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Ductility Based Seismic Analysis of Irregular RCC Framed Structure by Using STAAD Pro

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ABSTRACT: This paper is concerned with the effects of various vertical irregularities on the seismic response of a structure. The objective of the project is to carry out Response spectrum analysis (RSA) and Time history Analysis (THA) of vertically irregular RC building frames and to carry out the ductility based design using IS 13920 corresponding to Equivalent static analysis and Time history analysis. Comparison of the results of analysis and design of irregular structures with regular structure was done. The scope of the project also includes the evaluation of response of structures subjected to high, low and intermediate frequency content earthquakes using Time history analysis. Three types of irregularities namely mass irregularity, stiffness irregularity and vertical geometry irregularity were considered. According to our observation, the storey shear force was found to be maximum for the first storey and it decreases to minimum in the top storey in all cases. The mass irregular structures were observed to experience larger base shear than similar regular structures. The stiffness irregular structure experienced lesser base shear and has larger inter-storey drifts. The absolute displacements obtained from time history analysis of geometry irregular structure at respective nodes were found to be greater than that in case of regular structure for upper stories but gradually as we moved to lower stories displacements in both structures tended to converge. Lower stiffness results in higher displacements of upper stories. In case of a mass irregular structure, time history analysis gives slightly higher displacement for upper stories than that in regular structures whereas as we move down lower stories show higher displacements as compared to that in regular structures. When time history analysis was done for regular as well as stiffness irregular structure, it was found that displacements of upper stories did not vary much from each other but as we moved down to lower stories the absolute displacement in case of soft storey were higher compared to respective stories in regular structure. Tall structures were found to have low natural frequency hence their response was found to be maximum in a low frequency earthquake. It is because low natural frequency of tall structures subjected to low frequency earthquake leads to resonance resulting in larger displacements. If a high rise structure (low natural frequency) is subjected to high frequency ground motion then it results in small displacements. Similarly, if a low rise structure (high natural frequency) is subjected to high frequency ground motion it results in larger displacements whereas small displacements occur when the high rise structure is subjected to low frequency ground motion.

KEYWORDS: Dynamic analysis (Response Spectrum Analysis), Static Analysis, Time History Analysis,

I. INTRODUCTION

During an earthquake, failure of structure begins at points of weakness. This weakness emerges because of irregularity in mass, stiffness and geometry of structure. The structures having this discontinuity are named as Irregular structures. Irregular structures contribute a huge part of urban infrastructure. Vertical irregularities are one of the significant reasons of failures of structures during earthquakes. For example, structures with soft story were the most notable structures which collapsed. In this way, the impact of vertically irregularities in the seismic performance of structures turns out to be extremely essential. Height-wise changes in stiffness and mass render the dynamic characteristics of these structures not quite the same as the regular building. IS 1893 definition of Vertically Irregular structures. The irregularity in the building structures may be due to irregular distributions in their mass, strength and stiffness along the height of building. When such buildings are constructed in high seismic zones, the analysis and design become more complicated.

There are two types of irregularities-

- Plan Irregularities
- Vertical Irregularities.

II. RESEARCH PROBLEM

RC framed structures with infill walls are a common form of buildings of more than two stories high in state like Punjab, where the seismicity of the region is considered to be high. Infill walls, however, are treated as non-structural components even though they provide significant improvement in lateral stiffness of the frame structures. This leads to random selection of infill materials. The Indian Seismic Standard (IS 1893: 2016) which is currently being used for the analysis and design of new buildings in Punjab does not make any specific reference to in-fill walls. However, cracks on the infill wall do appear even under mild earthquakes and thus there is a need to know the strength limit of infill material under the action of credible earthquakes. Besides, some buildings are given higher importance factor even though the use of infill material is the same irrespective of how important the structure is. Thus, there is no information on the strength of infill wall for all categories of structures at different performance levels.

Moreover, there are many buildings which were not designed for seismic resistance. Although such buildings would not fulfil the requirements of the modern seismic codes, it is important to address the seismic resistance level of these buildings and to know the future course of action from the disaster management point of view.

III. METHODOLOGY

The steps undertaken in the present study to accomplish the above-mentioned objectives are as follows:

- Review of existing literatures by different researchers
- Selection of types of structures
 - ✓ Regular structure
 - ✓ Mass irregular structure
 - ✓ Vertical irregular structure
 - ✓ Stiffness irregular structure
- Performing dynamic analysis i.e. response spectrum analysis, Static analysis and Time history analysis on selected building models using STAAD.Pro V8i and SAP2000.
- Detailed discussion on the results with the help of graphs and tables considering all the included parameters.

