COMPARATIVE STUDY OF HIGH RISE RC FRAME STRUCTURE WITH SOFT STORY AT VARIOUS LEVELS AND VARIATION OF MASS IRREGULARITY

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Abstract:- *RC buildings with open ground storey are distinguished by the assembly of lateral displacement at the bottom storey or the ground storey. This is because of the reduced stiffness in the ground storey than that of the above stories; this phenomenon is called as soft storey effect. With the increasing demand of architectural features, soft storey is in common practice for parking in the present days .Usually; higher lateral displacements are seen in high rise building structures in presence of wind and seismic loads. Hence to reduce such displacements one of the lateral load resisting frame, shear walls are provided in the present project. Providing shear walls reduces the storey displacement/ storey drift and also increases the stiffness of the building.In the present work, RCC frame building is analyzed and designed using SAP2000 and ETABS. The present study has 2 basements and G+ 15 upper stories. The effect of wind and earthquake in the analysis and design are considered by referring the code IS 1893-2002 and IS 875-1987(part-3). The aim of this case study is to study the soft storey behavior in the seismic analysis with or without soft storey.*

Key Words: **Soft storey, Stiffness Irregularities, Storey Displacement, Storey Shear, Storey Stiffness, Storey Drift**

1. INTRODUCTION

Buildings usually require the open ground floor for stopping of the vehicles and to provide the open approach at the ground floors which indeed results in the high stiffness unevenness between the floors above the GF as well as at the GF. Due to the effect of soft storey there will an increment in the shear force at the ground level. When it is required for the structure to endure utilitarian after the tremor, for example, like the hospitals, the conventional design for the safety of life becomes unsuitable. For such cases, the structure must be designed for the adequate strength which in turn decreases the inelastic actions.The occurrence of the change in the stiffness along the height of the building is called as soft storey.
The IS code says that the soft storey is the one in which the horizontal stiffness is < than 70% of that in the storey above or < than 80% of the normal/ average horizontal stiffness of the 3 storeys above. In other words, it is the one in which the one or more floors have windows, more than average width of doors, large free spaces of other openings in the places where there is a need of shear wall for the stability purpose as an entity of the seismic design. For developing the lateral stiffness and the quality of the soft storey, unique designs are to be made.

2. OBJECTIVES

1) To study the conduct of the unevenness of the multi-storey structure.
2) To study the behavior and contrasting the results, using the dynamic analysis.
3) Studying the response of the building with the soil conditions i.e., with medium or stiff and soft soils.
4) Comparing the building response by considering the reduction factor of 3 and 5.
5) To evaluate the execution of the unevenness structure, that is exposed to loads such as earthquake and the wind.
6) Comparing the results in terms of displacement, base shear, stiffness and drift and hence studying the vertical unevenness of the building frames.

3. Details of the model

The present project is done for basements and G+15 floors. 12 models are carried out for the seismic analysis.
The main intention of this project is to the study the behaviour of the structure with soft storey at different levels. Wall sections are considered for the overall structure.
The building is located in the zone III,IV and V with varying soil types of soil type II and soil type III. The building is irregular in plan.

Table 1.1 Model Details

No. of storeys	2basements G+15
Storey height	B-2 1.7m B-1 3.4m G 4.4m 1to terrace 3m

Presence of soft storey levels	3,7,11
Zones	III,IV,V
Zone factors	0.16,0.24,0.36
Soil types	Medium and soft
Importance factor (I)	1
Response Reduction Factor (R)	3,5
Wind speed	39m/s

