Australian Journal of Basic and Applied Sciences, 7(13) November 2013, Pages: 1-6

AENSI Journals

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

Effect of Plan Irregular RC Buildings In High Seismic Zone

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ARTICLE INFO

Article history:
Received 12 October 2013
Received in revised form 14 November2013
Accepted 15 November 2013
Available online 20December 2013

Key words:
Seismic behavior, Plan Irregular, Response Spectrum, Re-entrant Corner, High Seismic Zone.

ABSTRACT

Background: Past earthquakes occurrences demonstrate that, buildings with irregularity is prone to earthquake damages. In order it is essential to identify the seismic response of the structure even in low seismic zones to reduce the seismic damages in buildings. **Objective**: The main objective of this study is to understand the behavior of the structure in high seismic zone. In this purpose a five storey-high building on eight different configurations having re-entrant corners with a regular configuration which served as a comparison, initially were investigated. These irregularities are taken as per clause 7.1 of the Indian standard code, IS 1893 (Part I): 2002. The whole models were analysed with the help of ETABS 9.7 version. The current study also considered the accidental torsion in both negative and positive of both X and Y directions. **Results & Conclusion:** The results proved that, building with severe irregularity are more vulnerable than those with less irregularity especially in high seismic zones. And also the eccentricity between the center of mass and the center of resistance has a significant impact on the seismic response of structures even though, in the absence of the dual system.

To Cite This Article: Amin Alavi, P. Srinivasa Rao., Effect of Plan Irregular RC Buildings In High Seismic Zone. ***Aust. J. Basic & Appl. Sci.**, 7(13): 1-6, 2013*

INTRODUCTION

Nowadays, most buildings are portrayed by irregular in both plan and vertical configurations. Irregularities in plan and lack of symmetry may imply significant eccentricity between the building mass and stiffness centers, giving rise to damaging coupled lateral/torsional response (Giordano,Guadagnuolo and Faella, 2008). Furthermore to design and analyse an irregular building a considerably high level of engineering and designer effort are required, whereas a poor designer can design and analyse a simple architectural features. In other words, damages in those with irregular features are more than those with regular one. Therefor, Irregular structures need a more careful structural analysis to reach a suitable behaviour during a devastating earthquake (Herrera, Gonzalez and Soberon, 2008).

Plan and elevation irregularities in Indian code (IS 1893):

The irregularity of the structure may can classify in two types i.e. plan and vertical, these can be characterized to five different types such as torsional, re-entrant corners, diaphragms discontinuity, out of plane offset and non parallel system for plan irregularity as well as vertical irregularity such as stiffness (soft storey), mass, vertical geometric, in plane discontinuity in vertical elements resisting lateral force and discontinuity in capacity (weak storey) (IS 1893(Part I): 2002)

The code, IS 1893 (Part I) : 2002 defined the re-entrant corners irregularity as below.

Re-entrant corner irregularity plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given direction (IS 1893(Part I): 2002).

Additionally, the IS 1893 has mentioned that, when the irregular building has more than 12m high and it is located in a high seismic zones i.e., IV and V should analyse by either time history method or response spectrum (IS 1893(Part I): 2002).

This study develops a nonlinear model for plane moment resisting frames by rigid diaphragms and applies it to a five storey building with eight different plan configurations. A regular plan configuration served as a comparison. The whole models were analysed by ETABS software 9.7. The guidelines and the methodology of the Indian standard of practice IS 1893 (Part I): 2002 is used to analyse the structures.

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Methodology:

Analysis methods are widely characterized as linear and nonlinear static and dynamic. Among them the linear static and dynamic methods are suitable when the structural loads are small (Ravikumar ,Narayan, Sujith and Venkat Reddy, 2012).

The main difference between the equivalent static procedure and dynamic analysis procedure lies in the magnitude and distribution of lateral forces over the height of the buildings. In the dynamic analysis procedure the lateral forces are based on properties of the natural vibration modes of the building, which are determined by the distribution of mass and stiffness over height. In the equivalent lateral force procedure the magnitude of forces is based on an estimation of the fundamental period and on the distribution of forces as given by a simple formula that is appropriate only for regular buildings (Kumar, Naresh and Gornale, 2012).

