STUDY OF VERTICAL IRREGULARITY OF TALL RC STRUCTURE UNDER LATERAL LOAD

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Abstract - *To study the behaviour of the building when the structure is subjected to the lateral loads (earthquake load and the wind load). For the urbanization and for the aesthetic purpose many irregular structures have been designed. As we all know that for good behaviour of the structure it is essential that the structure should be regular. Understanding the behaviour of the Setback building and comparing them with the building without setback building (Regular building) under the lateral load, Similarly for the Mass irregularity. Modelling and analysis of the models is been carried out using the Etab's 2013 software. The present study is limited for analysis of RC structure for lateral loads (EL & WL). The behaviour of the G+30 storey Regular building, Setback building and Mass irregularity building was studied. These building are analysed using Response Spectrum Method. The effect of the setback irregularity and mass irregularity is been studied by considering the parameter such as Storey displacement, storey drift, storey stiffness, Base shear and Time period and they are compared with the regular building.*

Key Words: Mass Irregularity, Setback, Storey displacement, base shear, Time period & Response spectrum Analysis

1.INTRODUCTION

Earthquake is the most devastating and destructive of all the natural calamities. Earthquake is distinctive shaking of the earth surface which results in damage of the structures and causes several hundreds of causalities or loss of life. The earthquake is caused due to the energy released at the movement of faulty rocks. There will be continuous movement of the rock. The earthquake occurred in past days proves that effect on the building Structures, loss of human lives, damage on the ancient structures, flyovers bridges etc. this will directly affect the growth of the country. Many researches are carried out to design an earthquake resistant structure, but still it is not been possible to design the earthquake resistant structure without causing damage. In order to overcome this problem we need to know the seismic performance of the structure or building with various aspects, which will help us to design the structure which will resist the frequent minor earthquake and gives sufficient caution whenever it is exposed to major earthquakes. Hence in present study there an effort made to study the behaviour of vertical irregular RC structure with mass and set back irregularity.

1.1 Scope of Study

The seismic performance of the RC structures mainly depends on the shape of the building and the structural system of the building. While symmetrical buildings effect in an equally uniform distribution of seismic forces all over its components. Unsymmetrical buildings result in tremendous indeterminate distribution of forces making the analysis and prediction becomes complicated. A desire to create an aesthetic and functionally efficient structure drives architects to perceive wonderful as well as imaginative structures. Earthquake resistant engineering emphasis the inconvenience of using irregular plans, recommending as an alternative the use of simple shapes. The effects that cause seismic action in irregular structures were observed in many recent earthquakes.

Furthermore to design and analyse an irregular building a considerably high level of engineering and designer effort are required, whereas a poor designer can design and analyse a simple architectural features. In other words, damages in those with irregular features are more than those in regular one. Therefore, irregular structures need a more cautious structural analysis to reach an appropriate behavior during a devastating earthquake.

1.2 OBJECTIVE OF STUDY

In this present study, The study of vertical irregularity and Mass irregularity of tall RC structure under lateral loads is carried out using Response Spectrum Analysis. Modelling and Analysis is done using Etabs 2013.

2. DISCRIPTION OF MODEL

The plan area of (35X25m) and equal length of 5m are considered. The building considered is an ordinary moment resisting frame of 30 story's with two types of irregular configurations. The different irregularities are mass irregularity and the setback. The stormy height is uniform throughout for all the building models considered for analysis. The software used for analysis of the frame models is ETABS 2013.