4. 3D modelling of the structure

The model done using the software SAP2000 is shownin the figure 1.1

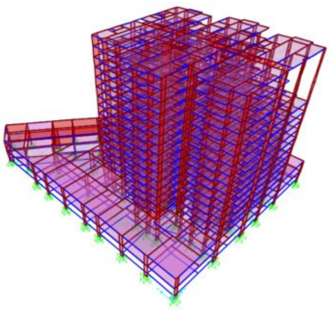


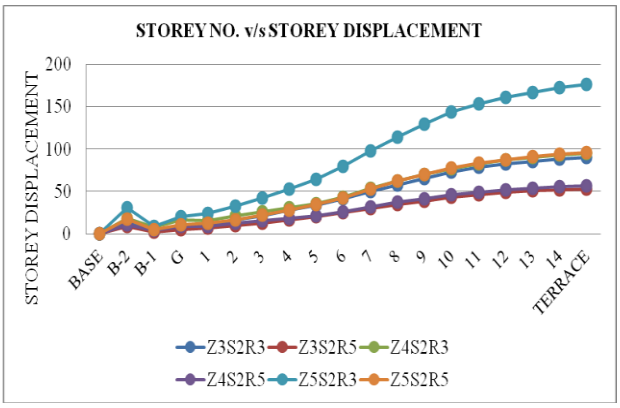
Figure 1.1 Modelling of the structure in 3D using SAP2000

5. RESULTS AND DISCUSSIONS

Results that are obtained from analysis are equipped in this particular chapter. Graphs are plotted for respective storey responses as like, storey-displacement, storey-drift, storey-shear and storey-stiffness. The graphs plotted are for the the response spectrum that are defined i.e. for RSX and RSY.

Structure on soil type II

- Storey displacement



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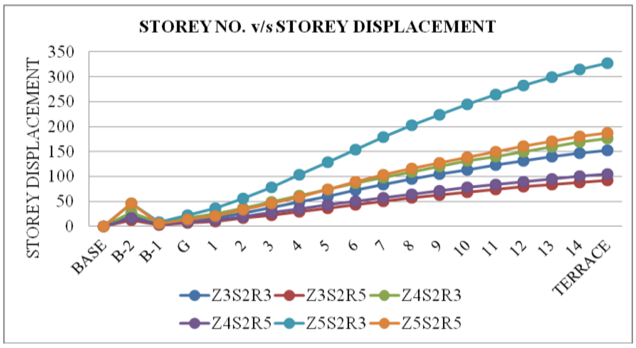

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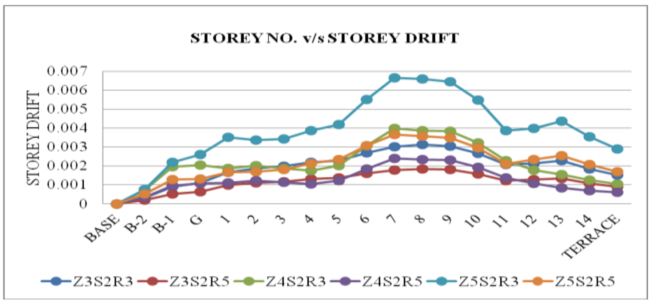
Chart5.1:Storey displacement for RSX and RSY

From the above chart i.e. in chart 5.1a, we can make out that the zone V in soil type II with maximum displacement ,having the response reduction factor as 5 and the zone III has the minimum displacement having the response reduction factor as 3.

From chart 5.1b we can make out that the zoneV in soil type II with maximum displacement, having the response reduction factor as 5 and the zoneIII has the minimum displacement having the response reduction factor as 3.

- Storey drift

From the chart 5.2a and 5.2 b shown below, it is observed that for the spectral cases RSX and RSY, minimum storey drift is at zone III with reduction factor being 5 and maximum storey drift is at zone V with reduction factor being 5 for soil type II. The graph shows that, it does not varies linearly as there is soft storey in the floors 3,7,14 since the presence of soft storey, the storey drift increases in d same floors itself.