Equivalent Linear Static Analysis Method:

In the equivalent static analysis method, the response of the building is assumed as linear elastic manner. To calculate equivalent linear static the IS 1893 (Part I): 2002 has given a formula as below.

$$V_B = A_h . W$$

Where

$$A_h = \frac{\mathrm{Z\,I}\,S_a}{2\,R\,g}$$

Where

Z is the zone factor, I is the importance factor, R is the response reduction factor and S_a/g is the average response acceleration coefficient which depends on the nature of foundation soil (rock, medium or soil site), natural period and the damping ratio of the structure (IS 1893(Part I): 2002).

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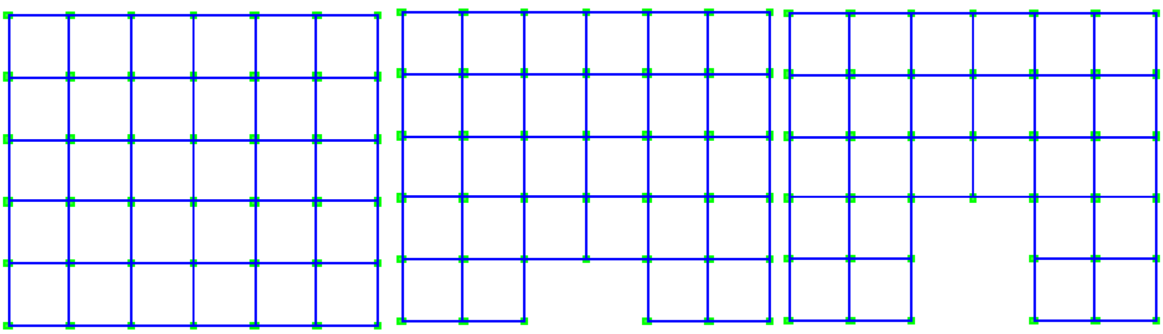
Linear dynamic analysis method (RSM):

The response spectrum method (RSM) was introduced in 1932 in the doctoral dissertation of Maurice Anthony Biot at Coltech. It is an approach to be found earthquake response structures using waves or vibration mode shapes. The concept of the “Response Spectrum” was applied in design requirements in the mid 20th century. It came into widespread use as the primary theoretical tool in earthquake engineering in the 1970s when strong-motion accelerograph data become widely available.

The maximum response of the building is estimated directly from the elastic or inelastic design spectrum characterizing the design earthquake for the site and considering the performance criteria for the building.

The response spectrum method plays an important role in practical analysis of multistory buildings for earthquake motions. It is also helpful to analyse the performance level of the structure.

Building modeling:



