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# COMPARATIVE STUDY OF THE STATIC AND TIME HISTORY ANALYSIS OF EXISTING RC FRAME

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**Abstract:** Considerable improvement in earthquake resistant design has been observed in recent past. As a result Indian seismic code IS: 1893 has also been revised in year 2002, after a gap of 18 years. This paper presents the seismic load estimation for multistorey building as per IS: 1893-2002 recommendations. The existing multistorey RC framed buildings of six storey is considered and analyzed. The Static and Dynamic analysis of the building is done, in Dynamic analysis lateral Load is considered. The Dynamic analysis is done by Time history method. This analysis for building and the results are used to compare the seismic parameters such as storey shear, base shear, storey displacement, bending moment and Axial force, computed as per the seismic code IS 1893-2002. The seismic forces, computed by IS: 1893-2002 are found to be significantly higher than that of static analysis except the base shear. The difference varies with structure properties. It is concluded that such study needs to be carried out for individual structure to predict seismic vulnerability of existing RC framed buildings that were designed using earlier code and due to revisions in the codal provisions may have rendered unsafe.

**Keywords**: Static Analysis, Dynamic Analysis, Time History Analysis, Earthquake Loads, IS 1893-2002, Existing RC building, Multistorey building.

## I. INTRODUCTION

Recommendations provided by seismic codes help the designer to improve the behaviour of structures so that they may withstand the earthquake effects without significant loss. Seismic codes are unique to a particular region or country. They take into account the local seismology, accepted level of seismic risk, properties of available materials, methods used in construction and building typologies. Further, they are indicative of the level of progress a country has made in the field of earthquake engineering and property. Most of the recommendations of IS codes are based on observation during past earthquakes as well as experimental and analytical studies made by scientists, engineers and seismologists.

In India, the first seismic code namely IS: 1893 (Criteria for earthquake resistant design of structures) was published in 1984 and seismic design requirements in building codes have steadily improved. IS: 1893-2002 has been revised in year 2002 after the gap of 18 years (IS:1893-1984). The building designed as per the earlier version of the code have to be checked for recommendations made by the revised code. Such comparison is to be carried out to establish whether existing buildings designed by earlier version are safe for revised recommendations also, Buildings known to possess structural deficiency should be retrofitted to withstand expected design earthquake vibrations. This project aims to determine and compare the seismic forces on buildings computed as per the last two version of IS: 1893. A multi-storey building of G+5 storey height is considered. Time History Analysis Methods will be used to compute the seismic forces on these buildings.

## II. OBJECTIVE

1. To Analyse and Design the existing multi-storey RC structure subjected to Static Load.
2. To perform Time History analysis on existing RC structure in commercial Software.
3. To compare behavior of multi-storey RC frame structure for Static and Dynamic load in terms of various responses such as Base reaction, Displacement, Bending Moment, Axial Force, Shear Force.

## III. BUILDING DATA

The analysis of G+5 building was carried out with the plan area of the building 14.6m x 15.5m. The total height of building is 21m with the soft storey. The sections of column are different at different floor height as the building was not constructed considering the lateral forces, at ground floor the sections is 230mm x 600mm, at first floor is 230mm x 530mm, at second floor is 230mm x 450mm, at third floor is 230mm x 380mm, at fourth floor is 230mm x 300mm, at fifth floor is 230mm x 230mm, and at the roof cap is 230mm x 230mm, Slab thickness is of 150mm and beam sections

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are of 230mm x 530mm. Table 1 Consists of Structural Details of Building and Table2 Consists of Seismic Parameters of the Building.

**Table 1:- Structural Details of Building**

| | |
|---|---|
| Plan Area | 227303000mm Sq. |
| Beam Size | 230mm x 530mm |
| Column Size | |
| Ground Floor | 230mm x 600mm |
| 1st Floor | 230mm x 530mm |
| 2nd Floor | 230mm x 450mm |
| 3rd Floor | 230mm x 380mm |
| 4th Floor | 230mm x 300mm |
| 5th Floor | 230mm x 230mm |
| Slab Thickness | 150mm |
| External wall thickness | 230mm |
| Internal wall thickness | 150mm |
| Height of Building | 18000mm |

**Table 2:- Seismic Parameters of Building**

| | |
|---|---|
| City | Pune |
| Seismic Zone | III |
| Zone Factor | 0.16 |
| Importance Factor | 1 |
| Response Reduction Factor | 5 |
| Soil Type | Medium Hard |
| Building Frame System | SMRF |
| Damping Ratio | 0.05 |