IV. RESPONSE SPECTRUM ANALYSIS

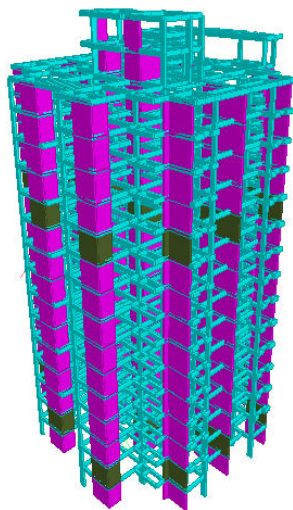
Response Structure analysis was performed on regular and various irregular buildings using STAAD-Pro.

S.No	Description	Load	Code used
	Dead load		
1	Slab = 150mm thickness	3.75 KN/sqm	Is 875 part-1:1987
2	Finishing	2.0 KN/sqm	Is 875 part-1:1987
3	230mm brick wall 3.5 mtr ht.	15 KN/m	Is 875 part-1:1987
4	115mm brick wall 3.5 mtr ht.	7.5 KN/m	Is 875 part-1:1987
5	230mm brick wall 1.0 mtr ht.	4.6 KN/m	Is 875 part-1:1987
6	115mm brick wall 1.0 mtr ht.	3.0 KN/m	Is 875 part-1:1987
7	230mm brick wall 2.0 mtr ht.	11.5 KN/m	Is 875 part-1:1987
	Live load		
8	Corridor	4 KN/sqm	Is 875 part-2:1987
9	Room & washroom	3 KN/sqm	Is 875 part-2:1987
10	Terrace	2 KN/sqm	Is 875 part-2:1987
11	Zone-2	.10	Is 1893:part-1
12	Zone-3	.16	Is 1893:part-1
13	Zone-4	.24	Is 1893:part-1

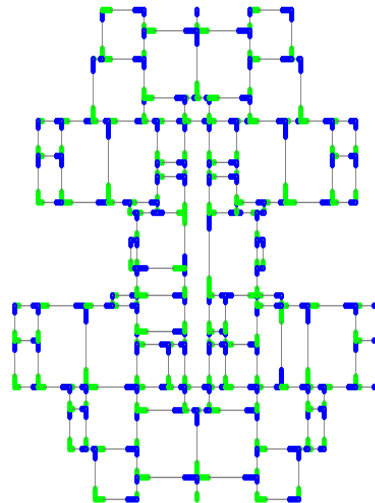
14	Zone-5	.36	Is1893:part-1
15	Importance factor	1	
16	Response reduction factor	1.5 smrf	
17	Damping	5 %	
18	Soil type	2	
19	Swimming pool	No	
20	Seismic parameter		Is1893:2016

STRUCTURALMODELLING:

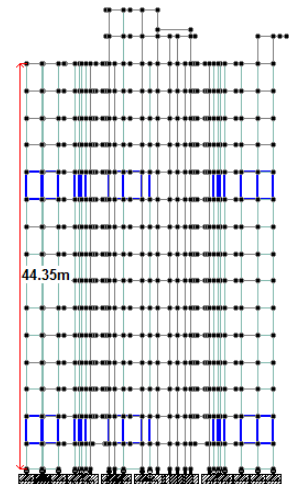
SPECIFICATIONS: Four types of RCC buildings were considered, Regular structure, Mass irregular structure, structure with ground storey as the soft storey and vertically geometric irregular building.

Regular structure (13 floor+mummt+ machine room):

a) 3D VIEW REGULAR
STRUCTURE (13STOREYS)



b) STRUCTURAL LAYOUT
PLAN REGULAR STRUCTURE
(13STOREYS)



c) FRONT VIEW OF
REGULAR STRUCTURE
(13 STOREYS)

Mass Irregular Structure(basement +7 Floors+Mummt+Swimming pool): The structure is modeled as same as that of regular Structure except the loading due to swimming pool is providing in the seventh floor & Terrace Floor. Swimming pool size-1: 4800x3000x1200mm (sixth floor) .Swimming pool size-2: 22750x5110x1200mm (terrace floor)

Stiffness Irregular Structure (9 floors+Mummt): The structure is same as that of regular structure but the ground storey has a height of 4.5 m and doesn't has brickinfill. Stiffness of each column= $12EI/L^3$ Therefore, Stiffness of ground floor/stiffness of other floors= $(3.5/4.5)^3 = 0.47 < 0.7$ Hence as per IS 1893 part 1 the structure is stiffness irregular.

Vertically Geometric Irregular (basement +7 Floors+Mummt+ machine room) - The structure is with steps in the setback is along Direction. Width of top story= 20m Width of ground story=40 $40/20=2 > 1.5$ Hence, as per IS 1893, Part 1 the structure is vertically geometric irregular structure.