Modeling

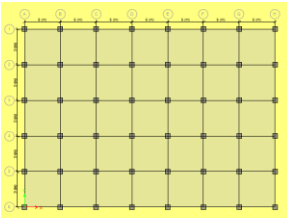

Fig-1 Regular Plan

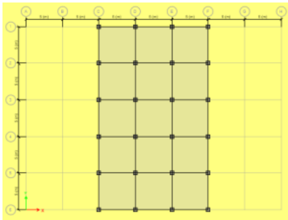

Fig-2 Setback Plan

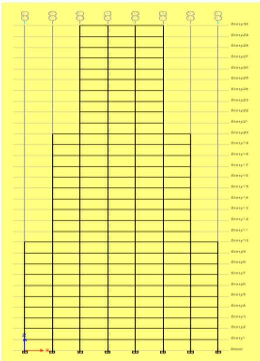

Fig-3 Model M1VZ5

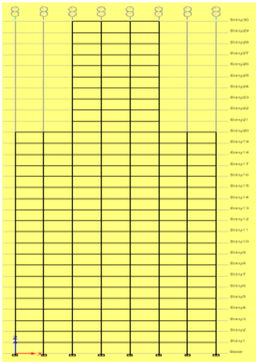

Fig-4 Model M2VZ5

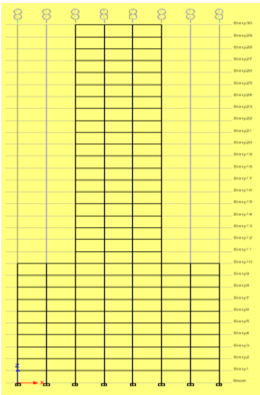

Fig-5 Model M3VZ5

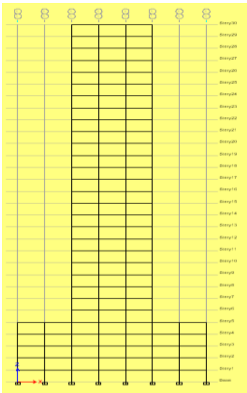

Fig-6 Model M3VZ5

The plan and elevations of models considered are as follows

MODEL RMZ5 - Building in rectangular shape with regular configuration for Zone 5.

MODEL RMZ2 - Building in rectangular shape with regular configuration for Zone 2.

MODEL M1VZ5 - Building with setback in 10th to 20th and 20th to 30th floors at 5m at regular 10 floors interval (ZONE 5).

MODEL M2VZ5 - Building with setback from 20th floor (ZONE 5).

MODEL M3VZ5 - Building with setback from 10th floor (ZONE 5).

MODEL M4VZ5 - Building with setback from 5th floor (ZONE 5).

MODEL MMZ5 - Building with mass irregularity at 10th, 20th and 30th floor for (Zone 5).

MODEL MMZ2 - Building with mass irregularity at 10th, 20th and 30th floor for (Zone 2).

The above mentioned models are considered for zone 5 and similarly same models are considered for zone 2 and they are named as RMZ2, model M1VZ2, model M2VZ2. Model M3VZ2 and model M4VZ2

Table-1 PARAMETERS CONSIDERED FOR ANALYSIS

Particulars	Quantity
Type of the structure	SMRF
Number of stories	30
Seismic zone	5 & 2
Floor height	3m
Grade of concrete	M40 & M25
Grade of steel	Fe550, Fe415
Type of the soil	Soft Soil
Importance factor	1
Response reduction factor:	5
Live load	3KN/m^2
Wind Speed	50 kmps
Terrain category	4
Class of the structure	C

Table-2 BEAM AND COLUMN SIZE DIMENSION

Ticulars	**Dimensions**	**Grade of concrete**
Beam Size		
1- 10 floors	300X550mm	M40
11-20 floors	300X500mm	M40
21-30 floors	300X400mm	M40
Column Size		
1- 10 floors	650X650mm	M40
11-20 floors	550X550mm	M40
21-30 floors	500X500mm	M40
Thickness of slab	150mm	M25
Interior wall thickness	150mm	
Exterior wall thickness	200mm	

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Table-3 LOAD DETAILS

Particulars	Quantity
Live load	3 kN/m^2
Live load on top roof	1.5 kN/m^2
Floor Finish	1.8 kN/m^2
Floor Finish on top roof	1.2 kN/m^2
Mass Irregularity load	25 kN/m^2

2. RESULTS AND DISCUSSIONS

This chapter represents the results and discussions of seismic analysis of vertical irregularities of RC tall Structures. Considering the different seismic zones that is Zone 5 and Zone 2, and the method of analysis is Response Spectrum Method. The results of both mass irregularity and the results of setback are discussed by considering the following parameters.

1. Storey Displacement
2. Storey Drift
3. Storey Stiffness
4. Base shear
5. Time Period

Comparison of Storey Displacement X-Direction

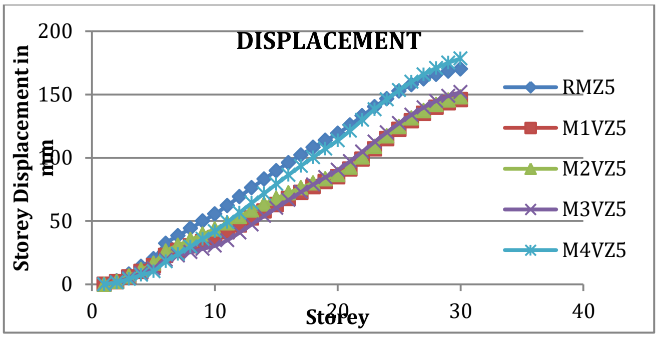

Chart-1 Setback results of storey displacement for Zone 5.