Regular Irr $_1$ Irr $_2$

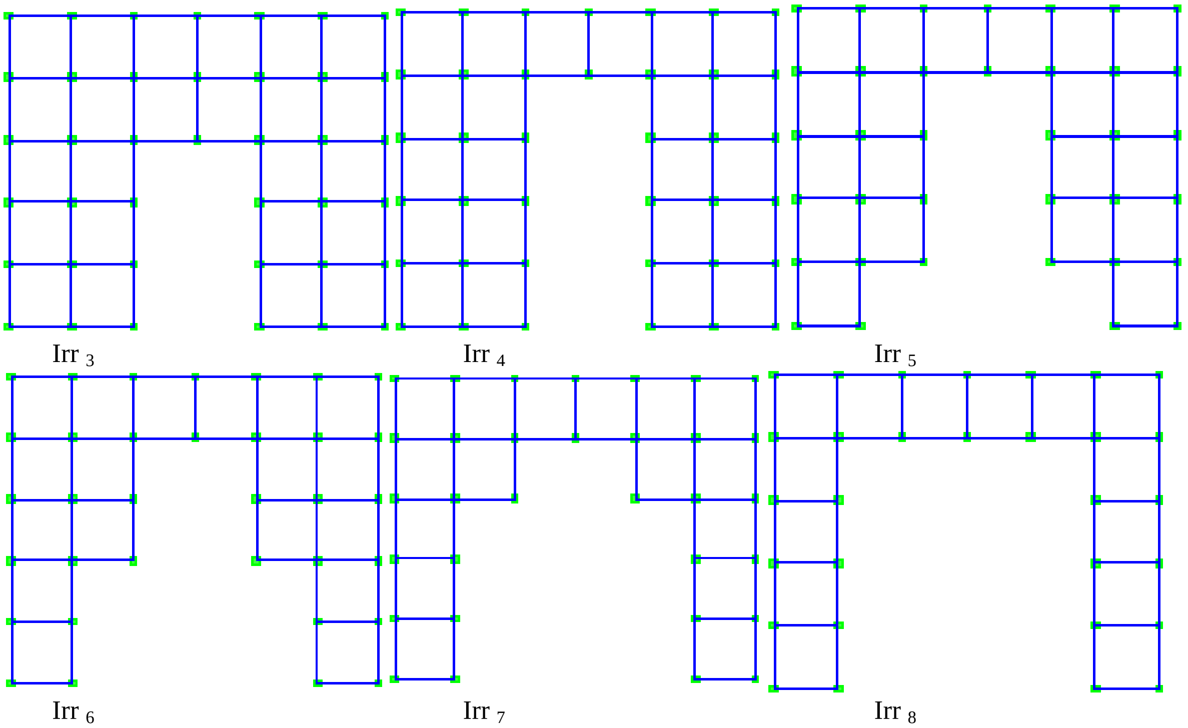


Fig. 1: Illustrative Examples

The plan analysed consists of 6x5 bays of equal length of 4m. Fig.1 shows the illustrative examples.

- The Regular has 5x6 bays of equal length of 4m.
- The Irr 1 has 6.67 % re-entrant corners in U shape.
- The Irr 2 has 13.33 % re-entrant corners in U shape.
- The Irr 3 has 20 % re-entrant corners in U shape.
- The Irr 4 has 26.67 % re-entrant corners in U shape.
- The Irr 5 has 33.33 % re-entrant corners in U shape.
- The Irr 6 has 40 % re-entrant corners in U shape.
- The Irr 7 has 46.67 % re-entrant corners in U shape.
- The Irr 8 has 53.33 % re-entrant corners in U shape.

The models analysed are located in a high seismic zone (V) with a damping ratio of 5% and medium soil. It has 5 storey with the height of 3.2m for each storey. The building assumed as residential.

RESULTS AND DISCUSSION

The fundamental natural periods and vibration modes have been considered to identify the dynamic properties of the building analysed. 0 displays fundamental natural periods and vibration modes. As the figure implies the Indian standard of practice IS 1893 uses a constant empirical formula to calculate the natural period which is thoroughly depends on the height of the building and does not debate the irregularity of the building whiles, the analytical analysis calculates that basis on the center of mass and stiffness of the structures and also the irregularity of the building role plays an important to calculate the natural period of vibration. 0 represents comparison of analytical and codal periods.

0 shows the maximum lateral top storey displacement in X – Y and Z - directions, and 0 consists of the maximum storey drift in both X and Y - directions.

The results showed that the displacements in X - direction is much more than Y - direction from Irr_5 to Irr_8 which means when the building is asymmetric about one direction it produces more displacement about its direction. It can be seen that the Irr_1 and Irr_2 have the similar displacement in both projections, which the structure beyond are less than 15% of its dimensions of the building, which may result in twisting of buildings.

The displacements in Z - direction don't depend on irregularity, in other words, the plan irregularity has no effects on the Z - direction. As the 0 implies the Z - displacements have just slightly different from each other.