V. CONCLUSION

We Three types of irregularities namely mass irregularity, stiffness irregularity and vertical geometry irregularity were considered. All three kinds of irregular RC building frames had plan symmetry. Response spectrum analysis (RSA) was conducted for each type of irregularity and the storey shear forces obtained were compared with that of a regular structure. Three types of ground motion with varying frequency content, i.e., low (imperial), intermediate (IS code), high (San Francisco) frequency was considered. Time history analysis (THA) was conducted for each type of irregularity corresponding to the above-mentioned ground motions and nodal displacements were compared. Finally, design of above-mentioned irregular building frames was carried out using IS 13920 corresponding to Equivalent static analysis (ESA) and Time history analysis (THA) and the results were compared. Our results can be summarized as follows-

- ✓ According to results of RSA, the storey shear force was found to be maximum for the first storey and it decreased to a minimum in the top storey in all cases.
- ✓ According to results of RSA, it was found that mass irregular building frames experience larger base shear than similar regular building frames.
- ✓ According to results of RSM, the stiffness irregular building experienced lesser base shear and has larger inter storey drifts.
- ✓ The absolute displacements obtained from time history analysis of geometry irregular building at respective nodes were found to be greater than that in case of regular building for upper stories but gradually as we move to lower stories displacements in both structures tended to converge. This is because in a geometry irregular structure upper stories have lower stiffness (due to L-shape) than the lower stories. Lower stiffness results in higher displacements of upper stories.
- ✓ In case of a mass irregular structure, Time history analysis yielded slightly higher displacement for upper stories than that in regular building, whereas as we move down, lower stories showed higher displacements as compared to that in regular structures.
- ✓ When time history analysis was done for regular as well as stiffness irregular building (soft storey), it was found that displacements of upper stories did not vary much from each other but as we moved down to lower stories the absolute displacement in case of soft storey were higher compared to respective stories in regular building.
- ✓ Tall structures have low natural frequency hence their response was found to be maximum in a low frequency earthquake.

REFERENCES

- [1] Achyutha, H.etal. (1985). "Finite element simulation of the elastic behaviour of infilled frames with openings." Computers & Structures 23(5):685-696.
- [2] Akhil R, Aswathy SKumar, "Seismic analysis of regular and irregular buildings with vertical irregularity using staad.pro", International Research Journal of Engineering and Technology (IRJET), Vol-04, Issue-06, June-2017(6)
- [3] Al-Chaar, G. K. (1998). Non ductile behaviour of reinforced Concrete frames with masonry infill panels subjected to in-plane loading. United States--Illinois, University of Illinois at Chicago.
- [4] Alexander Nicholas (2020). Irregularity Effects of Masonry Infill on Nonlinear Seismic Behaviour of RC Buildings., Volume 2020 | Article ID 408632 | <https://doi.org/10.1155/2020/4086320>
- [5] Amana T, K.M. & Ekramul, H. (2006). "A rationale for determining the natural period of RC building frames having infill." Engineering Structures 28 (4):495-502.
- [6] Ankit Purohit, Lovish Pamecha, "Seismic Analysis of G+12 Multi-storey Building Varying Zone and Soil Type", SSRG International Journal of Civil Engineering (SSRG-IJCE), vol-D4 Issue 6, June 2017(2)
- [7] ATC-40 (1996). Seismic Evaluation and Retrofit of Concrete Buildings. California.
- [8] BG Naresh kumar (2018) Analysis of Vertically Regular and Irregular Buildings Subjected to Seismic Load using Push over Analysis., International Journal of Engineering Research & Technology (IJERT) <http://www.ijert.org> SSN:2278-0181 Vol. 7 Issue 05, May-2018



- [9] Chopra, A.K. (2000). Dynamics of Structures; Theory and application to earthquake Engineering, Prentice Hall.
- [10] Dhanasekar, M. & Page, A.W. (1986). "The Influence of Brick Masonry Infill Properties on the Behaviour of Infilled Frames." Proceedings of the Institution of Civil Engineers: 593-605.
- [11] Dominguez Morales, M. (2000). Fundamental period of vibration for reinforced concrete buildings. Canada, University of Ottawa (Canada).
- [12] Doudoumis, I. N. & Mitsopoulou, E. N. (1995). The deficiency of the macro models with fixed support interface conditions in the analytical modelling of infill panels. Proceedings of the fifth conference on European seismic design practice, Chester.
- IS 13920-Ductility Design
- IS 1893- Calculation of Seismic forces
- IS 456-2000-Design of RC structures



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