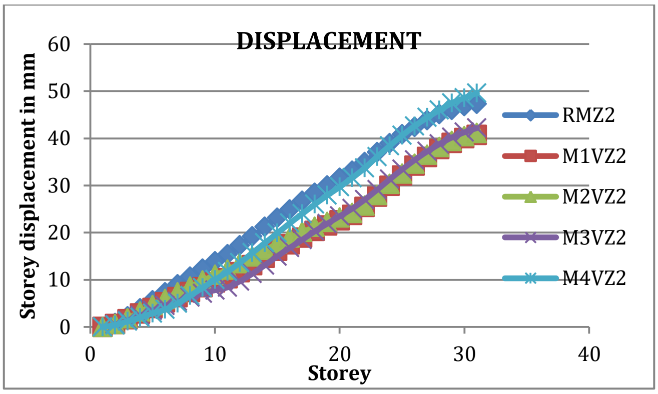

Chart-2 Setback results of storey displacement for Zone 2.

✓ It is observed from chart-1 and chart-2 that displacement increases with increase in storey in both the directions that is in X direction.

✓ Comparing all the models with regular model (RMZ5), it is seen that model M1VZ5 (Setback irregularity at 5th storey) has the higher displacement values.

✓ Comparing chart-1 and chart-2 it represents that the displacement of structure in zone 5 is maximum than displacement of the structure in zone 2.

Comparison of Storey Displacement X-Direction.

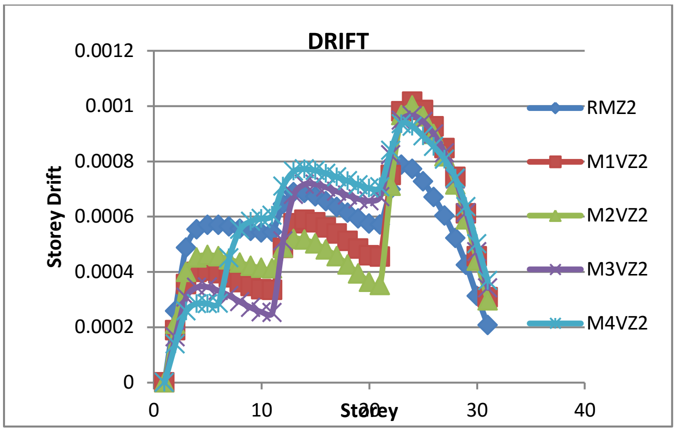

Chart-3 Setback results of storey drift for Zone 5.

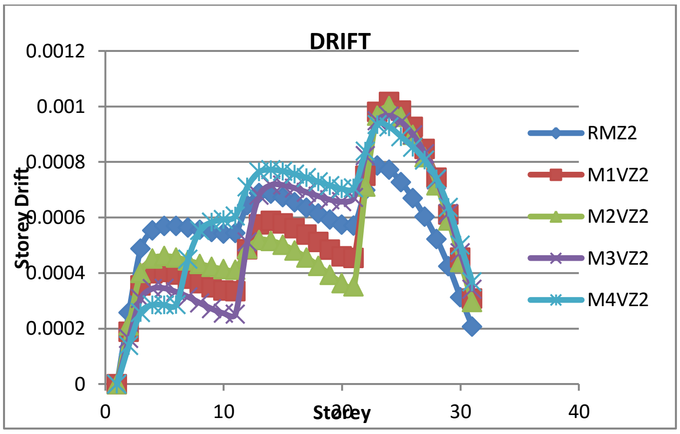

Chart-4 Setback results of storey drift for Zone 2.

✓ The storey drift is maximum in model M1VZ5 and increased by 22% when compared with regular model RMZ5.

✓ The storey drift is maximum in model M1VZ2 and increased by 24% when compared with regular model RMZ2.

✓ Comparing of all models in zone 5(RMZ5, M1VZ5, M2VZ5, M3VZ5 and M4VZ5) with models in zone2 (RMZ2, M1VZ2, M2VZ2, M3VZ2 and M4VZ2) it is observed that models in zone 5 has the higher storey drift values.

