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Effect of Irregularities on the Capacity and Ductility of Steel Structure by Pushover Analysis

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Abstract - *A structure can be classified as irregular if it contains irregular distributions of mass, stiffness and strength or due to irregular geometrical configurations. The introduction of irregularity in the structure creates complex design and construction problems as irregular structures behave differently from regular structure.*

This section deals with the comparative study which is carried out in order to compare the behavior of the structure with the effect of various irregularities on the capacity and ductility of the structure. In this paper pushover analysis is performed on regular shaped G+4 steel building. The same building is analysed by pushover analysis with consideration of different irregularities such as mass irregularity, vertical geometric irregularity and with inclusion of chevron type brace

Key Words*: *irregularity, mass irregularity, vertical geometric irregularity, capacity spectrum, pushover analysis,

1. INTRODUCTION

India is prone to strong earthquake shaking, and hence earthquake resistant design is essential. Irregular buildings constitute a large portion of the modern urban infrastructure. The group of people involved in constructing the building facilities, including owner, architect, structural engineer, contractor and local authorities, contribute to the overall planning, selection of structural system, and to its configuration. This may lead to building structures with irregular distributions in their mass, stiffness and strength along the height of building. When such buildings are located in a high seismic zone, the structural engineer's role becomes more challenging. Therefore, the structural engineer needs to have a thorough understanding of the seismic response of irregular structures. The revision of IS 1893 (Part 1): 2016, "Criteria for Earthquake Resistant Design of Structures" have been published by Bureau of Indian Standards recently in December 2016. IS 1893 (Part 1): 2016 defines mass and vertical geometric irregularities as follows. Mass Irregularity: cl.7.1, Table -6, as per new code, mass irregularity is considered to exist when the seismic weight of any floor is more than 150 % of that of the floor below. In buildings with mass irregularity and located in seismic zones III, IV and V dynamic analysis shall be performed,

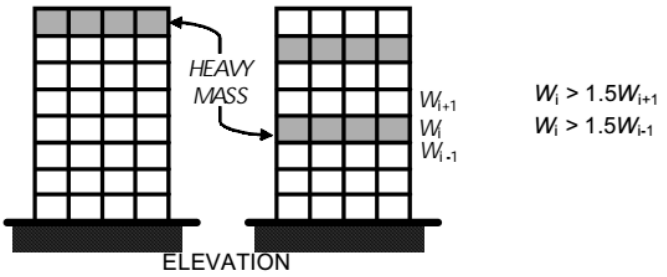

Fig. 1 Definition of Irregular Buildings: Mass Irregularity

Vertical Geometric Irregularity: cl. 7.1 , Table – 6, as per new code, the vertical geometric irregularity shall be considered to exist, when the horizontal dimension of the lateral force resisting system in any story is more than 125 % of the storey below.

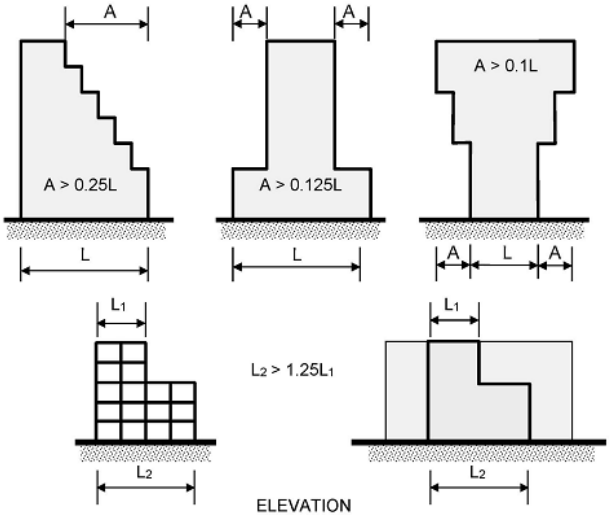

Fig. 2 Definition of Irregular Buildings: Vertical Geometric Irregularity

2. PROBLEM STATEMENT

In current study the behavior of the structure with the effect of various irregularities on the capacity and ductility of the structure analyzed. In this paper pushover analysis is

performed on regular shaped G+4 steel building. The same building is analysed by pushover analysis with consideration of different irregularities such as mass irregularity, vertical geometric irregularity and with inclusion of chevron type brace.