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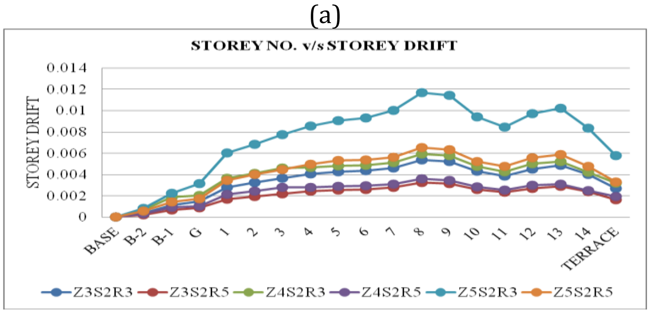

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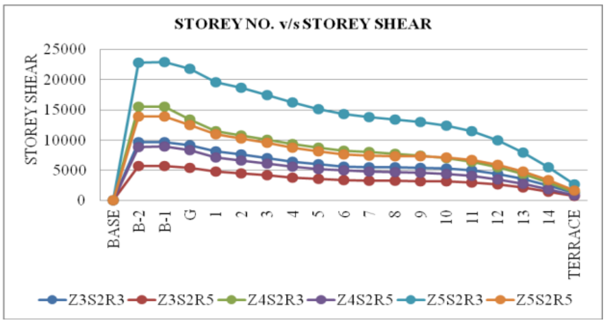
Chart 5.2: Storey drift for RSX and RSY

- Storey shear



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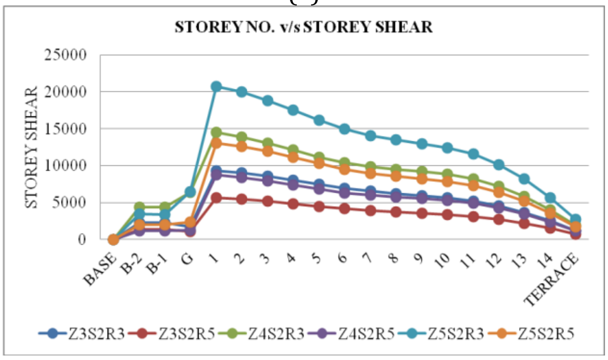

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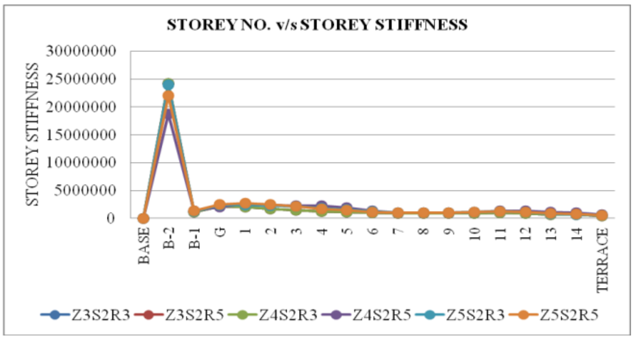
Chart 5.3: Storey shear for RSX and RSY

From the above charts, the highest values are for the spectral cases RSX and RSY for zone V and reduction factor 3. There will be more storey shear at the basement and the ground floor and decreases linearly as the storey decreases.

- Storey stiffness



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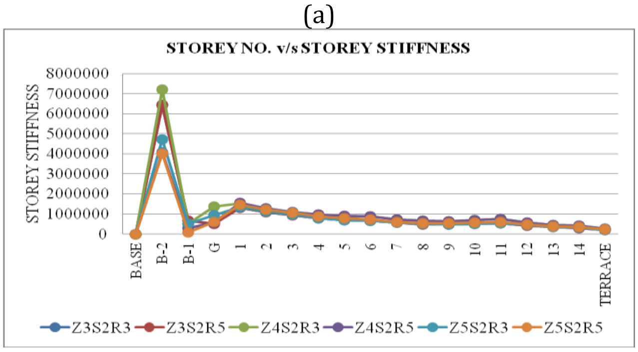

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Chart 5.4: Storey stiffness for RSX and RSY

From the graphs plotted, storey no. Versus the storey stiffness it can be observbed that the zone IV has the highest value for RSX and RSY with the reduction factor of 3 for soil type when compared to other models. It can be seen that the variation is more at the basement as hence decreases almost linearly when the storey increases.