Comparison of base shear results X-Direction

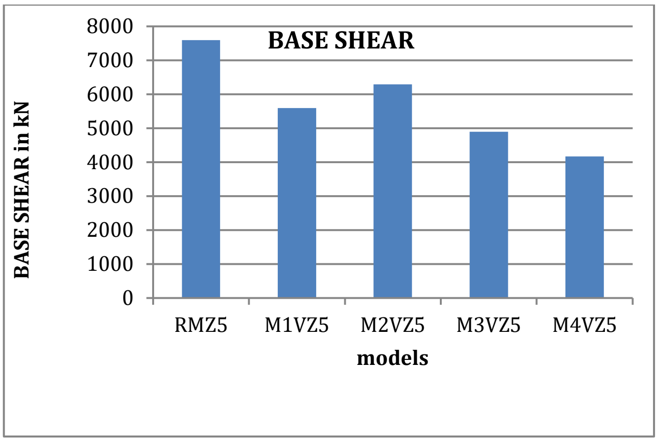

Chart-5 setback base shear results for zone 5

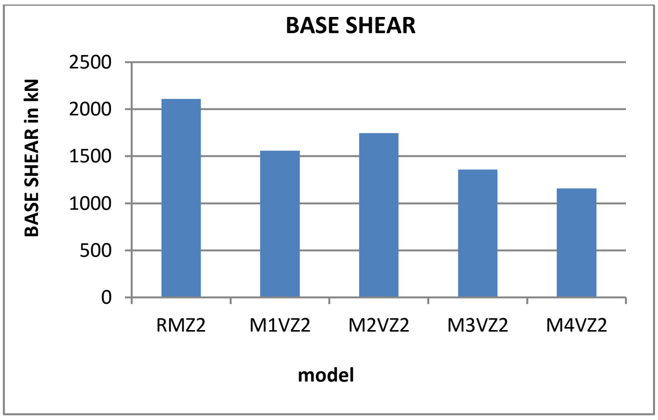

Chart-5 setback base shear results for zone 2

Table-4 Base shear

BASE SHEAR in kN		
MODEL	X direction	Y direction
RMZ5	7589.622	7538.308
MMZ5	7836.24	7783.111
RMZ2	2108.568	2094.312
MMZ2	2176.787	2162.027

- ✓ Base shear of regular model (RMZ5) and Setback irregularity models along X is been presented in chart-5 & 6 for Zone 5 & zone2 respectively.
- ✓ It is observed that the base shear is maximum in regular model compared with model with setback irregularity.
- ✓ The base shear in models M1VZ5, M2VZ5, M3VZ5 and M4VZ5 reduced by 26%, 17%, 35 and 45% respectively when compared with regular model RMZ5.
- ✓ Comparing of all models in zone 5 (RMZ5, M1VZ5, M2VZ5, M3VZ5 and M4VZ5) with models in zone2 (RMZ2, M1VZ2, M2VZ2, M3VZ2 and M4VZ2) it is observed that base shear of models at zone5 has the higher values.

