DIMENSIONAL SEISMIC ANALYSIS OF IRREGULAR REINFORCED CEMENT CONCRETE FRAMED STRUCTURE BY USING STAAD.Pro

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***Abstract*: The project's aim is to evaluate response spectrum (RS) and time history (THA) of vertically irregular RC building frames using IS13920 corresponding to Equivalent static analysis and time historical analysis. Their purpose is to carry on ductility based design. The findings were contrasted with the standard structure for study and design of irregular structures. The research also concerns the evaluation of responses from strong, weak, and medium-frequency earthquakes to structures subjected to time histories. There were three types of irregularities: mass irregularity, rigidity irregularity, and irregularities in vertical geometry. Our observation shows that the shop shear force is maximal in the first floor, and decreases in all cases to a minimum in the top floor. Mass irregular structures were found to be larger than equivalent regular structures.**

The irregular rigidity system has a smaller base shear and has larger interstory drifts. The absolute shifts obtained from historical study of the irregular geometry structure at the respective nodes were higher in the case of normal structures for the higher stories, but slowly as we shifted to lower stories, changes in both structures appeared to converge. Higher rigidity contributes to higher upper-story displacement. In the case of an unusual mass structure, an examination of time history provides slightly higher range for top stories than in normal structures, whereas in the case of lower stories, there are higher increase than in normal stories.

When the historical study of normal and rigid irregular structure was made, it was found that the displacements in the upper stories were not very different but that the absolute displacements were greater in case of softening than in the standard structure when we moved to the lower stories. High natural frequency structures have been found to have highest response during an earthquake of low frequency. It is because the low natural frequency of high-frequency earthquake systems results in vibration that contributes to greater displacements.

If a high-rise (low natural frequency) structure is subject to high-frequency earth shifting, it contributes to minor changes. Likewise, when the high-frequency earth motion underlies a low elevation structure (high natural frequency), it results in bigger movements and when a high-elevation structure is subject to low-frequency earth motion, slight displacements happen.

***Keywords*: Staad.Pro, Seismic Loads, Framed Structure.**

1. Introduction

The structural collapse begins at points of weakness during an earthquake. This vulnerability exists because of mass discontinuity, rigidity, and structural geometry. Such discontinuous structures are referred to as abnormal. Most of our urban infrastructure is supported by dysfunctional structures. One of the main reasons for structural failures in earthquakes is vertical irregularity. For example, soft-story structures were the most remarkable collapsing structures. The effect of vertical irregularities is therefore very important in the seismic performance of structures. High variations in rigidity and mass differentiate these buildings from their normal buildings for their dynamic properties.

IS 1893 definition of Vertically Irregular structures?

Regardless of the irregularity of the building structures, their density, strength and rigidity can be irregular in their weights. The study and construction of these buildings become more difficult when they are built in high-seismic areas.

There are two types of irregularities-

1. Plan Irregularities
2. Vertical Irregularities.

Vertical Irregularities are on the whole of five types-

i) a) **Stiffness Irregularity** — Soft Storey-A soft storey has less than 70% of the lateral rigidity above or under 80% of the total lateral rigidity over the top of the three racks.

b) **Stiffness Irregularity** — Extreme Soft Storey- The exceptionally soft surface is one in which lateral rigidity is not more than 60% or less than 70% of the average rigidity of the top three floors.

ii) **Mass Irregularity**- There would be considered mass anomalies when the seismic weight of any storey reaches 200% of the adjacent surface. Irregularity must not be taken into consideration in the case of roofs.

iii) **Vertical Geometric Irregularity-** A structure is considered to be Vertical geometric irregular the seismic weight of any storey exceeds 200% of the neighboring surface will be known as mass anomalies. In the case of roofs, anomalies should not be taken into account.
iv) **In-Plane Discontinuity in Vertical Elements Resisting Lateral Force**- An in-plan offset of the lateral force which resists elements larger than their length.
v) **Discontinuity in Capacity** — Weak Storey- A low floor has less than 80 percent of the lateral power in the storey above.
In accordance with IS 1893, a linear static structural analysis of a standard, restricted height structures can be employed since lateral forces are measured in this phase according to the specific structural time period based on codes. This research enhanced the effects on the higher vibrational modes and the actual distribution of forces across the range, thereby enhancing the linear dynamic analysis over the linear static analysis. Built induced earthquakes are optimized for structures, however, the forces actually operating on the structure are much greater than DBE. Thus, in higher seismic areas, a definition of Ductility based architecture is favored because structural ductility decreases the distance. The primary purpose of the development of an earthquake-resistant device is for the building to be ductile enough to cope with the earthquake forces it is exposed to during an earthquake.