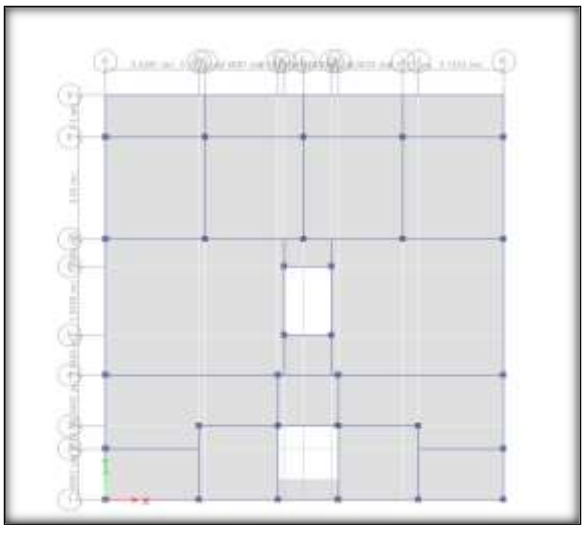

**Figure 1:- Plan of Building**

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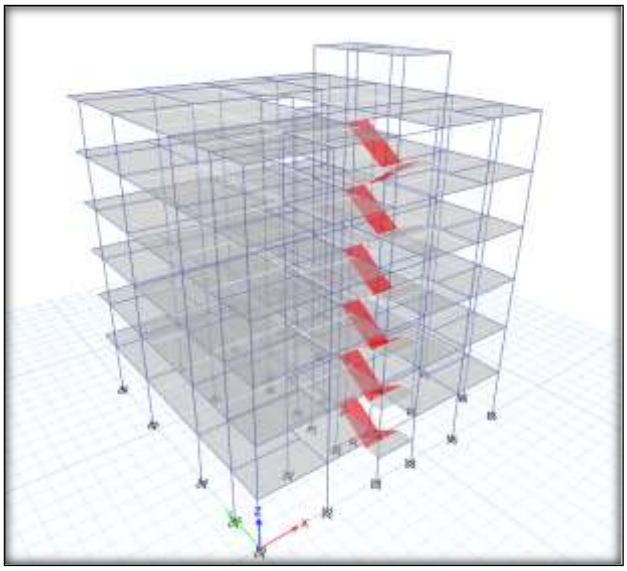

**Figure 2:- 3D View of Building**

## IV. METHODOLOGY

**MODEL I**

- Initially a building plan is selected and modelled in ETABS setting preliminary units, dimensions, and codes according to Indian standards.
- Assigning the properties for columns, beams and slabs.
- Assign the fixed supports as required for the building.
- Calculating loads such as dead and live as per IS 456:2000.
- Assigning dead load and live load on the building.
- Creating load combinations as per IS 456:2000.
- Analysis the model in ETABS.
- Note the results such as Axial force, Bending Moments, Base Shear etc.
- Manual Calculations are done using the forces that are noted.

**MODEL II**

- In same model, the Wind Load, Seismic Load, Time History Definitions and Load Cases are given from IS 875 part 3 and IS 1893:2002.
- The Load Combinations are created for Seismic Load from IS 456:2000 and IS 1893:2002.
- Analysis the model in ETABS.
- Note the results such as Axial force, Bending Moments, Base Shear etc.
- Compare the results from both models.

## V. RESULTS

**Storey Displacement**

This maximum displacement is given for the Static analysis in X and Y Directions

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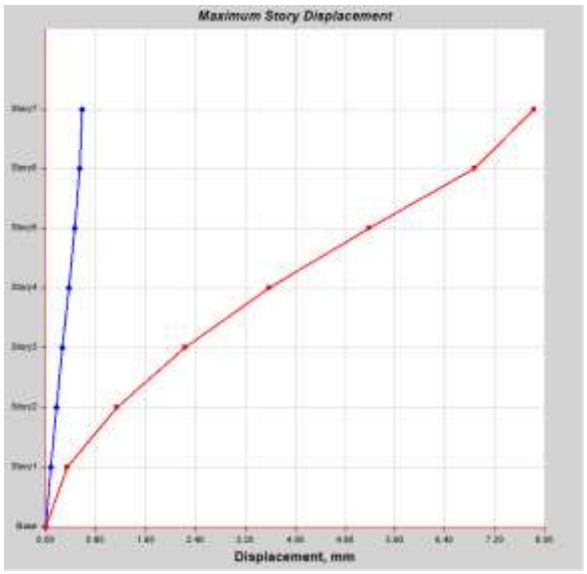


**Figure 3:- Storey Displacement in Static Analysis**

**Table 3 - Storey Displacement in Static Analysis**

| Storey | Elevation | Location | X-Dir | Y-Dir |
|---|---|---|---|---|
| | m | | mm | mm |
| Storey6 | 18 | Top | 0.55 | 6.868 |
| Storey5 | 15 | Top | 0.469 | 5.181 |
| Storey4 | 12 | Top | 0.37 | 3.583 |
| Storey3 | 9 | Top | 0.269 | 2.229 |
| Storey2 | 6 | Top | 0.172 | 1.142 |
| Storey1 | 3 | Top | 0.085 | 0.34 |
| Base | 0 | Top | 0 | 0 |

