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Behaviour of Irregular Reinforced Cement Concrete Building Frame during Earthquake

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Abstract: ***India have already faced so many calamities due to earthquake and is more susceptible to calamities caused by an earthquake. In this paper, dynamic behaviour of structure during an earthquake has been studied. During an earthquake, ground motion occurs in a random fashion both horizontally and vertically, in all directions radiating from the epicentre. The ground accelerations cause structures to vibrate and induce inertial forces on them. Hence structures in such locations need to be suitably designed and detailed to ensure stability, strength and serviceability with acceptable levels of safety under seismic effects***

Keywords: Earthquake, Buildings, Irregular, Storey, Structure

1. Introduction

To perform well in an earthquake, a building should possess four main attributes, namely simple and regular configuration, adequate lateral strength, stiffness and ductility. Buildings having simple regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation, suffer much less damage than buildings with irregular configurations. During an earthquake, failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are termed as Irregular structures. Irregular structures contribute a large portion of urban infrastructure. Irregularities are one of the major reasons of failures of structures during earthquakes. For example structures with soft storey were the most notable structures which collapsed. So, the effect of irregularities in the seismic performance of structures becomes really important. Height-wise changes in stiffness and mass render the dynamic characteristics of these buildings different from the regular building.

The magnitude of the forces induced in a structure due to given ground acceleration or given intensity of earthquake will depend amongst other things on the mass of the structure, the material, and type of construction, the damping, ductility , and energy dissipation capacity of the structure. By enhancing ductility, and energy dissipation capacity in the structure, the induced seismic forces can be resisted and a more economical structure can be obtained or alternatively, the probability of collapse reduced.

Figure 1: Soft storey building

2. Regular and Irregular Buildings

To perform well in an earth quake a building should possess four main attributes namely simple and regular configuration and adequate lateral Strength, stiffness and ductility. Buildings having simple regular geometry and uniformly distributed mass and stiffness in plan as well as elevation, suffer much less damage than buildings with irregular configuration. A building shall be considered as irregular for

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the purposes of this standard, if at least one of the conditions are applicable as per IS 1893(part1):2002

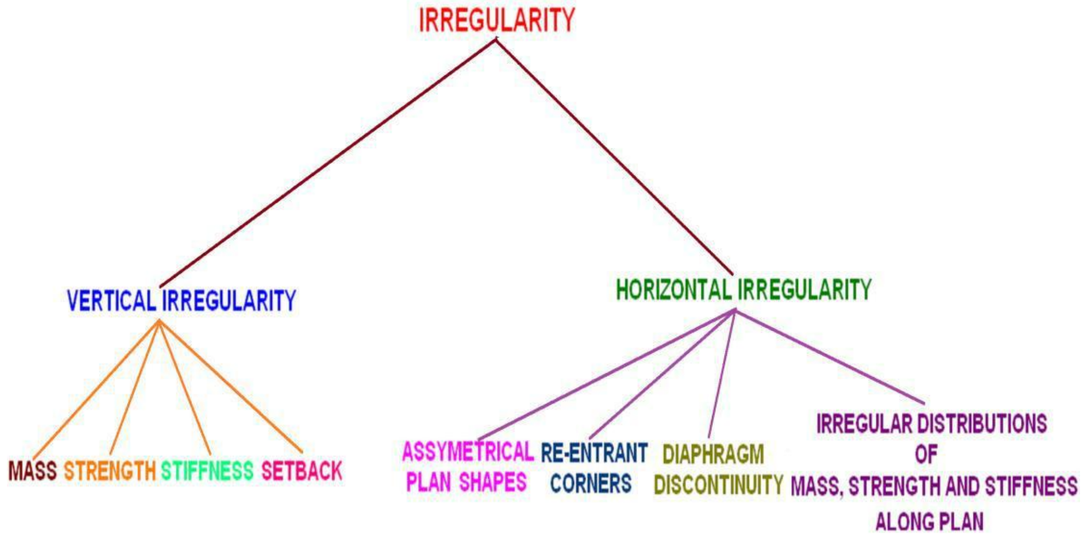

Figure 2: Classification of Structural irregularity

3. Behaviour of Irregular Building during an Earthquake

The seismic response of the building systems shows a large dependence on the type of analysis method adopted. In past years, the analysis methods were confined to linear static approach due to its simplicity. Although these methods yielded safe design; but were observed to be over conservative. The development of sophisticated computers and analysis programs enabled the researchers to move forward towards a more rational approach by stimulating the actual earthquakes on the building models to obtain the realistic seismic response.