3. METHODOLOGY

To carry out the study Effect of irregularities with following cases are discussed and the results are presented.

i. G + 4 steel building (regular)
ii. G + 4 steel building with consideration of mass irregularity
iii. G + 4 steel building with consideration of vertical geometric irregularity
iv. G + 4 steel building with inclusion of chevron type brace.

Building is modelled in SAP2000 and pushover analysis is performed to determine capacity spectrum.

4. PROBLEM STATEMENT & RESULTS

Case (i) G+4 storey regular steel building

G+4 storey steel building of plan dimensions 10m x 5m is located in Zone III on medium soil is considered for analysis

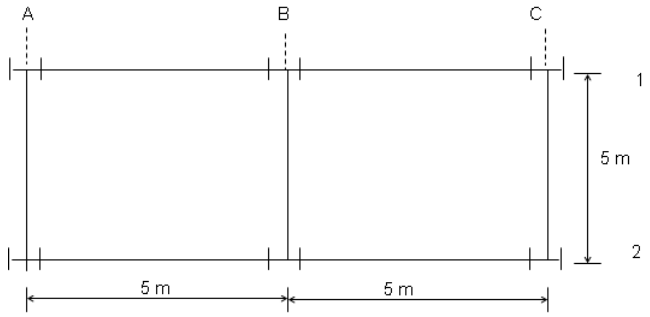

Fig. 3 Plan of Building under Consideration

Data considered:

Thickness of RCC slab = 125 mm,
Live load on roof = 1.5 kN/m2 (Nil for earthquake)
Live load on floors = 2.0 kN/m2,
Floor finish = 1 kN/m2,
Brick wall thickness = 230mm,
Parapet wall height = 1.0 m,
Storey height = 3.0 m

Seismic Data:

Zone III, Zone factor Z' = 0.16,
Importance factor I = 1.5
Response reduction factor R = 5.0,
Soil type = Medium soil

Schedule of Beams and Columns:

Roof Beam RB = ISMB 350,
Floor Beam FB = ISMB 450,
Brace = ISA 65x65x 5, Columns = UC 240
The loading diagrams on the frame are as follows:

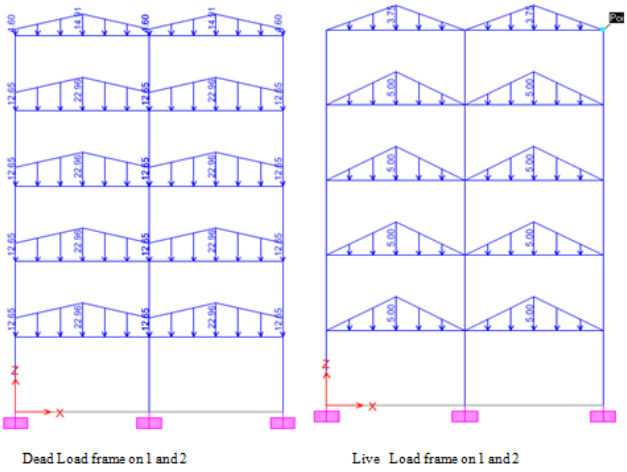

Fig. 4 Dead Load and Live Load on Frame 1 and 2

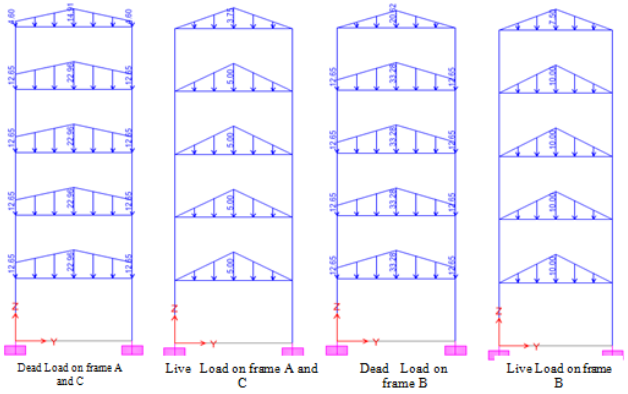

Fig. 5 Dead Load and Live Load on Frame A, B and C

Pushover analysis is performed on G+4 storey regular steel building frame and capacity spectrum is as follows:

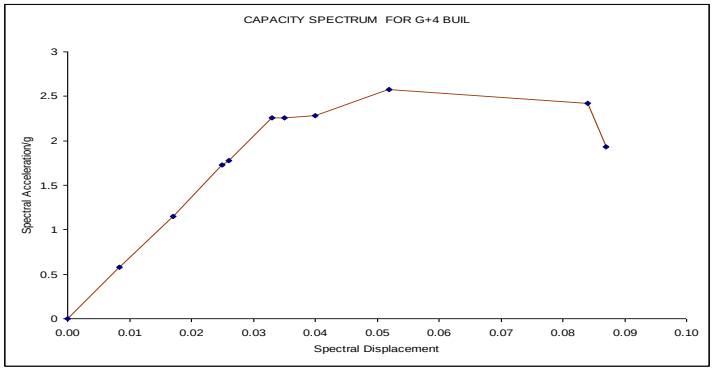

Fig. 6 Capacity Spectrum for G+4 Building

Case (ii) G + 4 steel building with consideration of mass irregularity

Case (i) is considered with consideration of mass irregularity. The data is same as considered in Case (i).

The loading diagrams on the frame are as follows:

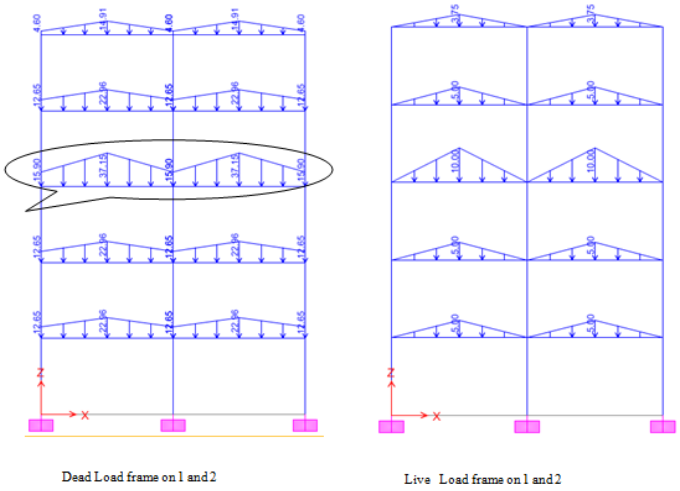

Fig. 7 Dead Load and Live Load on Frame 1 and 2

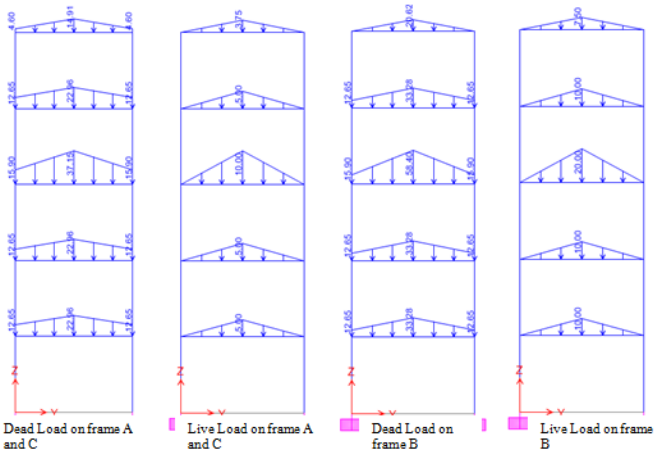

Fig. 8 Dead Load and Live Load on Frame A, B and C

Pushover analysis is performed on G+4 steel building frame with consideration of mass irregularity and capacity spectrum is as follows:

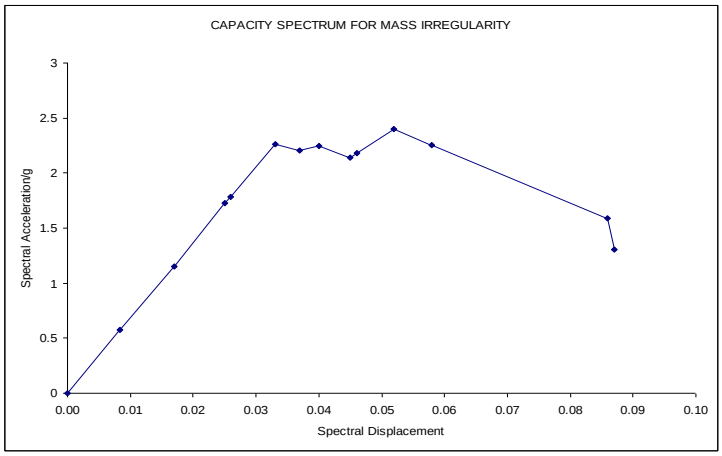

Fig. 9 Capacity Spectrum for Mass Irregularity

Case (iii) G + 4 steel building with consideration of vertical geometric irregularity

Case (i) is considered with consideration of vertical geometric irregularity. The data is same as considered in Case (i).

