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Comparative Study on behavior of irregular & regular geometry multistory buildings with floating columns and flat slabs as feature under different parameters based on IS 1893:2016 Part 1 using STAAD Pro.

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Abstract - *The paper is concerned with study of behavior of irregular shaped multistory building structures and regular shaped multistory buildings with floating columns and flat slab as feature in them. The objective is to carry out seismic analysis of various models of RCC buildings using Staad Pro for response spectrum analysis, modal time history analysis, Time history analysis and also finding out variation in peak storey shear value, base shear value, storey drift, displacement values for each of these regular shaped model and irregular shaped model with flat slab and floating columns and comparing the result of irregular vertically ,irregular horizontally and regular story structures on these parameters in bar chart graphical manner for variation in the result for different types of structures with same height and reaching a conclusion for variation of result in these structures in a comparative study.*

Key Words: Dynamic analysis (Response spectrum Analysis, Modal time history analysis, Time history analysis) peak story shear, base shear, storey drift, displacement, member stress, RCC Structure IS 1893:2016 part 1,

1.INTRODUCTION

In recent times, trend of multi storey parking, shops and commercial spaces is on rise in urban areas .Sometimes, such structures has to be constructed in very limited available space in cities so sometimes it is not possible to built the structure in regular building dimensions such as rectangular or square shape building and alternative type of buildings are possible to be constructed in such areas such as I shape U shape or L shape structure and sometimes vertically irregular structures are preferred due to design aesthetics or structure with less area at ground level and area increasing decreasing as go upwards . So, with this use of floating column concept and flat slab come in to use. So, this thesis is an attempt to study the behave pattern of such structures and their comparison with regular building on the parameters such as **(seismic response by response spectrum method for 6 mode shapes, Peak storey shear ,base shear value, time period frequency values, storey drift , displacement, torsional irregularity etc).** So, different building shapes were put into analyses and comparison of the result was done with floating column and flat slab as main feature in the buildings G+15 storey structures were analyse in three models of different horizontal and vertical geometries for studying behavior of floating columns in them and two models for studying behavior of flat slab buildings on above mentioned parameters. Also, comparison of economical value and stability behavior of G+20 storey high rise building was done for a normal beam column building and a building with floating column and flat slab building was done in Staad pro software as very less work done in this area in Staad pro software.

1.1. OBJECTIVES

- To Calculate the Design lateral forces on following structures using Response spectrum Analysis, Time history Analysis , and to compare the results of different models of RCC structures having floating column and flat slabs as feature in them using STAAD pro V8i software:
  - Vertically irregular model with floating column.G+15
  - Regular model with same height.G+15
  - Horizontally irregular model with floating column.G+15
  - Horizontally irregular model with flat slab.G+15
  - Regular model with flat slab.G+15

- To study the variation in values of peak storey shear for following models:
  - Vertically irregular model with floating column.
  - Horizontally irregular model with floating column.
  - Regular model with same height.

- To study the variation in values of base shear for following models:
  - Vertically irregular model with floating column.
  - Horizontally irregular model with floating column.
  - Regular model with same height.

- Horizontally irregular model with flat slab
- Regular model with flat slab.

- To study the variation in local displacement, member stress values, storey drift values
  For different set of models of these RCC structures with floating column and flat slabs as feature also regular structures for reaching a conclusion of effect of shape and irregularities(mass, stiffness, vertical geometry irregularities, torsional irregularities) of different structures in results as per Is1893:2016 part1.

- To carry out seismic design of following models for study of safety and economical value
- G+20 floating column flat slab building .
- Same height G+20 normal beam column building.

2. METHODOLOGY

The steps undertaken in the present study to accomplish the above mentioned objectives are as follows:-

Step1:- Planning and plotting the models:-Different models were planned and plotted after reviewing existing literatures/paper by different researchers and using autocad for plotting .