Structural analysis is mainly concerned with finding out the behaviour of a structure when subjected to static and dynamic action. This action can be in the form of load due to the weight of things such as people, furniture, wind, snow, etc. or some other kind of excitation such as an earthquake, shaking of the ground due to a blast nearby, etc. In essence all these loads are dynamic including the self weight of the structure because at some point in time these loads were not there. The distinction is made between the dynamic and the static analysis on the basis of whether the applied action has enough acceleration in comparison to the structure's natural frequency. If a load is applied sufficiently slowly, the inertia forces (Newton's second law of motion) can be ignored and the analysis can be simplified as static analysis. Structural dynamics, therefore, is a type of structural analysis which covers the behaviour of structures subjected to dynamic (actions having high acceleration) loading.

In this paper a (G + Stilt + 9 story) multi-storied Reinforced Cement Concrete frame building having Plan Dimension 18.79m x 26.10m & 32.45 m height (In which Basement & Stilt is used for parking purpose) proposed to be constructed in Meerut (U.P.) under Group Housing Scheme is selected for structural analysis.

Therefore, this papers aims towards Linear Static, Linear Dynamic & Nonlinear dynamic analysis of selected building having original symmetrical plan about Z-axis & unsymmetrical plan about Z-axis (created for study purpose) by using STAAD Pro V8i. (Re-entrant Corner: L_z – 26.10 m ; A_{z1} – 6.57 m ; A_{z2} – 4.39 m ; $A_{z1}/L_z = 0.25 > 0.15$)

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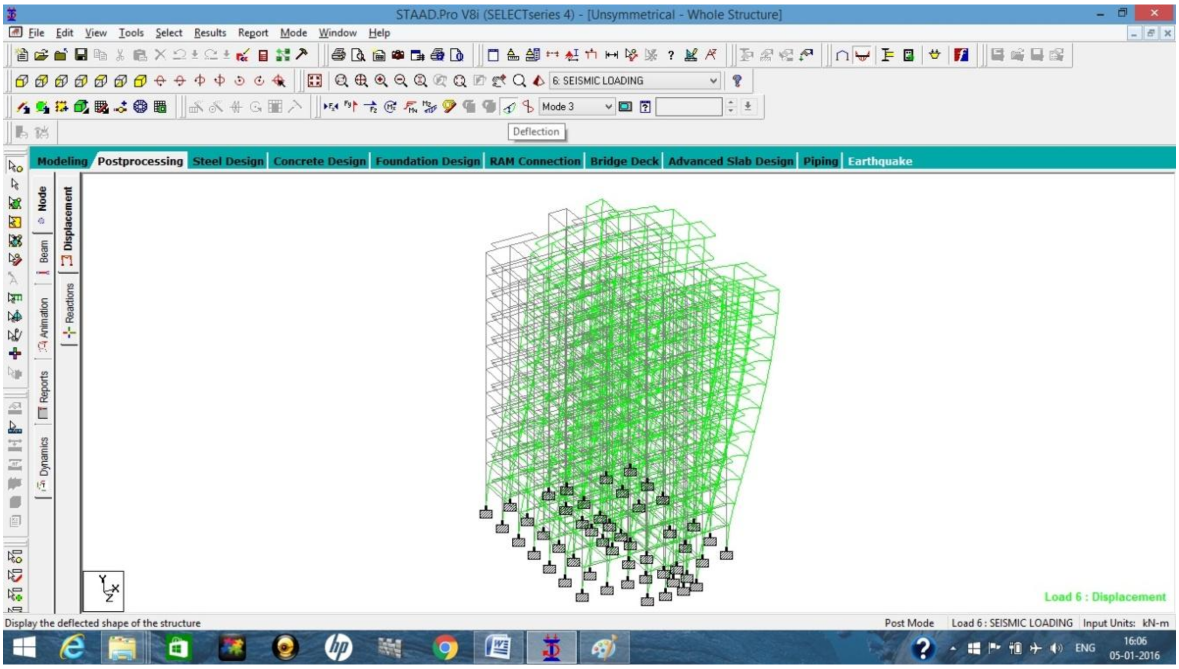

