Seismic Behaviour of Multistoried Building Due to Different Irregularities

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Abstract— Irregular buildings constitute a large portion of the modern urban infrastructure. Structures are never perfectly regular and hence the designers routinely need to evaluate the likely degree of irregularity and the effect of this irregularity on a structure during an earthquake. Need for research is required to get economical & efficient lateral stiffness system for high seismic prone areas. For optimization & design of high rise building with different structural framing systems subjected to seismic loads. To improve the understanding of the seismic behaviour of building structures with different irregularities.

Keywords: ETAB software, Structural irregularities, Response spectrum method, Earthquake, IS 1893

I. INTRODUCTION

The behaviour of a building during an earthquake depends on several factors such as stiffness, lateral strength, and ductility, simple and regular configurations. The buildings with regular geometry, uniformly distributed mass and stiffness in plan as well as in elevation suffer much less damage compared to irregular configurations. But nowadays thirst and demand of the new generation engineers are planning towards an irregular configuration for better aesthetic perspective. Hence earthquake engineering has developed the key issues in understanding the role of different types of building configurations.

A. Objectives:

1) To calculate the design lateral forces on regular and irregular buildings using response spectrum analysis and to compare the results of different structures.
2) To check the analysis results of ETABS for lateral stability checks as per IS code 1893:2016 provisions for seismic loads.
3) To study irregularities in structures namely mass, stiffness, diaphragm discontinuity, plan and vertical geometry irregularities.
4) To calculate the response of buildings subjected to seismic zone IV using response spectrum and to compare the results.

B. Noteworthy Contribution in the Field of proposed Work

Sanjay Kumar Sadhu and Dr. Umesh Pendharkar concluded Square configuration (horizontal aspect ratio=1) gives better performance and Vertical aspect ratio should be kept less than 4. M Anvesh, Shaikh, Ankesh Sharma and Biswobhanu Bhadra and Pavan Kumar and Shaikh Abdul Aijaj, Abdul Rahman and Girish Deshmukh concluded irregular structure increases lateral displacement. Dileshwar Rana, Prof. Juned Raheem concluded Seismic performance improves with number of bays.

II. PROBLEM STATEMENT

Fifteen storey (G+15) reinforced concrete frame buildings will be analyse with the help of ETAB software by using Response spectrum method. Following properties are considered for buildings.

A. Analysis Property Data

1) Material used was M40 Grade Concrete.
2) Yield stress fy = 500 N/mm2
3) Compressive Cube Strength of Concrete = 25 N/mm^2
4) Poisson's ratio = 0.15
5) Analysis was done using ETABS Software 9.7

B. Building Details

1) Type of frame: Special RC moment resisting frame fixed at the base
2) Number of storey: G+15
3) Ground Floor height: 3m
4) Floor height: 3.0 m
5) Depth of Slab: 120 mm
6) Size of beam: (250 × 800) mm
7) Size of column: (400 × 900) mm
8) Spacing between frames: (i) 6 m in X & Y direction (General), (ii) 30 m × 24 m in X & Y direction
9) Live load on floor: 2 kN/m^2
10) Floor finish: 1.0 kN/m^2
11) Thickness of wall: 230 mm
12) Density of concrete: 25 kN/m^3
13) Density of masonry wall: 19 kN/m^3
14) Depth of foundation from ground level = 1.5 m

C. Seismic Data

1) Type of soil: Medium
2) Seismic zone: IV
3) Importance factor: 1.2
4) Reduction factor: 5
5) Response spectra: As per IS 1893(Part-1):2016
6) Damping of structure: 5 percent

D. Load combinations as per IS 1893:2016 (part 1)

For the analysis following load combinations specified by the IS 1893: 2016 are used. The basic load combinations given by the code as per clause 6.3.4.1 are as follows

- 1.5 x [DL-Self Weight]
- 1.5 x [DL + LL]
- 1.2 x [DL + LL + EQX]
- 1.2 x [DL + LL - EQX]
- 1.2 x [DL + LL + EQX-]
- 1.2 x [DL + LL – EQX-]
- 1.2 x [DL + LL + EQY]
- 1.2 x [DL + LL - EQY]
- 1.2 x [DL + LL + EQY-]
- 1.2 x [DL + LL – EQY-]

