COMPARATIVE STUDY OF LINEAR AND NON-LINEAR SEISMIC RESPONSE
OF RC STRUCTURE SITUATED IN DIFFERENT SEISMIC ZONES OF INDIA

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Abstract - The G+14 multi story irregular building is taken for present study. This building is modelled and analysed by using ETABS V9.7.4. Assuming the material property as linear and non linear. This building is analysed by considering all Indian seismic zones. For each zone three types of soil is taken and analysed (i.e. hard soil, medium soil and soft soil). The analysis is done by equivalent static analysis and pushover analysis. The performance of the building is studied by comparing the base shear, displacement, story drift in both analyses.

Key words: Asymmetric building, Equivalent Static Analysis, Pushover Analysis ETABS.

1. INTRODUCTION

The main objectives of structural designer under the seismic loads are the safety of the building under severe earthquake. To design the structure under seismic loads it is required to know the performance of buildings under inelastic deformation. Now a day in metro cities many tall residential buildings are constructed asymmetric in plan and asymmetric in elevation. So these buildings are more vulnerable under the action of earthquake. For the investigation of earthquake these buildings becomes complex for analysis. We can get the accurate performance MDOF structures by using non linear time history analysis. But in day to day or everyday design of building in this method is not practical because it consume more time. In such situation performance of structure under seismic can be estimated by using the pushover analysis. Many of the designer use linear static method for earthquake analysis. This method couldn’t give proper results. Hence it is necessary to know the error of performance of building in both the methods of analysis and is carried out with different zones and soil properties.

1.1 OBJECTIVES

The target of the current study is as follows

1. To look at the base shear of the structure which is situated in various Indian seismic zones with various soil types.
2. To compare the displacements of the structure which is located in different Indian earthquake zones with different soil types.
3. To compare the story drift of the structure which is located in different Indian seismic zones with different soil types.

2. BUILDING DESCRIPTION

The scope of the present thesis is to study the behaviour of asymmetric RC structure located in different Indian seismic zones and different soil types. The performance of building is concentrated by base shear, lateral displacement and story drift by using Equivalent static analysis (ESA) and Pushover analysis (PA). These analysis were carried out according to IS 1893:2002, ATC-40. The model of present study is created and analysed in ETABS version 9.7.4 software.

<table>
<thead>
<tr>
<th>Description</th>
<th>Asymmetric structure</th>
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<tbody>
<tr>
<td>Type of structure</td>
<td>Residential Building</td>
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<tr>
<td>No. of stories</td>
<td>15(G+14)</td>
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<tr>
<td>Height of building</td>
<td>45.75m</td>
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<tr>
<td>Column size</td>
<td>(300X700)m</td>
</tr>
<tr>
<td></td>
<td>(300X1000)mm</td>
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<tr>
<td>Beam size</td>
<td>(230X450)m</td>
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<tr>
<td></td>
<td>(230X600)mm</td>
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<tr>
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<td>Height of the floor</td>
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<td>Concrete grade for Columns</td>
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<td>Concrete grade for Beams and Slab</td>
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Table 2 CODAL VALUES

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<td>Response Reduction Factor, R</td>
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<td>Importance Factor, I</td>
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Table 3 LOADS ON BUILDING

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<td>Live load on floor</td>
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<td>Floor finish</td>
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<td>Wall load</td>
<td>10.4kN/m 9.8kN/m</td>
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</tbody>
</table>

2.1 MODEL LABELS:
- \( Z_2S_2 \) = zone–II and soil type-II
- \( Z_2S_2 \) = zone–III and soil type-II
- \( Z_2S_2 \) = zone–IV and soil type-II
- \( Z_2S_2 \) = zone–V and soil type-II

2.2 PROCEDURE OF MODELLING AND ANALYSIS.

2.2.1 CREATING MODEL FOR NON LINEAR STATIC ANALYSIS

In ETABS v9.7.4 the model is developed. Columns, beams and slab are modeled as 3D frame element. After the modeling a non linear load combinations are defined in software. The next work is to assign the hinges. In current study hinges are assign for beams and columns only. Hinges may be assign as many numbers as we can in software. These hinges are along the frame element. In current study, hinges for beams are assign at start, middle and end of the beam elements. For column start and end of element assign. The hinges in software will take automatically at their relative distance of structure elements. Default plastic is available in software. These default hinges are as per ATC-40.

2.2.2 PUSHOVER ANALYSIS PROCEDURE

The procedure for pushover analysis used for the present study is as follows.

Defining the material property, load combinations, specifying seismic zone factor, soil type and time period. Assigning the loads (such as live load, dead load, ff etc.). Creating 3D model of the building. Assigning default hinge properties. For beam assign hinges moment M3 and shear V2. For columns assign hinges PM2M3. Then load cases are defined to run pushover analysis. First gravity load is applied to the building and then lateral load is applied in transverse and longitudinal direction. After completion of linear analysis design the building. The design is done as per the IS456:2000. The structural elements are designed as per the defined load combination. The structure is design before pushover analysis because to generate
the hinges for the elements of structure. After this pushover analysis is carried out. Pushover analysis gives capacitive curve, performance point.

Table 4 Base Shear (KN)

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<th>Model</th>
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<th>PUSH-X</th>
<th>PUSH-Y</th>
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![Base shear(KN)](image)

Fig 3: Base Shear

Table 5 Displacement in x direction by ESA

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Table 6 Displacement in Y direction by ESA

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Table 7 Displacement in X direction by NSA

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<th>ZS3</th>
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Table 8 Displacement in Y direction by NSA

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<th>Story</th>
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Table 9 Drift in X direction by ESA

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Table 10 Drift in y direction by ESA

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</table>

Table 11 Drift in x direction by NSA

<table>
<thead>
<tr>
<th>Story</th>
<th>(Z_2S_2)</th>
<th>(Z_3S_2)</th>
<th>(Z_4S_2)</th>
<th>(Z_5S_2)</th>
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<tbody>
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Table 12 Drift in y direction by NSA

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<th>(Z_4S_2)</th>
<th>(Z_5S_2)</th>
</tr>
</thead>
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</tbody>
</table>
3. CONCLUSIONS

On the basis of present study following conclusions are drawn

1. It is found, the total lateral load carrying capacity of the structures are higher in the both the directions, when nonlinear strength of the materials is considered. The asymmetry of the structure has very less influence in this.

2. The lateral deformation capacity of the each storey is gradually decreasing from top to bottom in the type of analysis but it is found to be higher in case of nonlinear static analysis.

3. The lateral deformation capacity of the symmetric structure is found to be higher than that of asymmetric structure. As the asymmetry of the structure is increasing, the lateral deformation capacity is decreasing.

4. Storey drift is gradually increasing from bottom to middle storey and from middle storey it gradually decreasing to top storey.

5. The building shows less performance point in loose soil.

REFERENCES


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