This maximum displacement is given for the Dynamic analysis in X and Y Directions

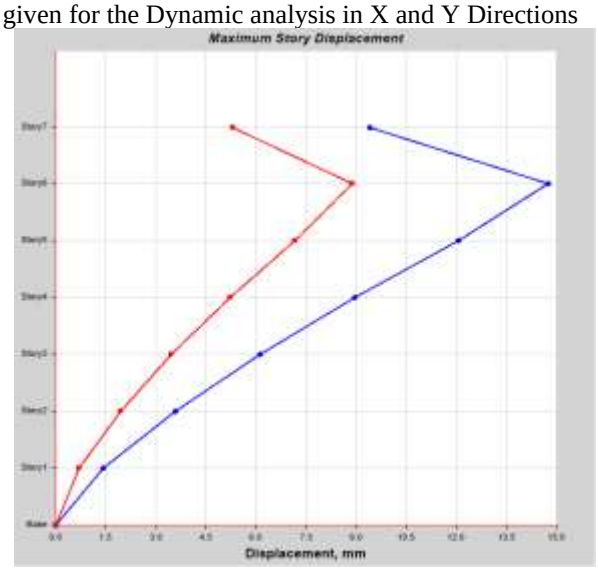


**Figure 4:- Storey Displacement in Dynamic Analysis**

  

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**Table 4 - Storey Displacement in Dynamic**

| Storey | Elevation | Location | X-Dir | Y-Dir |
|---|---|---|---|---|
| | m | | mm | mm |
| Storey6 | 18 | Top | 14.742 | 8.876 |
| Storey5 | 15 | Top | 12.063 | 7.167 |
| Storey4 | 12 | Top | 8.955 | 5.223 |
| Storey3 | 9 | Top | 6.126 | 3.465 |
| Storey2 | 6 | Top | 3.585 | 1.942 |
| Storey1 | 3 | Top | 1.421 | 0.7 |
| Base | 0 | Top | 0 | 0 |

**Comparison of Static and Dynamic Results**

**1. Storey Displacement**

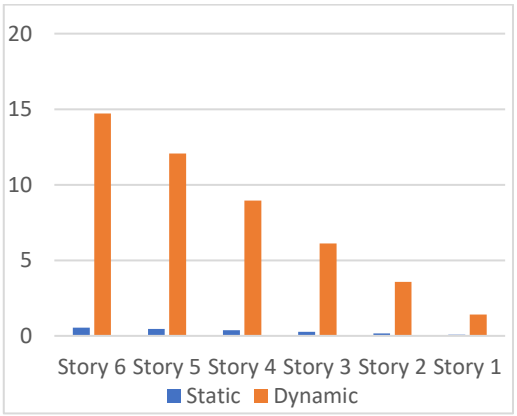


**Chart 1 :- Storey Displacement**

The Storey Displacement of the building at different Storey of the building in Static and Dynamic loading of the Building are given, on the Top Storey that is Storey 6 shows 14.72 mm of displacement in Dynamic analysis and 0.55 mm of displacement in static Analysis.

**2. Base Reaction**

The above given Chart 2 shows the Base Reaction of the Building in Static Analysis and Dynamic Analysis. The Base Reaction of Static Analysis of Building is 42005kN and that of the Dynamic Analysis Building is 33604kN. The Difference between Base Reaction of Static Analysis of Building and Dynamic Analysis of Building is 25%.