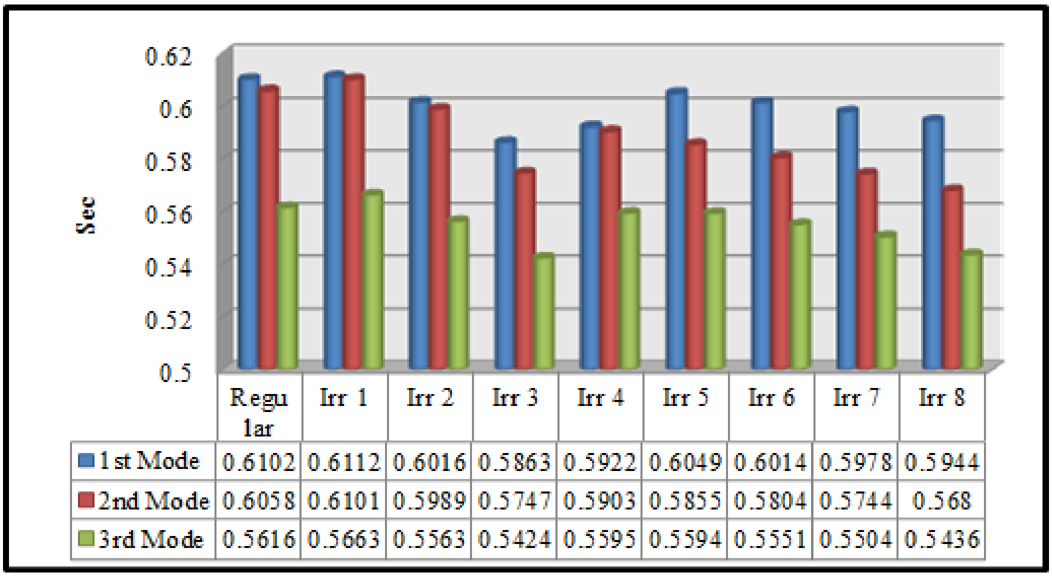


Fig. 2: Comparison of First, Second and Third Mode of Vibrations

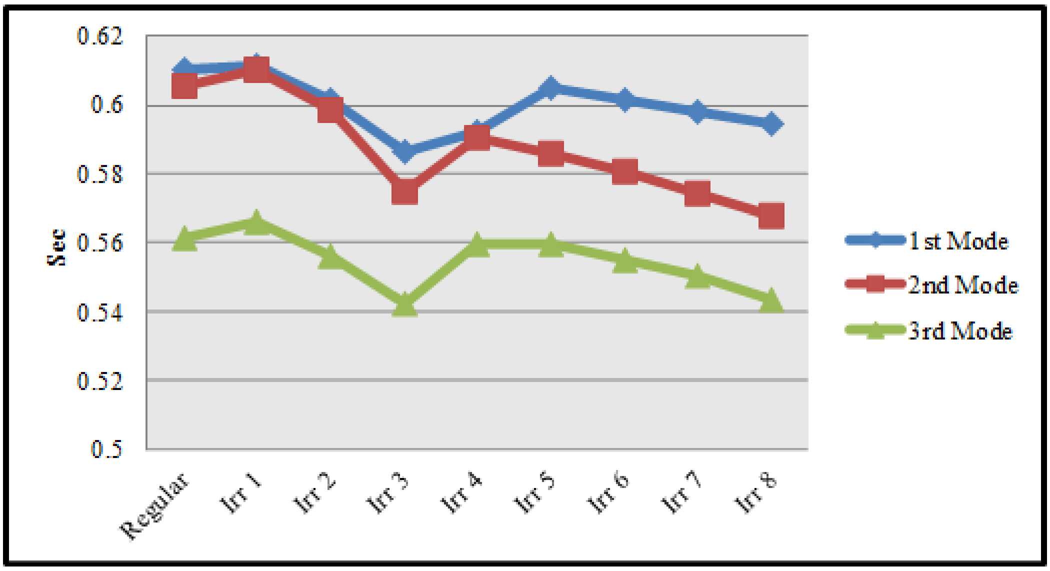


Fig. 3: Fundamental Natural Period

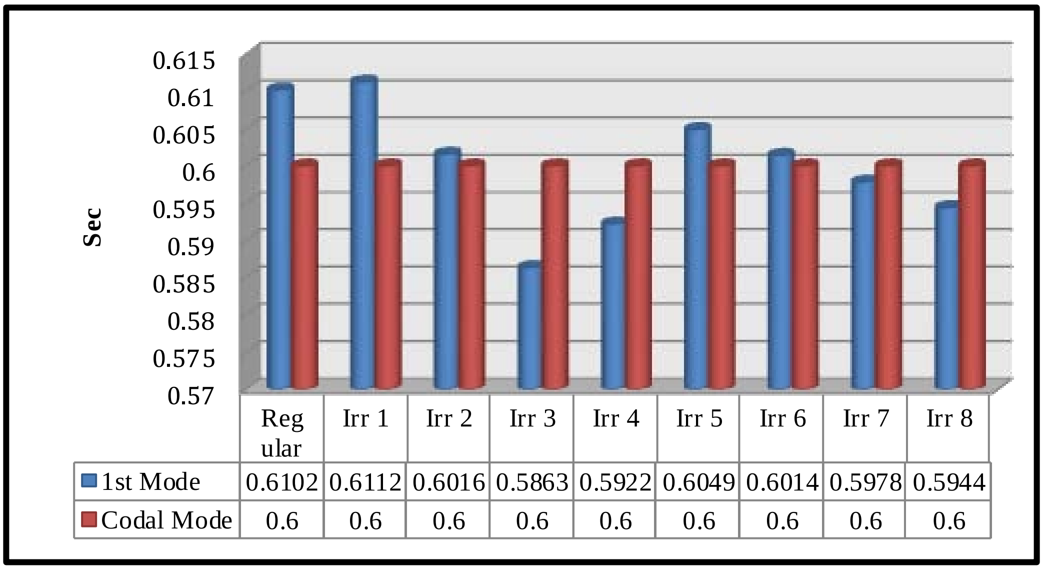
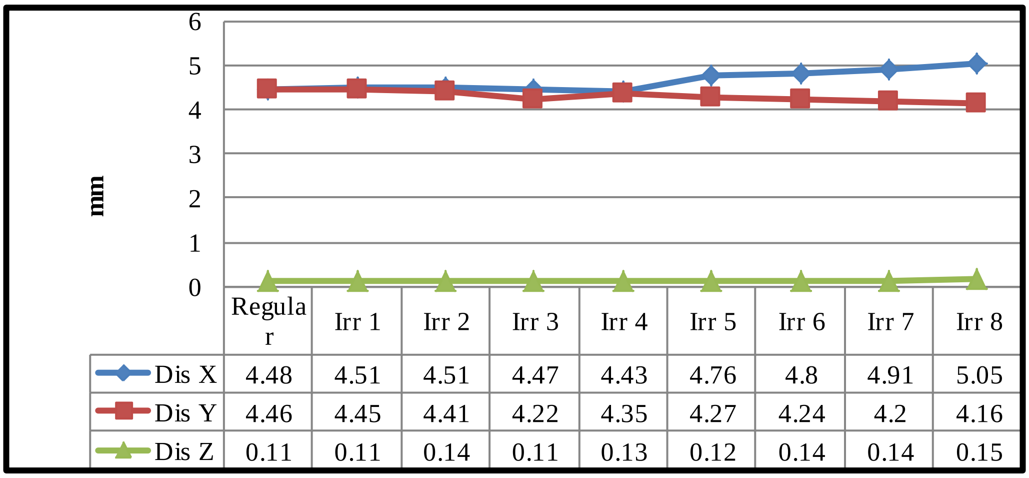


Fig. 4: Comparison of Analytical and Codal Periods