- 1.5 x [DL + EQX]
- 1.5 x [DL - EQX]
- 1.5 x [DL + EQX-]
- 1.5 x [DL - EQX-]
- 1.5 x [DL + EQY]
- 1.5 x [DL - EQY]
- 1.5 x [DL + EQY-]
- 1.5 x [DL - EQY-]
- 0.9 DL + 1.5 EQX
- 0.9 DL - 1.5 EQX
- 0.9 DL + 1.5 EQX-
- 0.9 DL - 1.5 EQX-
- 0.9 DL + 1.5 EQY
- 0.9 DL - 1.5 EQY
- 0.9 DL + 1.5 EQY
- 0.9 DL - 1.5 EQY

III. MODELING

The main aim of the model is to study the change in building responses (mainly deflection and storey drift) due to various irregularities as peer IS 1893:2002 and IS 1893:2016. The building is analysed in 6 stages as follows,

A. Regular Structure:

It is simple structure and is configured as per the problem statement. All the loads and details are same as mentioned conforming to IS 1893. It is a simple structure analyzed for earthquake resistant conforming to the Indian design standard codes.

B. Structure with Plan Irregularity:

It is the modification over the first model. Plan irregularity is introduced by removing size 18m x 12 m from middle side of plan as per the Indian Standard code specifications.

C. Structure with Vertical Irregularity:

It is the modification over the first model. Vertical irregularity is introduced by removing five stories after every each span from half of total plan dimensions as per the Indian Standard code specifications.

D. Structure with Stiffness Irregularity:

It is the modification over the first model. Stiffness irregularity is introduced by removing beams at seventh and thirteenth slab level as per the Indian Standard code specifications.

E. Structure with Mass Irregularity:

It is the modification over the first model. Mass irregularity is introduced by adding extra 5kN/m² load at ninth and fifteenth slab level as per the Indian Standard code specifications.

F. Structure with Weak Storey:

It is the modification over the first model. Weak storey irregularity is introduced by removing four columns at ground storey in each row as per the Indian Standard code specifications.

IV. CONCLUSION

The project discusses the performance evaluation of RC (Reinforced Concrete) Buildings with irregularity. Structural irregularities are important factors which decrease the seismic performance of the structures. The study as a whole makes an effort to evaluate the effect of irregularity on RC buildings, in terms of dynamic characteristics and the influencing parameters which can regulate the effect on Story Displacement, Drifts of adjacent stories, Excessive Torsion, Base Shear, etc. The overall performance of regular building should be better than irregular building.

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REFERENCES

[1] IS: 1893-(part-1)-2016 "Code of practice for criteria for Earthquake resistant design of structures."
[2] IS: 875(part-1)-1987 "Code of practice for Design loads (other than earthquake) for building structures-Dead loads."
[3] IS: 875(part-2)-1987 "Code of practice for Design loads (other than earthquake) for building structures-Imposed loads."
[4] M Anvesh, Shaikh and Pavan Kumar, "Effect of Mass Irregularity on Reinforced Concrete Structure Using Etabs," International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 10, October 2015.
[5] Sanjay Kumar Sadhu and Dr. Umesh Pendharkar, "Effect of Aspect Ratio & Plan Configurations on Seismic Performance of Multi-storeyed Regular R.C.C. Buildings": An Evaluation by Static Analysis. International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 1, January 2016).
[6] Dileshwar Rana, Prof. Juned Raheem, "Seismic Analysis of Regular & Vertical Geometric Irregular RCC Framed Building". International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 02 Issue: 04 | July-2015
[7] Shaikh Abdul Aijaj, Abdul Rahman and Girish Deshmukh, "Seismic Response of Vertically Irregular RC Frame with Stiffness Irregularity at Fourth Floor". International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459,ISO 9001:2008 Certified Journal, Volume 3, Issue 8, August 2013)
[8] Mohammed Yousuf, P.M. Shimpale, "Dynamic Analysis of Reinforced Concrete Building with Plan Irregularities". International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 9, September 2013) .

[9] Prof. Milind and V. Mohod, "Analysis of Structures with Plan Irregularity." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 4 Ver. VII (Jul. - Aug. 2015)

