Slab: A Review, IJSCER, ISSN 2319-6009, Vol.02-Feb 2015.

[6] Salman I. Khan and Ashok R. Mundhada Comparative study of Seismic Performance of multistoried R.C.C buildings with Flat slab & Grid slab Available online (IJCET) Vol. 5, No.3 16 May2015.

[7] Dhanaji R. Chavan, Mohite D., Dr. C. P. Pise,Behaviour Of Multi-Storied Flat Slab Building Considering Shear Walls: A Review. (IJERA) ISSN : 2248-9622, Vol. 6, Issue 10, (Part -2) October 2016.

[8] B.Anjaneyulu, K Jaya Prakash Analysis And Design Of Flat Slab By Using Etabs Software, International Journal of Science Engineering and Advance Technology, IJSEAT, Vol. 4, Issue 2 FEBRUARY-2016

[9] S. N. Utane, Prof. H. B. Dahake ”Effect of shape irregularity on flat slab industrial building under lateral loading” International journal of modern trends in engineering & research. (IJMTER) ISSN: 2349-9745,Volume 03, Issue 03, [March – 2016].

[10] Vinod Goud et al.(2016) Analysis and Design of Flat Slab with and without Shear Wall of Multi-Storied Building Frames IOSR Journal of Engineering (IOSRJEN) Vol. 06, Issue 09 (Sep. 2016), ||V1|| PP 30-37

[11] Reshma, Arunima V Seismic Analysis Of Multi Storied Irregular Building Using Flat Slab And Grid Slab In Zone III & V Volume: 04 Issue: 06 | June -2017.

[12] Sudhir Singh Bhaduria, Nitin ChhuganiComparative Analysis and Design of Flat and Grid Slab System With Conventional Slab SystemInternational Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 04 Issue: 08 | Aug -2017.