Figure 3: Deflection

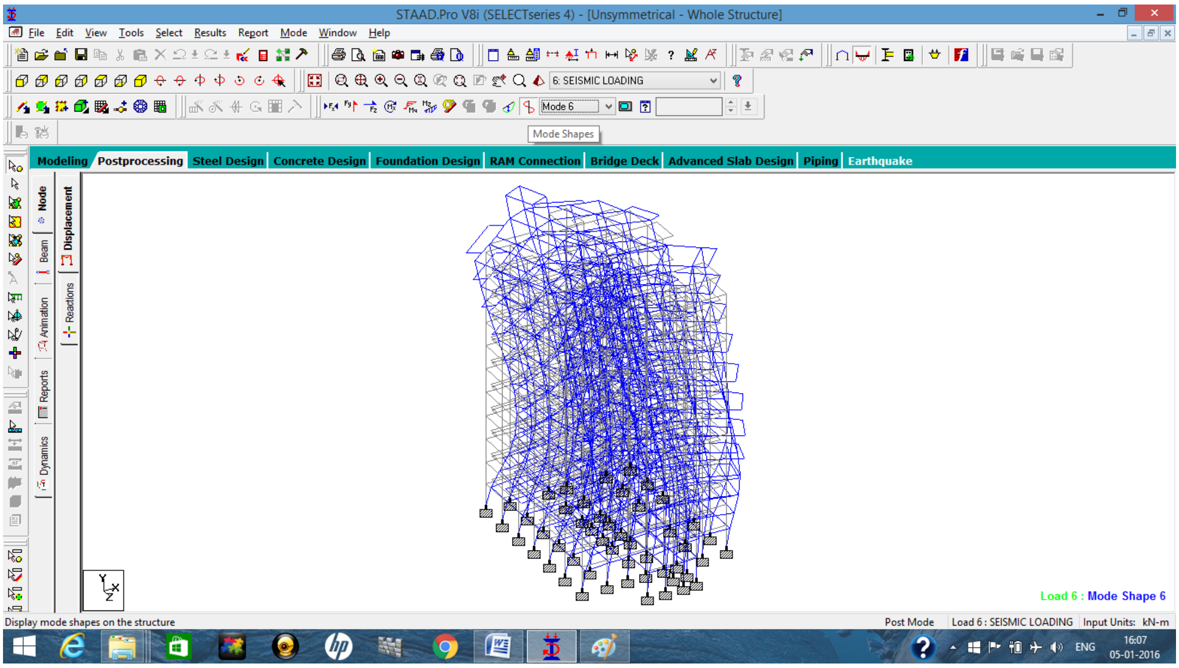

Figure 4: Mode Shape

4. Sesmic Analysis

It is a major tool in earthquake engineering which is used to understand the response of buildings due to seismic excitations in a simpler manner. In the past the buildings were designed just for gravity loads and seismic analysis is a recent development. It is a part of structural analysis and a part of structural design where earthquake is prevalent.

4.1 Loads On Structures Considered

- Static
- Dynamic

4.1.1 Dead Loads

All permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights. the unit weights of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24 kN/m” and 25 kN/m” respectively.

4.1.2 Imposed Loads

Imposed load is produced by the intended use or occupancy of a building including the weight of movable partitions, distributed and concentrated loads, load due to impact and vibration and dust loads. Imposed loads do not include loads

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due to wind, seismic activity, snow, and loads imposed due to temperature changes to which the structure will be subjected to, creep and shrinkage of the structure, the differential settlements to which the structure may undergo.

4.1.3 Seismic Load

Design Lateral Force

The design lateral force shall first be computed for the building as a whole. This design lateral force shall then be distributed to the various floor levels. The overall design seismic force thus obtained at each floor level shall then be distributed to individual lateral load resisting elements depending on the floor diaphragm action.