- Base shear

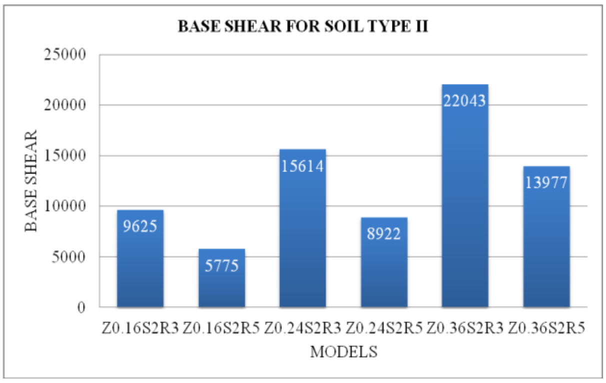
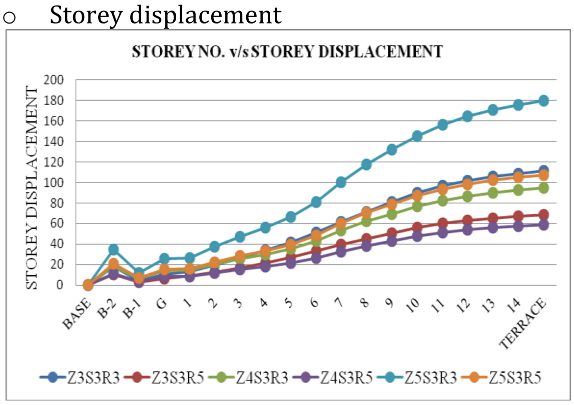


Chart 2.5 : Base shear for EQX

From the graph plotted for the base shear of respective zones, it is seen that the zone V has the maximal base shear with 22043 KN and the zone III has the minimum base shear of 5775 KN.

Structure on soil type III

- Storey displacement



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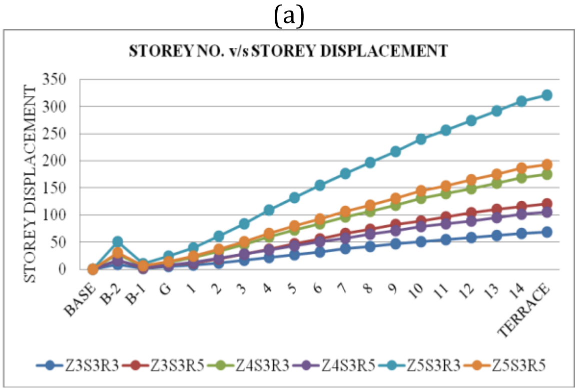

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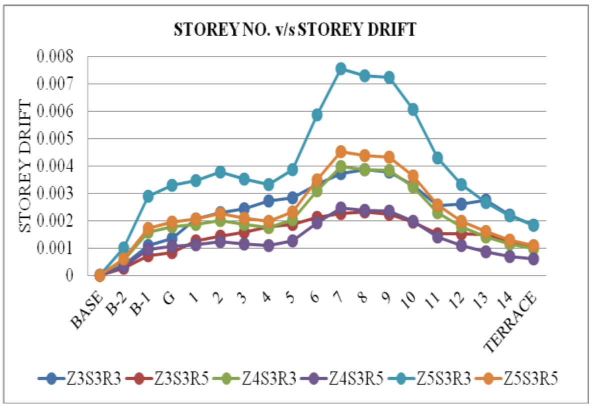
Chart 2.6: Storey displacement for RSX and RSY

We can see that the spectral cases RSX,RSY has the maximum values for zone V, 'R' value being 3, and the minimum values for R being 5 and with R being 3. It can be said that with increasing storeys the storey displacement also increases.