Step2:-Modeling the Project in Staad pro software. Three models of 27mx27m with 45 mtr height (G+15) for analysis of results of floating column multi storey structures one with vertical irregular Geometry ,one with horizontally irregular L shape geometry and one with regular geometry vertically and horizontally. One model of flat slab horizontally irregular flat slab structure and one with regular geometry flat slab structure of 27mx27m base dimension with same height(G+15).Two models of G+21 one with vertically irregular geometry and one with regular geometry were modeled in staad pro for the analysis.

Step3:-Defining the Project properties and Loads.:- Sizes of columns and beam were defined with dead load and live loads and supports.

Step4:-Response spectrum and static analysis of the Models.:-Response spectrum for analysis of dynamic behavior by measuring pseudo spectral acceleration, velocity or displacement as function of structural period for given time history and level of damping.

Static analysis for flat slab system with constant loads applied and system being simulated does not depend on time.

Step5:-Running the Analysis of the Models. Analysing with factors like local displacement, peak storey drift, max absolute stresses etc

Step6:-Analysing the Result of Different Models of Multistorey structures on Different parameters.:- Analysis of values of the runned analysis of different models separately .

Step7:- Collecting the Result and discussion of the results. :-Noting down the result of analysis of different models and representing it in graphical method for comparing the values for variation on different parameters.

Step8:-Future scope of the project and conclusion.:-After reaching conclusions from the analysis of results of different models looking for future scope of development in design and analysis of multistory structures.

Table -1: General Loadings:-

S.NO	DESCRIPTION	LOAD	CODE USED
	Dead loads		
1	Slab=180mm thickness floating column models	4.5kn/sqm	IS 875 Part1:1987
2	finishing	2 kn/sq.m	IS 875 Part1:1987
3	Slab=275mm thickness Flat slab models.	6.875kn/sqm	IS 875 Part1:1987
4	finishing	2 kn/sq.m	IS 875 Part1:1987
5	Slab=150mm,125mm, 115mm,100mm for floating column flat slab models	3.06kn/sq.m Avg.	IS 875 Part1:1987
6	230 mm brick wall 3m ht.	13.8kn/m	IS 875 Part1:1987
7	115 mm brick wall 3m ht.	7.5kn/m	IS 875 Part1:1987
8	Parapet wall	3 kn/m	IS 875 Part1:1987
	Live load		
9.	Load on floor corridor	4kn/m	IS 875 Part1:1987
10.	Live load terrace	2kn/m	IS 875 Part1:1987
11	Zone 5	0.36	IS 1893:Part1
12	Importance factor	1	
13	Response reduction factor	1.5 SMRF	
14	Damping	5%	
15	Soil type	2	
16	Seismic parameter		IS1893:2016

2.1 BRIEF DESCRIPTION :

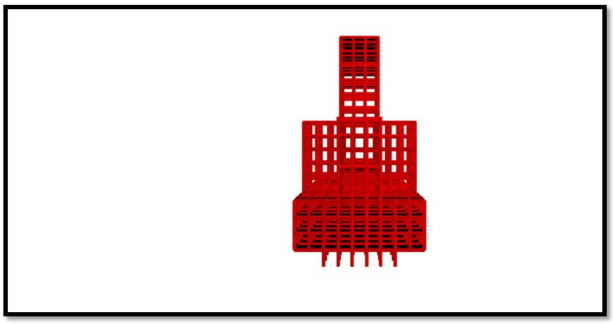
Various models of the multistory structures with flat slab and floating column as feature were analysed in staad pro for variation in seismic response with respect to shape using response spectrum method as per IS1893:2016 part1 and also for other parameters of irregularity checking of these models such as peak storey shear, base shear, member stresses, lateral displacement per storey of structure and variation of scale factor value for each model according to shape and at last in model 6 and model 7 analysis for earthquake design and comparison for economical value of construction of floating column flat slab building and normal beam column building was studied through design of both the models and noticing the value of steel and concrete used.