Design Seismic Base Shear

The total design lateral force or design seismic base shear (V_b) along any principal direction shall be determined by the following expression:

$$\mathbf{V_b = A_h\, W}$$

Where,
A_h = horizontal acceleration spectrum
W = seismic weight of all the floors

Fundamental Natural Period

The approximate fundamental natural period of vibration (T,), in seconds, of a moment-resisting frame building without brick in the panels may be estimated by the empirical expression:

$Ta=0.075\, h^{0.75}$ for RC frame building
$Ta=0.085\, h^{0.75}$ for steel frame building
Where,
h = Height of building, in m.

This excludes the basement storey, where basement walls are connected with the ground floor deck or fitted between the building columns. But it includes the basement storeys, when they are not so connected. The approximate fundamental natural period of vibration (T,), in seconds, of all other buildings, including moment-resisting frame buildings with brick lintel panels, may be estimated by the empirical Expression:

$$\mathbf{T=.09H/\sqrt{D}}$$

Where,
H= Height of building
D= Base dimension of the building at the plinth level, in m, along the considered direction of the lateral force.

Distribution of Design Force

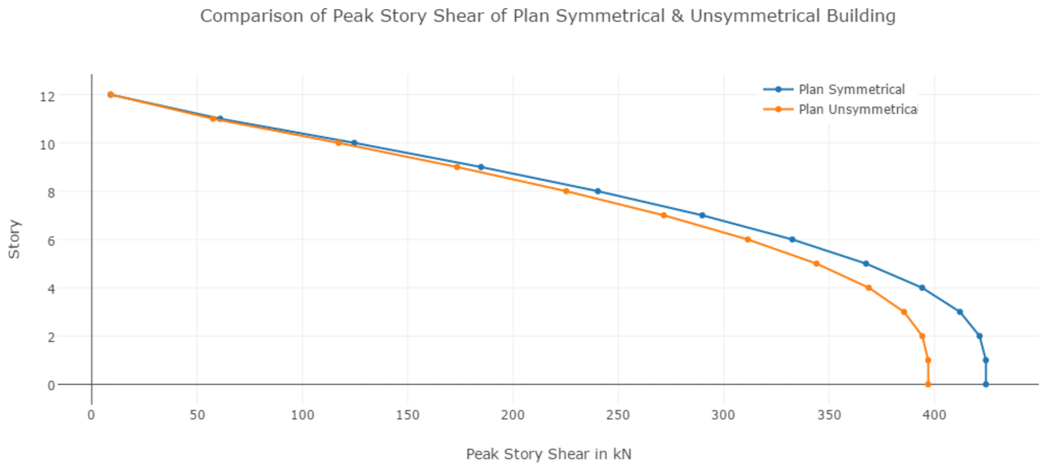
Vertical Distribution of Base Shear to Different Floor Level

The design base shear (V) shall be distributed along the height of the building as per the following expression:

$$Q_i = V_B \frac{W_i h_i^2}{\sum_{j=1}^{n} W_j h_j^2}$$

Where,
Qi=Design lateral force at floor i,
Wi=Seismic weight of floor i,
hi=Height of floor i measured from base, and
n=Number of storey's in the building is the number of levels at which the masses are located