- Storey drift



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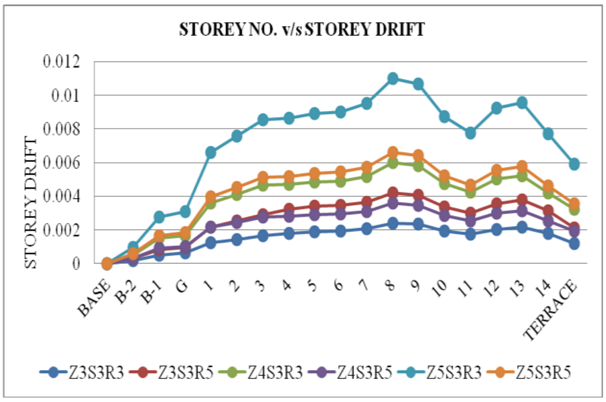

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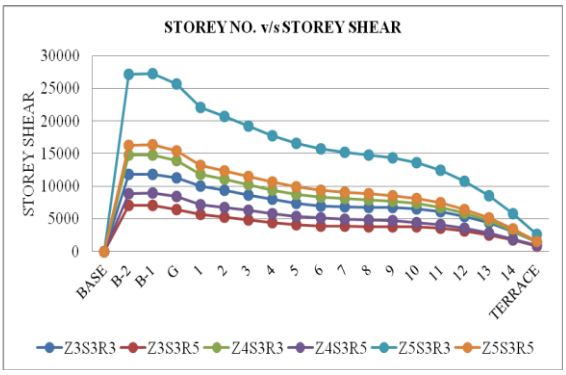
Chart 5.7: Storey drift for RSX and RSY

From the graphs, RSX and RSY the maximum value is for the zone V with response reduction factor 3 and least for the zone III and R being 5 when compared to other models. The graph shows that, it does not varies linearly as there is soft storey in the floors 3,7,14 since the presence of soft storey, the storey drift increases in the same floors itself but for RSY direction, the drift increases for the storey 8.

- Storey shear



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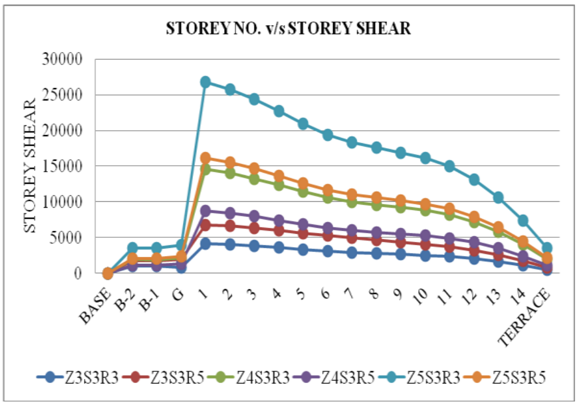

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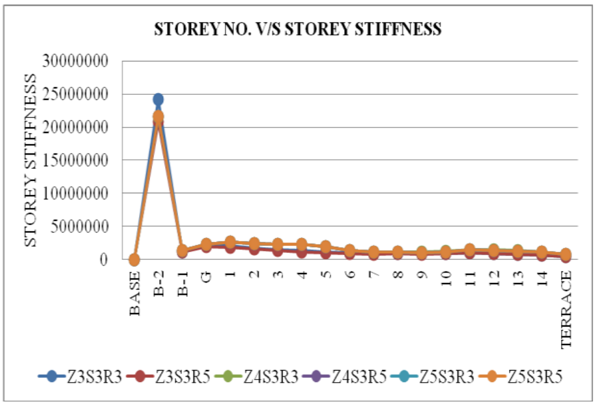
Chart 5.8: Storey shear for RSX and RSY

It is seen that, for RSX and RSY the storey shear is least in the zone III,R5 and R3 and maximum in the zone V where R is 3 than compared to other models. There will be more storey shear at the basement and the ground floor and decreases linearly as the storey decreases.