2. Objectives:

- The structural side forces of normal and irregular buildings can be measured using the response spectrum analysis and the effects of various structures comparable.
- For research three structural irregularities, namely mass, rigidity and irregularities in vertical geometry.
- For the study of time history and comparing results the reactions of buildings subject to different types of land movements, namely low , medium and high frequency ground movement, are measured.
- Conduct an earthquake-resistant ductility-based design as per IS 13920, consistent with comparable static analysis and study of time history and comparing design variations.

3. Scope of the Study:

- Only RC buildings are considered.
- Also vertical anomalies have been investigated.
- The structures were the subject of linear elastic analysis.
- As fixed to the base, the column was constructed.
- The contribution of the infill wall to rigidity was not taken into account. Infill wall loading was considered.
- The relation between the soil structure is overlooked.

4. Research Methodology:

- A study by different scholars of current literature.
- Selection of structure forms.
- Modeling the structures selected.
- Complex analysis and evaluation of test findings on selected building models.
- Buildings are constructed according to the results of the study.

5. Analysis Methods:

Seismic analyzes are a crucial method to understand buildings' response to seismic excitations more easily in earthquake engineering. In the past the structures have only been built for gravity and recent research is seismic engineering. This is part of the structural study of the earthquake and is part of the structural architecture.
Earthquake analysis approaches are special. Many of the programs included are:
I. Equivalent Static Analysis
II. Response Spectrum Analysis
III. Time History Analysis

Equivalent Static Analysis:
The corresponding static analysis is primarily an elastic technique of architecture. However, it is simple to implement than the multi-model response approach, because the absolute simplification assumptions are maybe more compatible with other absolute assumptions elsewhere in the design process.

The following steps are used in the analogous static analysis procedure:
- Estimate the building's first mode response time from the spectrum design response.
- Using the basic design response range to assess the conformity with the presumed postelastic (dutility) response level of the lateral basis shear of the entire structure.
- Distribute the base shear among the different lumped mass rates normally centered on a triangular inverted shear distribution of 90% of the base shear with 10% of the base shear being applied at the highest level to permit higher mode effects

Response Spectrum Analysis:
This approach helps a building to take into account multiple modes of response. For all but extremely simple or very complex structures, this is necessary in many building codes. The structural response can be described as a combination of many different modes. To evaluate these modes for a system, computer analysis can be used. In each mode, the design spectrum corresponds to the modal frequency and the modal mass and is then combined to approximate the total structure response. The scale of forces is measured in all directions and then results are observed on the structure. The mixture methods are as follows**:**

- Absolute - peak values are added together
- Square root of the sum of the squares (SRSS)
- Complete quadratic combination (CQC) - a method that is an improvement on SRSS for closely spaced modes.

Time History Analysis:

Techniques of time historical analysis include the step-by - step solutions in the time domain of the movement multidegree equations, which constitute the actual buildings answer. This is a structural engineer's most sophisticated method of analysis. The solution is to explicitly work with the earthquake motion chosen for a specific building as an input parameter. This research approach is generally restricted rather than to testing the suitability of hypotheses taken during the design of important structures.
The following steps in the study of time history are:

- Modal matrix estimation
- Active vector intensity estimation
- Obtaining of a standard coordinate displacement response
- Receiving the physical coordinate displacement response
- Efficient earthquake response forces measurement at each level.
- Maximum reaction estimate

Three different kinds of ground motions, namely low(Imperial), intermediate(IS code) and high frequency(India), were compare to the results. In this sense the results of an irregular structure were compared. The last thing is the nature and evaluation of irregular structures in accordance with IS 13920 relating to the related static analysis and time history analysis