	Regular	Irr 1	Irr 2	Irr 3	Irr 4	Irr 5	Irr 6	Irr 7	Irr 8
Dis X	4.48	4.51	4.51	4.47	4.43	4.76	4.8	4.91	5.05
Dis Y	4.46	4.45	4.41	4.22	4.35	4.27	4.24	4.2	4.16
Dis Z	0.11	0.11	0.14	0.11	0.13	0.12	0.14	0.14	0.15

Fig. 5: Lateral Top Displasment

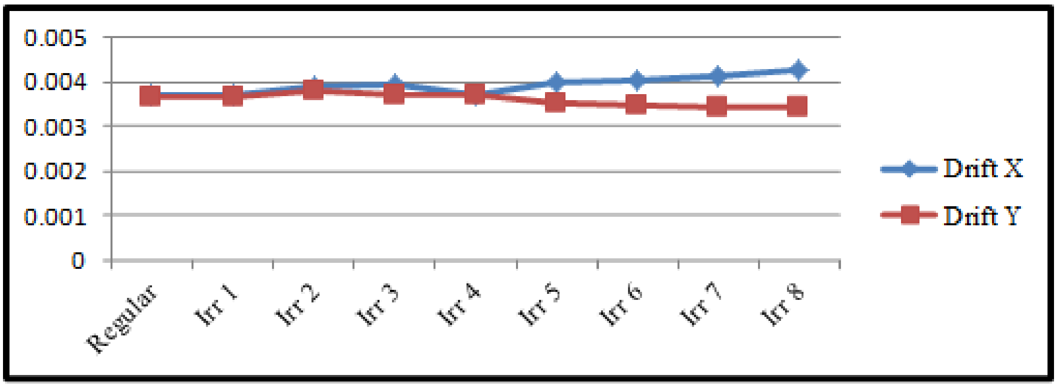


Fig. 6: Storey Drift

Conclusions:

In this work, the re-entrant corner irregularity of plan asymmetric RC building structures about the Y direction of IS 1893 code was considered to obtain the behaviour or the seismic response of RC buildings during a strong ground motion.

- ❖ The results have been proved that, the code, IS 1893 doesn't consider the irregularity of buildings on both the fundamental natural periods and the linear static analysis method which indicates that the IS 1893 code should seriously consider the upgrading of these specified to at least current operational code.
- ❖ The eccentricity between the center of mass and the center of resistance has a significant impact on the seismic response of structures even though, in the absence of the dual system.
- ❖ The maximum lateral top displacement and also the storey drift occurred in the Irr $_8$ which is more irregular than others and the least observed in the regular one.
- ❖ The results also have been proved that, building with severe irregularity are more vulnerable especially in high seismic zones.
- ❖ The elastic analysis underestimates the storey drift especially when the building enters to the nonlinear level.

REFERENCES

Chopra A.K. and E.F. Cruz, 1986. Elastic Earthquake Response of Building. Journal of Structural Engineering, 112(3).

Agrawal, Pankaj and Manish Shrikhande., 2010. Earthquake Resistant Design of Structures: PHL Learning Private Limited, pp: 234-238.

Banginwar, Rucha S., M.R. Vyawahare and P.O. Modani., 2012. Effect of Plans Configurations on the Seismic Behaviour of the Structure by Response Spectrum Method. International Journal of Engineering Research and Applications (IJERA) 2(3): 1439-1443.

Costa, Anibal G., Carlos S. Oliveira and Ricardo T. Duarte., 1988. Influence of Vertical Irregularities on Seismic Response of Buildings. proceedings of ninth world conference on earthquake engineering 5.

Dubey, S.K and Sangamnerkar., 2011. Seismic Behaviour of Assymetric Rc Buildings. international journal of advanced engineering tecknology, 2(4): 296-301.

Australian Journal of Basic and Applied Sciences, 7(13) November 2013, Pages: 1-6

Duggal, S.K., 2011. Earthquake Resistant Design of Structures. sixth ed. new delhi: oxford university press.

FEMA., 2006. Risk Management Series Designing for Earthquakes Fema 454. In PROVIDING PROTECTION TO PEOPLE AND BUILDINGS.

Giordano, A., M. Guadagnuolo and G. Faella, 2008. Pushover Analysis of Plan Irregular Masonry Buildings. In the 14th worl conference on earthquake engineering. Beijing, Chaina, 12-17.

Herrera, Raul Gonzalez and Consuelo Gomez Soberon, 2008. Influence of Plan Irregularity of Buildings." In the 14th worl conference on earthquake engineering. Beijing, Chaina, 12-17.

Jaiswal, Dr. O.R., 2000. Seismic Response of Building Frame with Irregular Profile.

Kumar, B.G. Naresh and Avinash Gornale, 2012. Seismic Performance Evaluation of Torsionally Asymmetric Buildings." International Journal of Science and Engineering Research 3, 6.

Ravikumar, M.C., K.S. Babu Narayan, B.V. Sujith and D. Venkat Reddy, 2012. Effect of Irregular Configurations on Seismic Vulnerability of Rc Buildings. architeture research, 2(3): 20-26.

STANDARDS, BUREAU OF INDIAN, 2002. Cretria for Earthquake Resistant Design of Structures IS 1893(Part 1): 2002. In part 1 general provisions and buildings. New delhi.

STANDARDS, BUREAU OF INDIAN, 2000. Plain and Reinforced Concrete IS 456:2000. BUREAU OF INDIAN STANDARDS.