- **MODEL 1:** Vertically irregular model with floating column G+15 studied for seismic response using response spectrum method.
- **MODEL2:** Regular model with same height G+15 studied for seismic response using response spectrum method.
- **MODEL3:** Horizontally irregular model with floating column.G+15 studied for seismic response using response spectrum method.
- **MODEL4:** Horizontally irregular model with flat slab G+15 studied for seismic response using response spectrum method.
- **MODEL5:** Regular model with flat slab G+15 studied for seismic response using response spectrum method.
- **MODEL6:** Flat slab floating column combination structure G+20 studied for earthquake design and wind design and designed for economical value.
- **MODEL7:** Normal beam column structure G+20 studied for earthquake design and wind design and designed economical value.

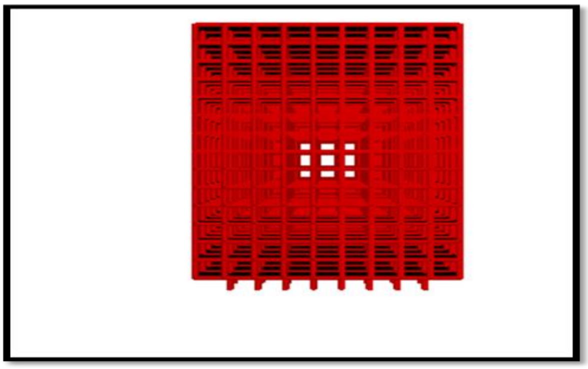
CODES USED:

1. IS 456: Code of practice for plain and reinforced concrete.
2. IS 875: Ends of practice for design loads part2 imposed loads.
3. IS 1893:2016:-Criteria for earthquake resistant design.

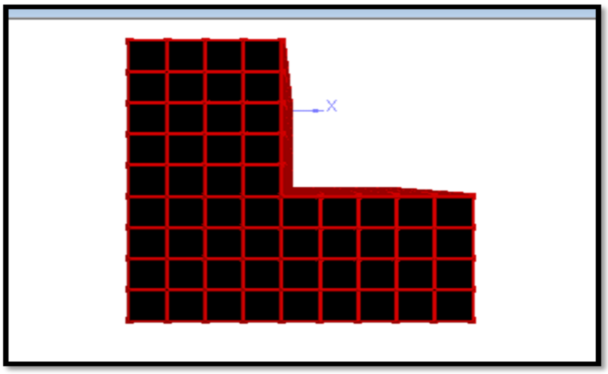
MODEL1:



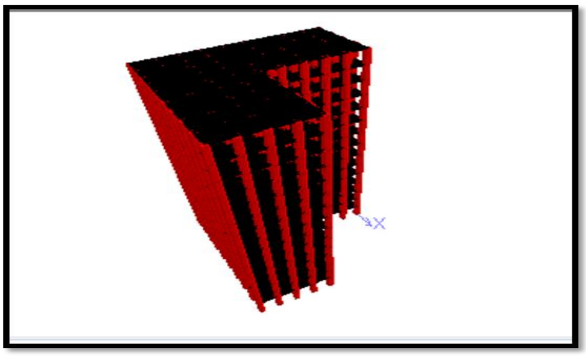
MODEL 2:



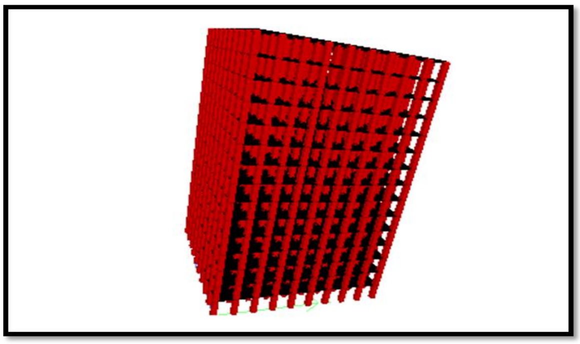
MODEL3:



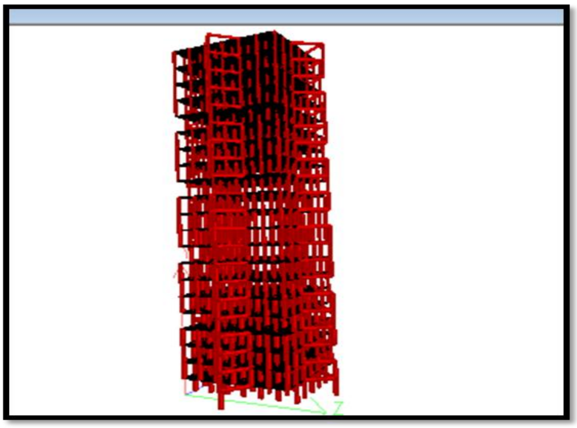
MODEL 4:



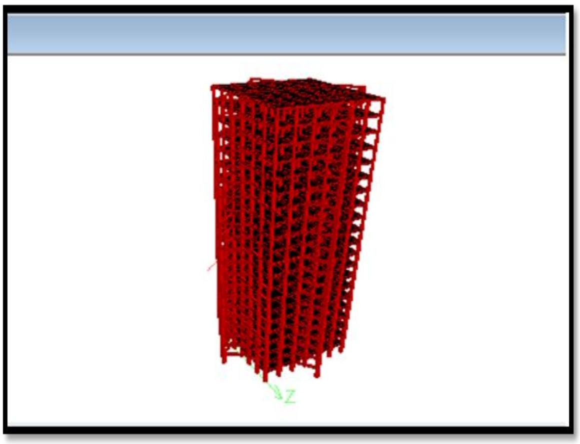
MODEL5



MODEL 6:



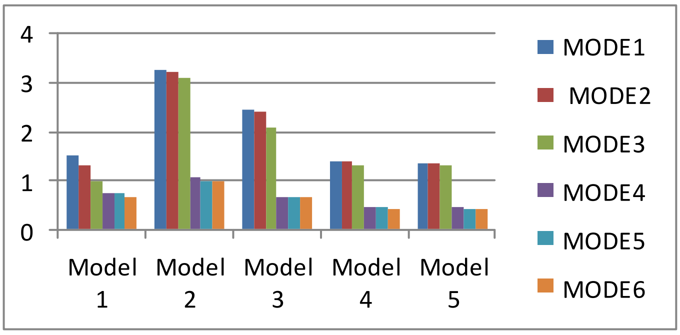
MODEL 7:



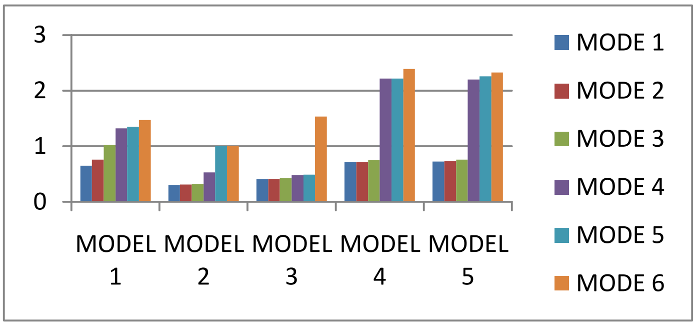
RESULTS:

Following is the variation in the values modelingand analysis of different models of structures using response spectrum method and also for other factors of irregularities as per Is1893:2016 part1.