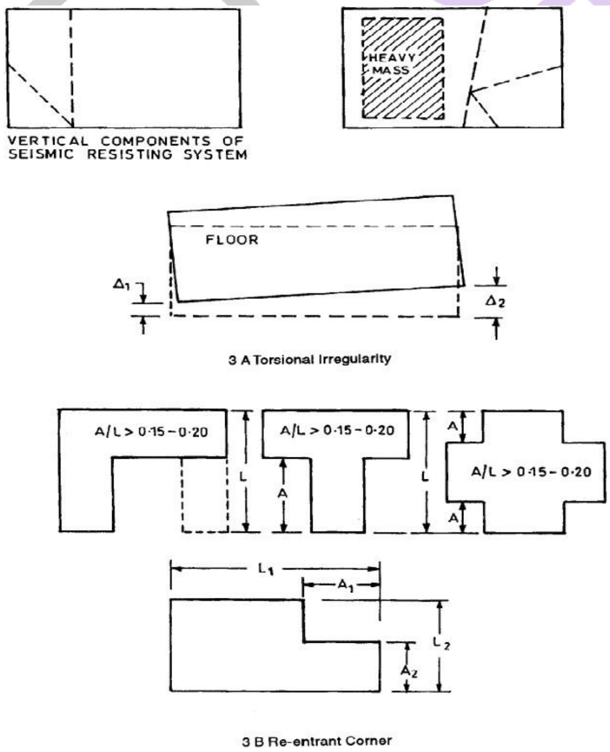
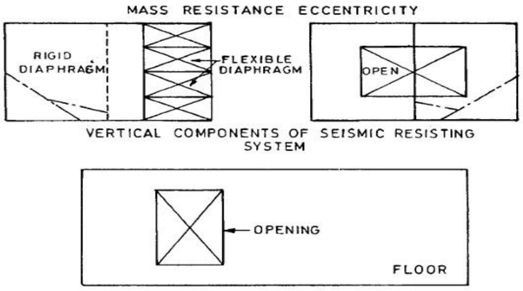
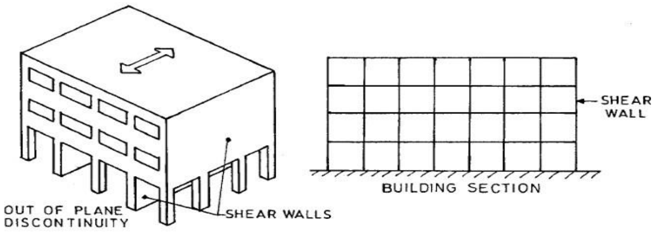


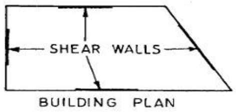
Figure 1: Irregular Structures



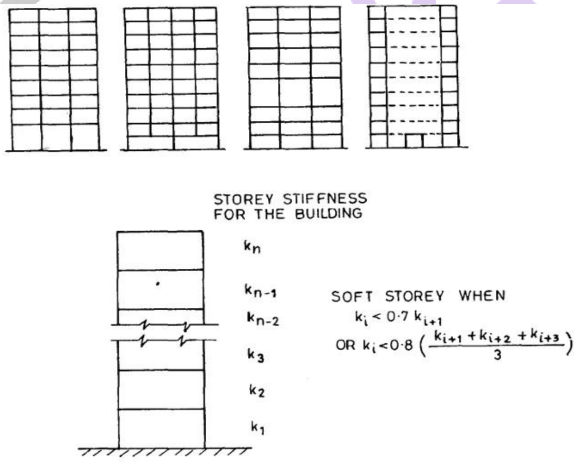
3 C Diaphragm Discontinuity



3 D Out-of-Plane Offsets



3 E Non-Parallel System



4 A Stiffness Irregularity

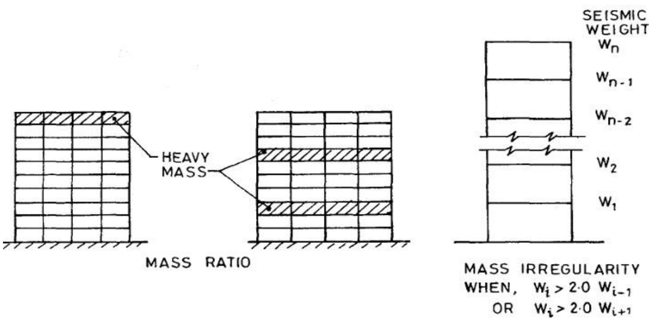
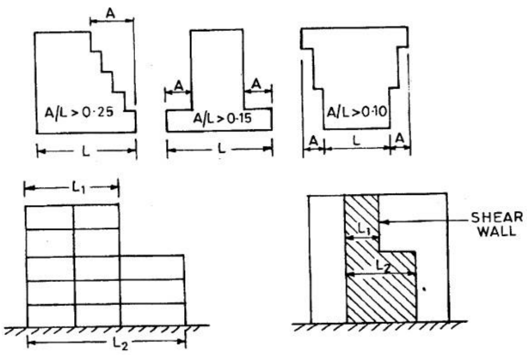
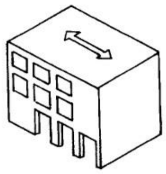
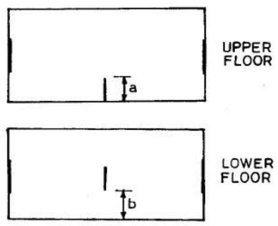


Figure 2: Vertical Irregularity

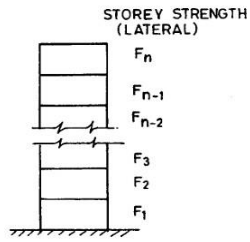


4 C Vertical Geometric Irregularity when $L_2 > 1.5\ L_1$





In-Plane Discontinuity in Vertical Elements Resisting Lateral Force when $b > a$



4 E Weak Storey when $F_i < 0.8\ F_i + 1$

5. Methodology:

Response Analysis of the structure was carried out using Staad-Pro in regular and separate irregular buildings. The shear forces for each floor were determined and each structure was drawn on a diagram.