5. Comparison of Peak Storey Shear Forces of Plan Symmetrical and Plan Unsymmetrical



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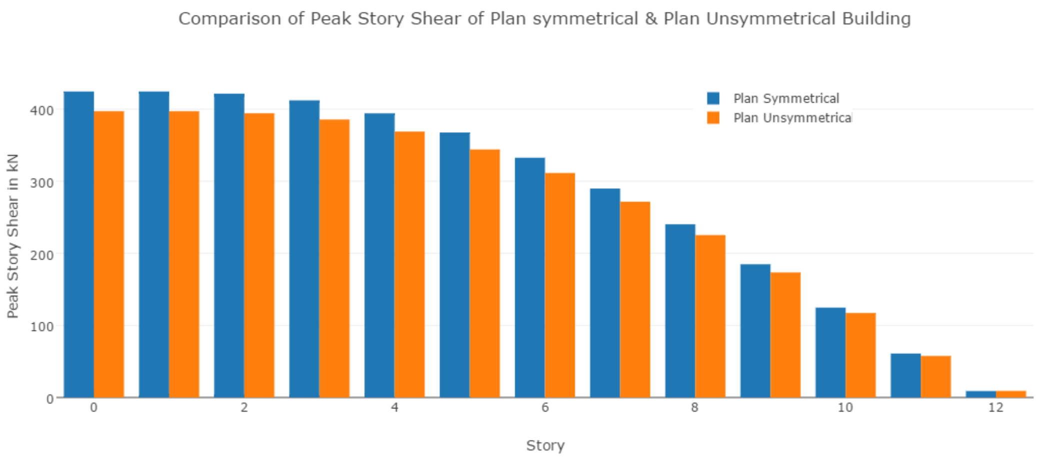

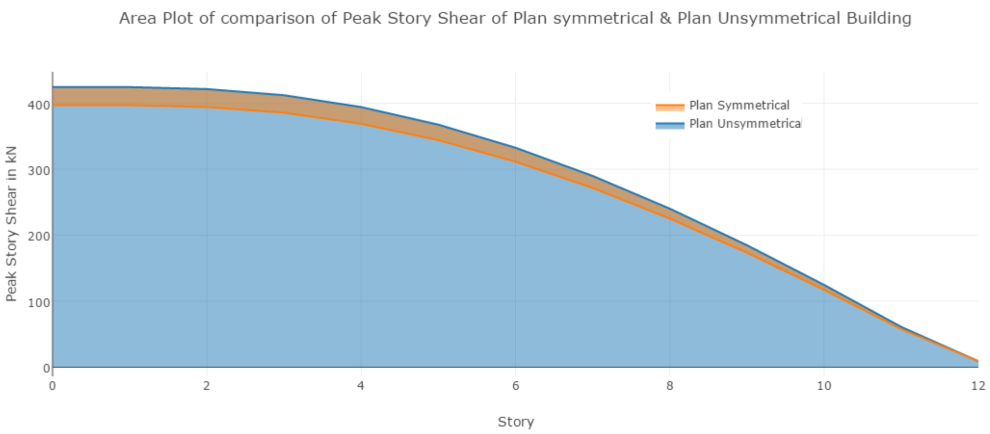

Figure 5: Comparison of Peak storey Shear of plan Symmetrical & Unsymmetrical Building

6. Results and Conclusions

Outcomes of analysis are:

1) Base shear of plan symmetrical building is more than plan Unsymmetrical Building.
2) Peak Storey Shear of top storey of plan unsymmetrical building is more than Plan symmetrical building.
3) The first mode, spectral acceleration of plan symmetrical building is more than plan Unsymmetrical Building.
4) The first mode, Design Seismic Coefficient of Plan symmetrical building, related to the motion in x direction is more than Plan Unsymmetrical Building.
5) Mass participation Factor for first mode in z- direction of Plan symmetrical building is more than Plan Unsymmetrical Building.
6) Generalized Modal Weight of building is found to more in case of Response Spectrum Method than Time History Method for first mode.

References

[1] Esteva, L. (1992). ― Nonlinear Seismic response of Soft- First Story Buildings Subjected to Narrow – Band Accelerograms‖, Earthquake Spectra, Vol. 8, pp.373-389.

[2] IS 1893 (Part 1) (2002), "*Criteria for Earthquake Resistant Design of Structures-General Provisions and Buildings*", Bureau of Indian Standards, New Delhi.

[3] IS: 875(Part I) (1987), "*Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures- Part 1 Dead Loads-Unit Weights of Building Material and Stored Materials*", Bureau of Indian Standards, New Delhi.

[4] IS: 875(Part II) (1987), "*Code of Practice for Design Loads(Other Than Earthquake) for Buildings and Structures- Imposed Loads",* ", Bureau of Indian Standards, New Delhi.

[5] Chopra, A.K., and Goel, R.K. (2004), ―Evaluation of modal and FEMA pushover analyses: Vertically _regular' and irregular generic frames‖, Earthquake spectra, Vol.20, No.1, pp. 255 – 271.

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