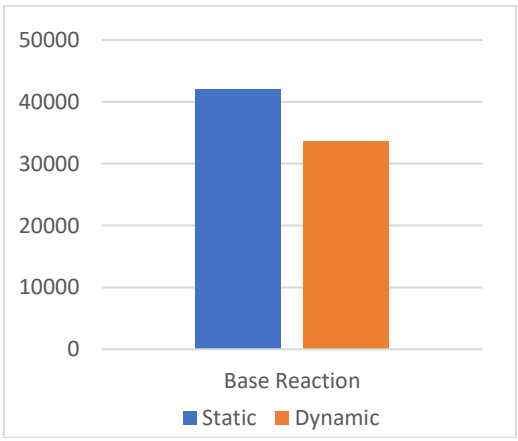


**Chart 2 :- Base Reaction (Fz)**

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### 3. Max Bending Moment

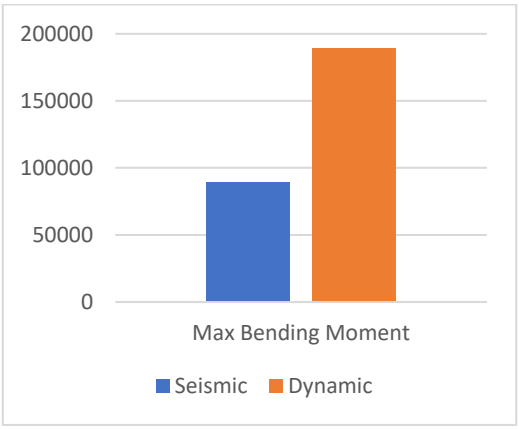


**Chart 3 :- Max Bending Moment**

The above given Chart 3 shows the Max Bending Moment of the Building. The Max bending Moment of the Static Analysis Building is 89022.371 kN-m and that of the Dynamic Analysis Building is 189409.33 kN-m. This is due to that equivalent lateral force on the Structure are applied to have the effect of ground shaking during earthquake. Thus, 12% of difference in Bending Moment is obtained on the members with Seismic Load Considerations.

### 4. Max Axial Force

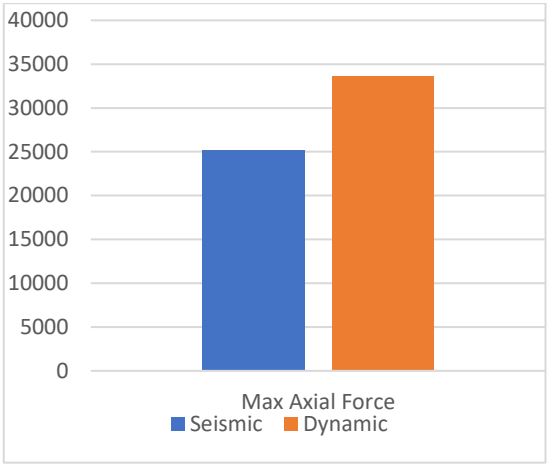


**Chart 4 :- Max Axial Force**

The Chart 4 given below shows the Max Axial Force on Columns for Static Analysis as well as for Dynamic Analysis of Building. The Dynamic Analysis Axial Force is higher than Static Analysis Axial Force because of vibration in vertical direction due to Earthquake Loads. The Difference of Axial force between Static and Dynamic analysis is of 33%.

### 5. Max Shear Force

The above given Chart 5 shows the Max Shear Force in Static and Dynamic Analysis of Building. In the same way shear force obtained on the member with Dynamic Load has 45% additional than with the Static Load.

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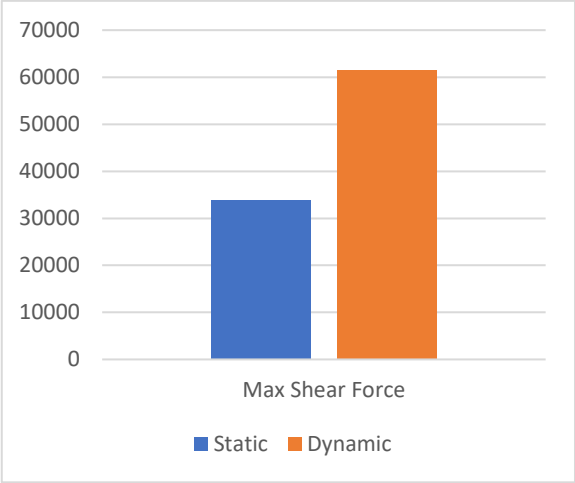


**Chart 5 :- Max Shear Force**

## VI. CONCLUSION

The objective of the paper is to study and evaluate the behavior of buildings under seismic and non-seismic conditions with practical application of conditions. The Analysis is conducted and the conclusions are drawn below.

1. The Storey Displacement of the building at different Storey of the building in Static and Dynamic loading of the Building are given. The difference between the displacement of Static and Dynamic Analysis is very high, for the Top Storey the difference in displacement is 2676%.
2. The Difference between Base Reaction of Static Analysis of Building and Dynamic Analysis of Building is 25%.
3. The Max bending Moment of the Static analysis building and Dynamic analysis building which gives the difference of 12% in on the members.
4. The Max Axial Force on Columns for Static Analysis as well as for Dynamic Analysis of Building are given, The Dynamic Analysis Axial Force is higher than Static Analysis Axial Force because of vibration in vertical direction due to Earthquake Loads. The Difference of Axial force between Static and Dynamic analysis is of 33%.
5. The Max Shear Force in Static and Dynamic Analysis of Building is given. In the same way shear force obtained on the member with Dynamic Load has difference of 81% with the Static Analysis.
6. Due to technological development and availability of computer aided software Dynamic Analysis can be done easily and the same is recommended to analyse Multi-storey building to archive effective and economical design.

Thus, the analysis results were compared and it was concluded that the bending moment, shear force, axial force and displacement values were drastically higher in the seismic analysis. To restrain the additional seismic loads of the structure, relevant design method is to be adapted like using seismic design strategies and devices in the construction

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