Live Load	3kN/m^2
Density of RCC considered:	25kN/m^3
Thickness of slab	150mm
Depth of beam	400mm
Width of beam	350mm
Dimension of column	400x400mm
Density of infill	20kN/m^3
Thickness of outside wall	20mm
Thickness of inner partition wall	15mm
Height of each floor	3.5m
Earthquake Zone	IV
Importance factor	1
Type of Soil	Rocky
Type of structure	Special Moment Resisting Frame
Response reduction Factor	5

Four styles of Irregular structures, Regular building structure, irregular mass structure, ground floor structure and irregular vertically rectangular building were considered. There were 10 of the first three systems.

1. **Regular structure (10 storeys):**

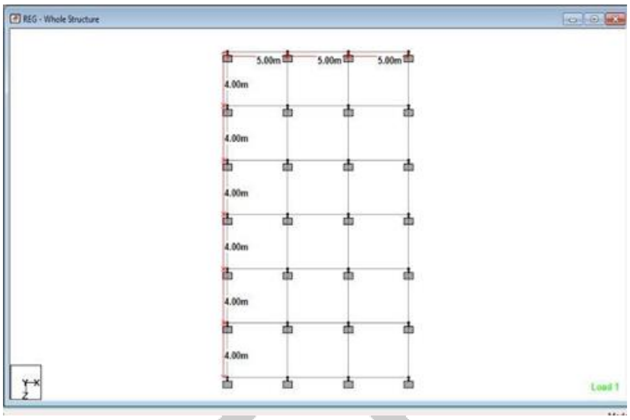


Figure 3: Standard construction plan (10 floors)

2. **Mass Irregular Structure (10 storeys):**

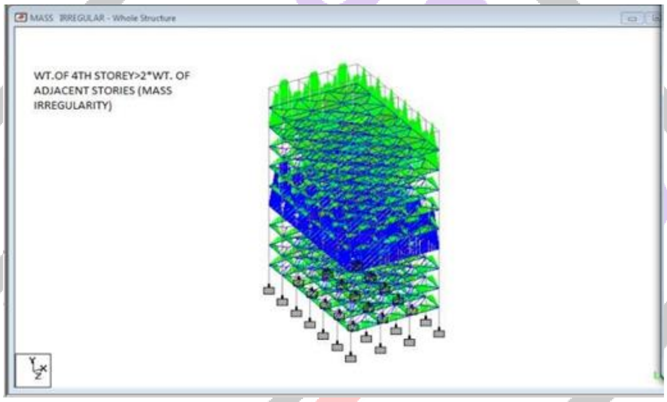


Figure 4: Mass standard building 3D view (10 floors) with 4th and 8th floor swimming pools

3. **Stiffness Irregular Structure (Soft Storey):**
4.

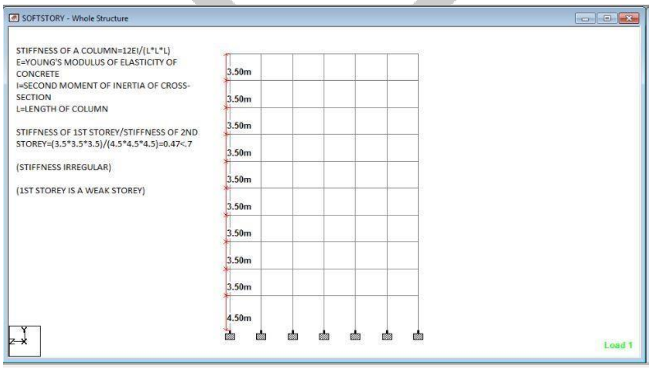


Figure 5: Irregular rigidity (10 stories) Structure

5. Vertically Geometric Irregular

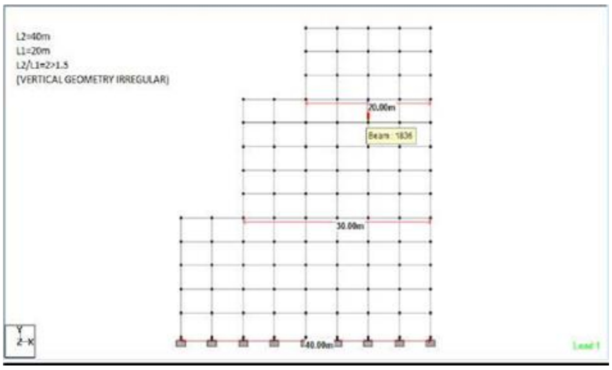


Figure 6: Vertical Geometric irregular structure (14 storeys)