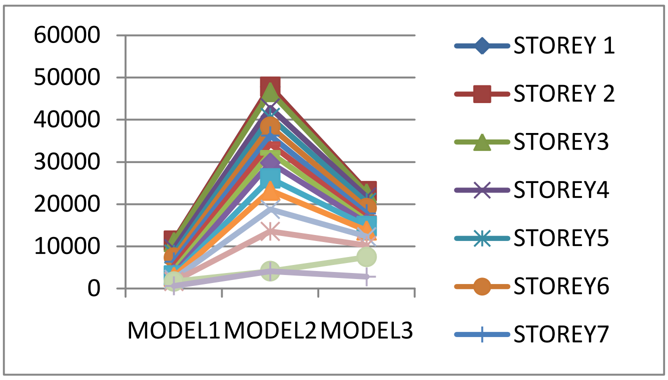
T1.FREQUENCY PERIOD VALUES ANALYSIS FOR 5 MODELS AND 6 MODES:-



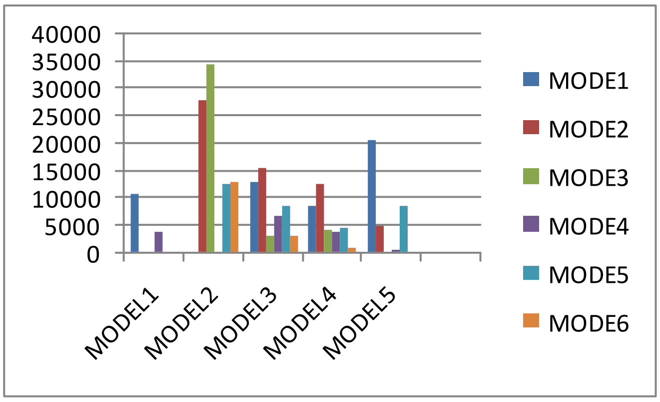
T2.FREQUENCY CYCLE/SEC VALUES FOR 5 MODELS AND 6 MODES:-



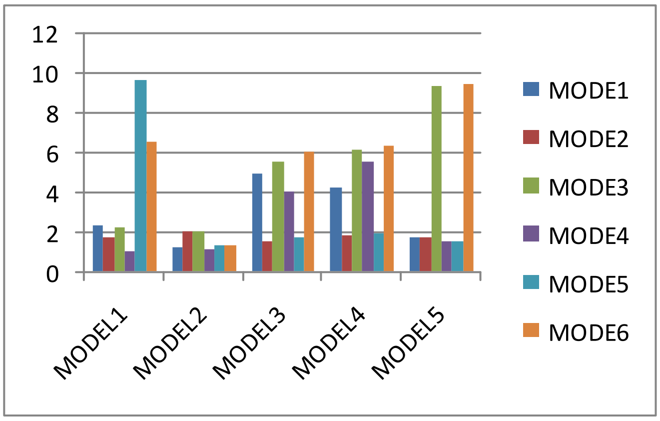
T3.PEAK STOREY SHEAR VALUES FOR 3 MODELS 15 STOREYS:-



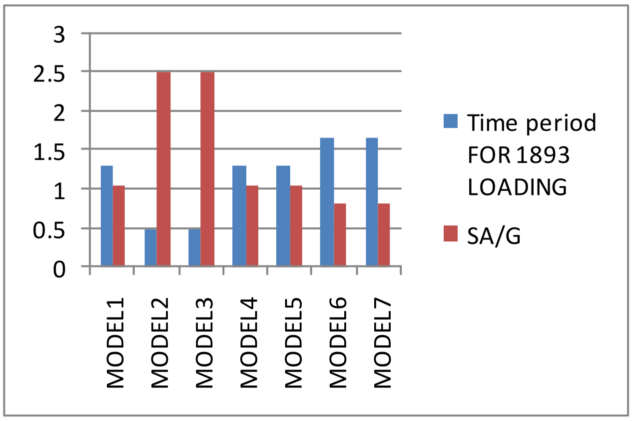
T4.BASE SHEAR VALUES FOR 5 MODELS IX 6 MODE SHAPES(MODES):-



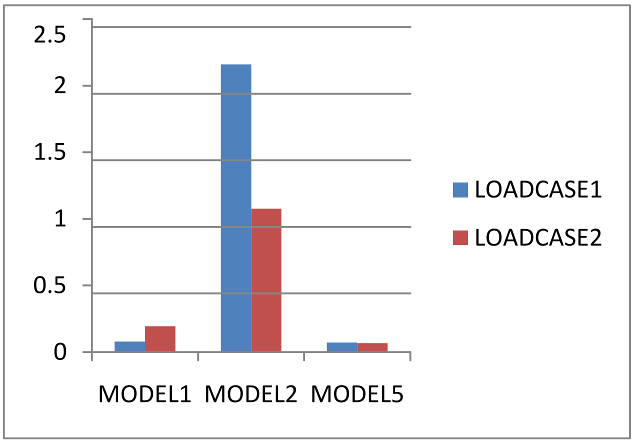
5.RESPONSE SPECTURM LOADCASE VALUES(GENERALIZED WEIGHT):-



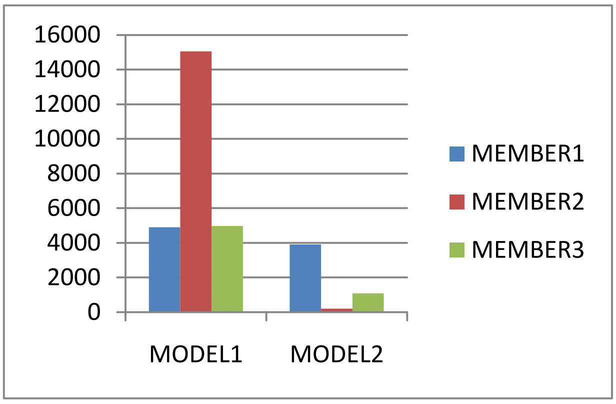
T6. NATURAL FUNDAMENTAL TIME PERIOD VALUES:-