RESULTS OF MASS IRREGULARITY

BASE SHEAR RESULTS

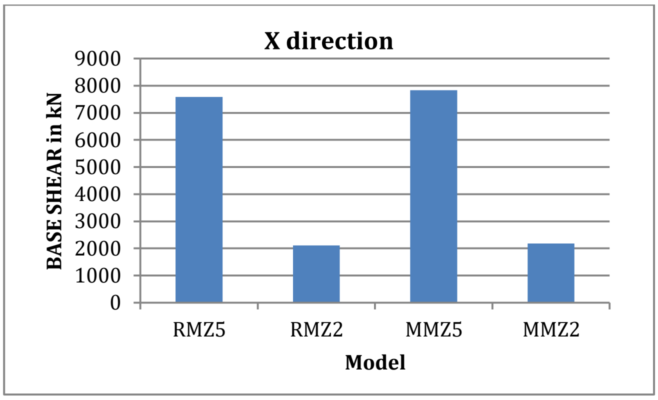

Chart-7 Base shear results for zone 5 & 2

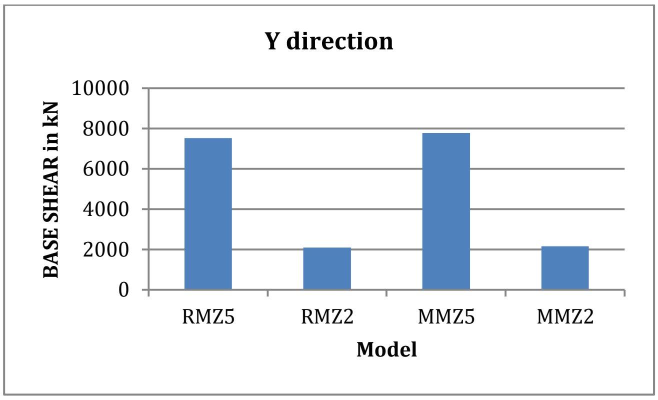

Chart-8 Base shear results for zone 5 & 2

✓ Base shear of regular model (RMZ5) and Mass irregularity model along X and Y-direction is been presented in figure 5.8.1 and figure 5.8.2 for Zone 5 respectively. Similarly Base shear of regular
✓ model (RMZ5) and Mass irregularity models along X and Y-direction is been presented in figure 5.8.3 and figure 5.8.4 for Zone 2 respectively.
✓ It is observed that the base shear is maximum in mass irregularity model compared with model with regular model.

✓ Comparing the model RMZ5 in zone 5 with model RMZ2 in zone2 it is observed that models in zone 5 has the higher base shear values.

Table-5 Base shear

BASE SHEAR in kN		
MODEL	**X direction**	**Y direction**
RMZ2	2108.5684	2094.312
M1VZ2	1560.4699	1570.135
M2VZ2	1745.9683	1705.54
M3VZ2	1359.9852	1343.45
M4VZ2	1157.0767	1175.759

STOREY DRIFT RESULTS

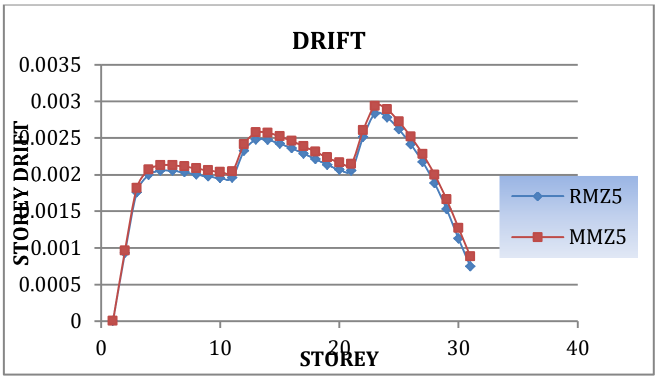

Chart-9 Storey Drift results for zone 5

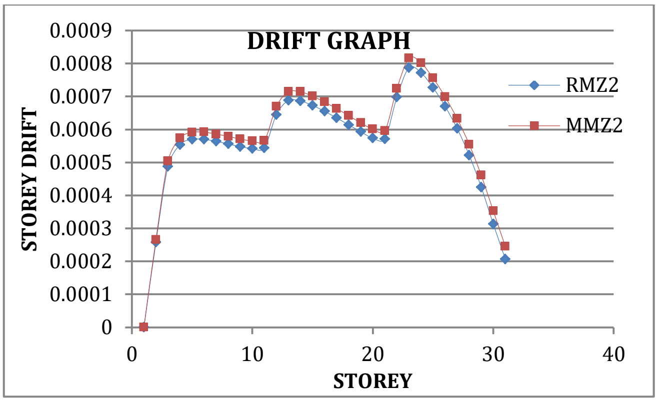

Chart-10 Storey Drift results for zone 2

- ✓ Storey drift of regular model (RMZ5) and Mass irregularity model along X and Y-direction is been presented in figure 5.7.1 and figure 5.7.2 for Zone 5 respectively.
- ✓ The storey drift is maximum in model MMZ5 and increased by 3.5% when compared with regular model RMZ5.
- ✓ The storey drift is maximum in model MMZ2 and increased by 3% when compared with regular model RMZ2.
- ✓ Comparing the model RMZ5 in zone 5 with model RMZ2 in zone2 it is observed that models in zone 5 has the higher storey drift values

3. CONCLUSIONS

- ✓ From the present study it is concluded that the building with irregular structural configuration are subjected to severe damage when compared to the regular structure.
- ✓ During earthquake structure located in zone 2 are less affected when compared to the structure located at zone 5.
- ✓ There is difference in the base shear in all models this is due to the seismic weight of the building.
- ✓ The storey lateral displacement of mass irregular frame will increase as the heavy mass floor level increases in the buildings. Regular frame has the least displacement.
- ✓ At last, we finish up from the outcomes unpredictable structures are to be treated with appropriate plan and ought to be trailed by all IS code procurements given the guidelines

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