CONCLUSIONS

Three different types of irregularities, namely mass irregularities and irregularities of stiffness and vertical geometry, were considered. For any type of irregularity, Response spectrum analysis (RSA) was performed and the shear strength obtained was compared with that of a normal structure. Three types of ground movement were considered with different frequency contents, i.e. low frequency (imperial), intermediate frequency (IS code), high rate (India). For each irregularity form that corresponds to the above ground movements, time history analyzes (THA) were carried out and nodal displacements were compared. The abovementioned irregular frames were finally constructed using the IS 13920, which corresponds to Static Analysis Equivalent (ESA) and the Analyzes of Time History (THA), and the results compared. We may summarize our findings as follows.

- T he shelving force for the first floor was found to be maximal and decreased in all cases to a minimum in the top floor, based on RSA tests.
- T he mass irregular building frames were found to have a higher base shears than equivalent normal structural frames, as per the results of the RSA.
- The abnormal stiffness of the building has less baseline shear and greater inter-store drifts, according to results of the RSM.
- The absolute displacements obtained from an study of time history of irregular geometry of construction in the respective nodes were higher than the normal building for upper stories, but slowly the lower story displacements appeared to converge in both constructions. Such a geometry, the upper stories are irregularly formed because of their lower stiffness (due to L form). Higher rigidity contributes to higher upper-story displacement.
- Time history analyzes created marginally higher displacement for the upper stories than for regular buildings in the case of mass irregular structures, while when we step down, the lower stories demonstrated higher displacement than in normal structures.
- The Time history research was carried out on the normal and stiffness of irregular buildings (soft floors), but when we went down to lower stories it was found that the absolute movement in soft floors was higher than the stories of standard buildings.
- The Long history research for both normal and irregular stiffness buildings (soft-story), it was discovered that displacements of upper stories did not vary significantly from one another. In the case of soft stories we moved down into lower stories but, compared to respective stories in standard buildings, absolute displacement was higher.

Tall structures have low natural frequency and have a maximum response in a low frequency earthquake.

REFERENCES

[1] Valmundsson and Nau, 1997, Seismic Response of Building Frames with Vertical Structural Irregularities, Journal of structural engineering, 123:30-41.

[2] Anibal G Costa, Carlos S. Oliviera, Ricardo T Duartze,1998, Influence of Vertical Irregularities on Response of Buildings

[3] Lee Han Seon ,Dong Woo Kee, 2007, Seismic response characteristics of high-rise RC wall buildings having different irregularities in lower stories, Engineering Structures 29 (2007):3149–3167

[4] Sadjadi R, Kianoush M.R. , Talebi S , 2007, Seismic performance of reinforced concrete moment resisting frames, Engineering Structures 29 (2007):2365–2380

[5] Athanassiadou C.J, 2008, Seismic performance of R/C plane frames irregular in elevation, Engineering Structures 30 (2008):1250–1261

[6] Karavallis, Bazeos and Beskos, 2008, Estimation of seismic inelastic deformation demands in plane steel MRF with vertical mass irregularities, Engineering Structures 30 (2008) 3265–3275

[7] Sarkar P, Prasad A Meher, Menon Devdas, 2010, Vertical geometric irregularity in stepped building frames, Engineering Structures 32 (2010) 2175–2182

[8] Poonam, Kumar Anil and Gupta Ashok K, 2012, Study of Response of Structural Irregular Building Frames to Seismic Excitations, International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD), ISSN 2249-6866 Vol.2, Issue 2 (2012) 25-31

[9] Ravikumar C M, Babu Narayan K S, Sujith B V, Venkat Reddy D, 2012, Effect of Irregular Configurations on Seismic Vulnerability of RC Buildings, Architecture Research 2012, 2(3): 20-26 DOI: 10.5923/j.arch.20120203.01

[10] Haijuan Duana, Mary Beth D. Hueste, 2012, Seismic performance of a reinforced concrete frame building in China, Engineering Structures 41 (2012):77–89

[11] Shahrooz Bahrain M. and Moehle Jack P., Seismic Response And Design of Setback Buildings- Journal of Structural Engineering, Vol. 116, No. 5, May, 1990 1423-1439