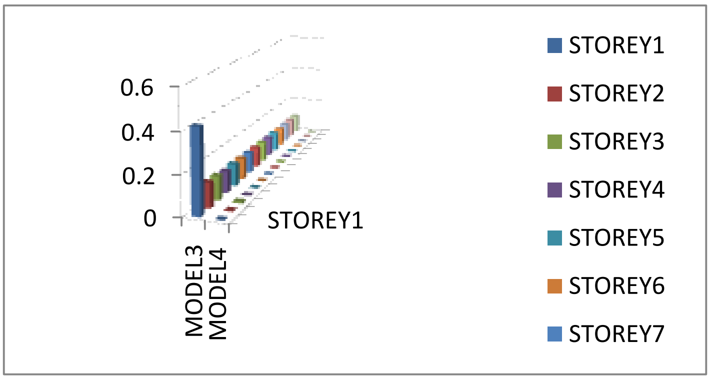
T7.LOCAL DISPLACEMENT VALUES:-



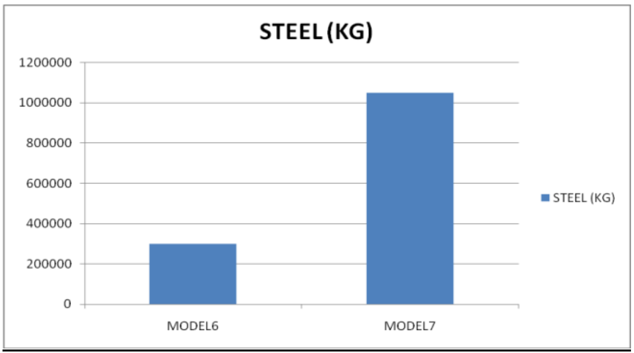
T8.MEMBER STRESS VALUES:-



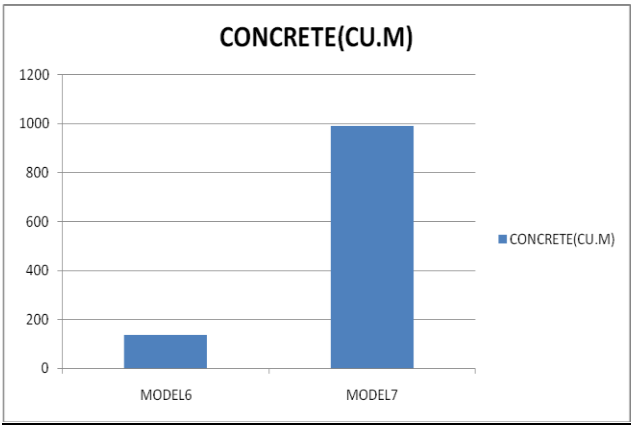
T9.STOREY DRIFT VALUES FOR MODEL 3 AND MODEL4:-



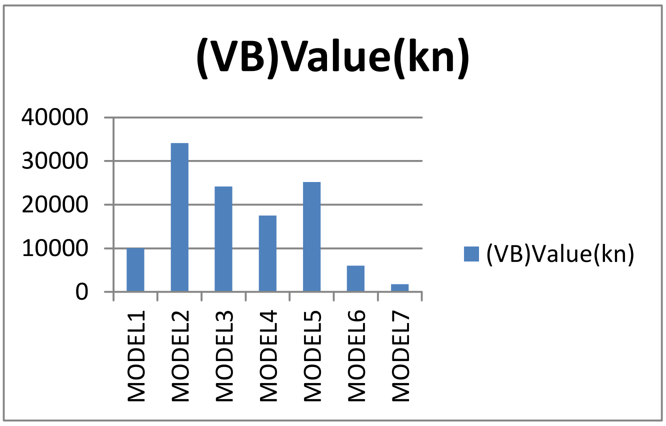
T10.STEEL TAKEOFF FOR MODEL6 AND MODEL7:-



T11.CONCRETE TAKEOFF FOR MODEL 6 & MODEL 7:-



T12 (Vb design seismic base shear) FOR ALL THE MODELS:-



3. CONCLUSIONS

Various types of irregularities according to IS 1893:2016 Part1 were studied in different models of RCC multistory structures with floating column and flat slab as main feature in them with Response spectrum analysis in first 5 models and earthquake analysis and study of economical values in model 6 and 7 by designing and results were compared. Our results can be summarized as follows:-

1. Mode shapes determine the deformation in the shapes of the structure under earthquake conditions and results shows that mode shapes has highest value for a horizontally regular G+15 structure as compared to other structures such as a G+15 vertically irregular structure and horizontally irregular structure with same height with floating column and for flat slab structure irregular & regular shaped flat slab structure has almost same value for all mode shapes in dynamic analysis from response spectrum method thus, showing mass in regular shaped structure is almost **twice** as compared to vertically irregular and horizontal irregular structure thus showing mass regularity is more in this type of structure for high rise building . Thus, concluding that heavy structures vibrates slowly.

2. Frequency cycle/sec and frequency period values shows a inverse relationship in the analysis of first 5 models .Thus, showing that cycle/sec were lower for heavy structures .

3.Peak storey shear values in the analysis of first three models shows that model with regular shaped G+15 structure has higher value than other two models i.e model1 and model3 and storey 2 shows highest value and story 14 shows lowest value in all the structures respectively. Thus, showing that lateral force acting due to seismic pressure were maximum for regular shaped building .