- Storey stiffness



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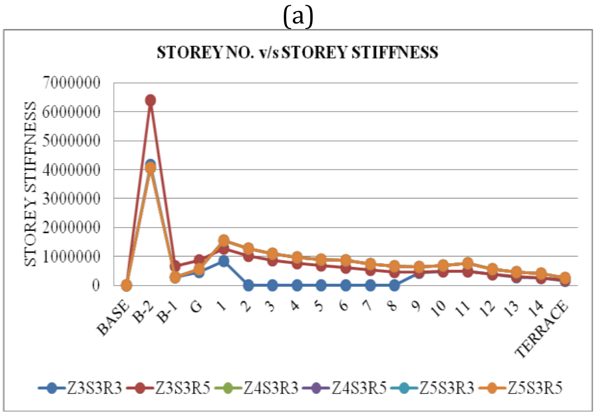

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Chart 5.9: Storey stiffness for RSX and RSY

RSX and RSY in charts above has the highest values at zone III when compared to other models. There is an increase at the basement and constantly decreases for other storeys.

- Base shear

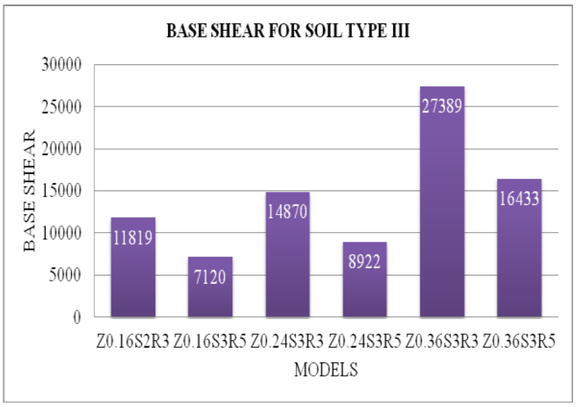

Chart 5.10 : Base shear for EQX

It is seen from the graph that the lowest base shear is in the zone III and response reduction factor 5 with the value 7120KN and the highest base shear value is 27389KN for the zone V and response reduction factor being 3 when compared to that of the other models.

6. CONCLUSIONS

1. The effort has been made to study the complete irregular building with the different types of irregularities. The major analysis work is done on soft storey. This structure has been considered with and without soft storey which is ongoing.

2. In this work soft storey at different levels and complete dynamic analysis has been done. The modelling has been done using SAP2000 which is good in analysing complete 3D structure.

3. The effort has been made to study the behaviour of the building with and without soft storey using SAP2000.

4. In this work, different parameters have been considered to study the lateral behaviour of the building, we can conclude that, soft storey is majorly affected by the lateral loads.

5. From the results and discussion, we can conclude that, if the building is analysed in OMRF with soft storey the, lateral displacement, stiffness and storey shear are high and it tends to fail. Whereas, with SMRF, the building is safer and also, has considerable values of lateral displacement, stiffness and storey shear.

6. Similarly, from the above results, we can also conclude that as the zone factor changes, and the soil type changes, the building is much affected for seismic loads.

7. From these, it can be concluded that, an irregular building with multiple storeys must be designed for SMRF.

a. Finally, it can be stated that the selection of the structure type depends upon the loads which the structure has to withstand; the designer can depend upon the studies like the one in this thesis to get better optimized and economical structure for the society and also which results in the lesser harm on the environment.

8. SCOPE FOR FUTURE WORK

The present work can be extended to meet the required demand of the pioneers in order to apprehend the complex etiquette of the asymmetric edifices and torsional effects in edifices. A portion of the proposals for future review are recorded underneath.

1. Similar studies can be carried out for irregular shaped tall structures.

2. Time history and P-delta analysis can be carried out.

3. Damper can be adopted for the present work and results are compared without dampers.

4. Lateral resisting systems like tube frame etc. can also be considered.

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