4.Base shear value is the total lateral force acting on building at its base which is equal to storey shear in bottom storey and was highest in model 2 and was highest for modes 1&2 .Thus, concluding that shear walls need to be employed shear forces in regular building model2 and model 5 in case of flat slab.

5.Response spectrum values for generalized weight shows that regular flat slab G+15 story structure showed highest value for the modes and specially mode 6 . Thus, concluding that vibrations were faster in this structure as stiffness was high.

6.Natural fundamental Time period values was highest for flat slab building thus showing greater mass and stiffness and Sa/g spectral acceleration value was highest for floating column structures showing greater spectral acceleration or displacement.

7.Local displacement value was highest for model 2 G+15 regular horizontal structure. Thus, showing that structure with longer period shows greater displacement.

8.In the analysis of member stress(moments per unit width) values model 1 showed highest value for 3 members compared to model 2.Thus, concluding that a regular planned structure is under lesser member stresses as compared to vertical geometrically irregular structure.

9 In the analysis of storey drift for a G+15 floating column structure and a flat slab structure Dmax/Dv i.e (0.8 for model 3 and 0.3 for model 4) values for both the structures were less than 1.2 or 1.4. Thus, ruling out any possibility of torsional irregularity for both types of structures.

10. A floating column flat slab G+20 irregular structure utilized a much less quantity of steel and concrete etc as compared to same height normal beam column structure but with lower stability as seismic weight was also greater but stiffness was almost same in both structure but natural fundamental time was slight lesser in model6.

11.Vb value was lowest in geometrically irregular structure in floating column structure and horizontally irregular flat slab structure and normal beam column structure in analysis of types of structures as compared to other geometry structures. Thus, showing that these structures have less seismic weight as compared to others.

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