The loading diagrams on the frame are as follows:

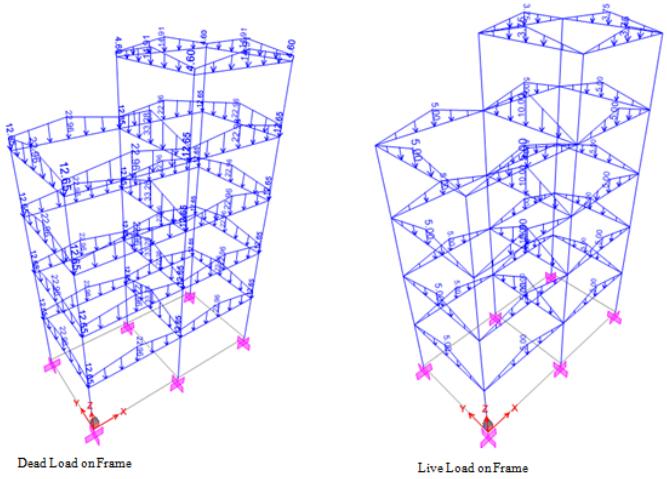

Fig. 10 Dead Load and Live Load on Building under

Consideration for Vertical Geometric Irregularity Pushover analysis is performed on G+4 steel building frame with consideration of vertical geometric irregularity and capacity spectrum is as follows:

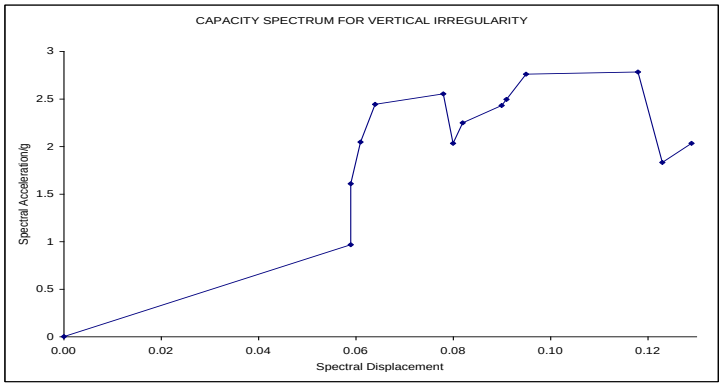

Fig. 11 Capacity Spectrum for Vertical Geometric Irregularity

Case (iv) G + 4 steel building with inclusion of chevron type brace

Case (i) is considered with inclusion of chevron type brace. The data is same as considered in Case (i). The size of brace used is ISA 65 x 65 x 5.Pushover analysis is performed on G+4 steel building frame with inclusion of chevron type brace and capacity spectrum is as follows:

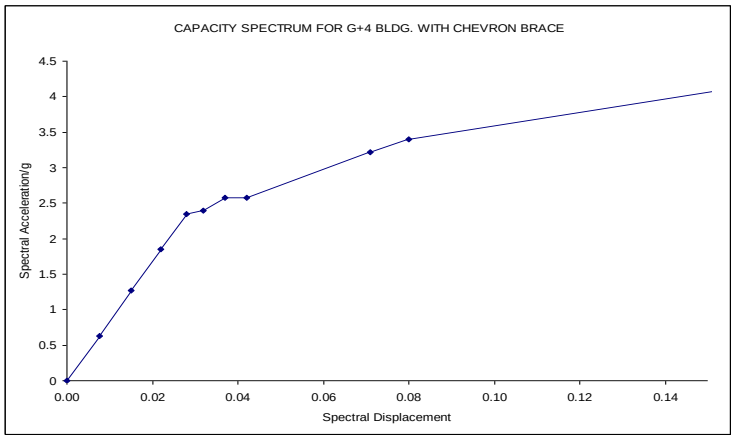

Fig. 12 Capacity Spectrum for Chevron Brace

Capacity spectrums for all cases is as follows:

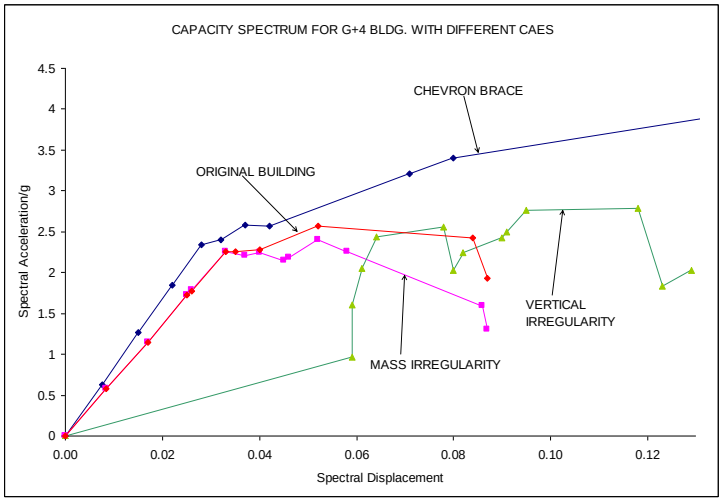

Fig. 13 Capacity Spectrum for G+4 Building with Different Cases

5. CONCLUSIONS

G+4 steel building with all different cases is analyzed and pushover analysis is performed. Capacity spectrum for all different case is plotted. Combined capacity spectrums for all different cases are shown in Fig. 13. From that we can conclude following points.

- It can be observed that the capacity is increased with inclusion of chevron type brace.
- Also capacity spectrum of original G+4 building and building with mass irregularity is nearly same up to yield and then capacity is decreased in case of mass irregularity.
- Capacity spectrum for vertical irregularity does not give satisfactory shape.

REFERENCES

1. IS 1893:2016, “Criteria for Earthquake Resistant Design of Structures” Bureau of Indian Standards, New Delhi

2. ATC, “Seismic Evaluation and Retrofit of Concrete Buildings”, Volume- 1.Applied Technology Council (Report No.40), Redwood City, California (1996)

3. Habibullah A, and Pyle S., “Practical Three Dimensional Nonlinear Static Pushover Analysis”, Structures Magazine, winter (1998)

4. Chopra A.K. and Goel R.K. "A Modal Pushover Analysis Procedure to Estimate Seismic Demands for Buildings", PEER Report 2001/03, University of California Berkeley (2001).

5. Ansari K. Md., Vidhyadhar S. H., 2016, Seismic Analysis Of Multi Storied RC Building Having Vertical Mass Irregularity With And Without Shear Wall, International Research Journal of Engineering and Technology, Volume: 03 Issue: 06, pp-1867-1875

6. Mahesh S., Rao P. B., 2014, Comparison of analysis and design of regular and irregular of multi Story building in various seismic zones and various types of soils using ETABS and STAAD, IOSR Journal of Mechanical and Civil Engineering, Volume 11, Issue 6, pp-45-52

7. Singh R., Singh K. V., 2018, Analysis of Seismic Loads acting on multistory Building as per IS: 1893 -2002 and IS: 1893-2016 :- A comparative Study, Journal of Civil Engineering and Environmental Technology, Volume: 04, Issue: 05, pp-405-408

8. Harsha S. B., Vikranth J., 2014, Study and Comparison of Construction Sequence Analysis With Regular Analysis by Using ETABS, International Journal of Research Sciences and Advanced Engineering, Volume 2, Issue 8, pp-218 – 227.

9. Rakeshkumar Gupta, Prof. D.L.Budhlani,2018, Review of IS 1893:2016 with IS1893:2002 for high rise structure with irregularities, International Journal of Innovations in Engineering and Science, e-ISSN: 2456-3463,Vol. 3, No.7 2018

10. Mayur R. Rethaliya, Bhavik R. Patel , Dr. R. P. Rethaliya,2018, A Comparative Study of Various Clauses of New IS 1893 (Part 1):2016 and Old IS 1893 (Part 1):2002, International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887, Volume 6 Issue I, January 2018

11. SK Abid Sharief, M Shiva Rama Krishna, S V Surendhar,2019, A Case Study on Seismic Analysis of an Irregular Structure, International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-6, April 2019

12. Lovneesh Sharma, Sandeep Nasier, 2019, Dynamic Seismic Evaluation of Irregular Multi-Storey Buildings Using Bracing in Zone V as Per Is: 1893-2016, International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-7, May, 2019

13. Devesh P. Soni and Bharat B. Mistry, 2006, Qualitative Review of Seismic Response of Vertically Irregular Building Frames, ISET Journal of Earthquake Technology, Technical Note, Vol. 43, No. 4, December 2006, pp. 121-132

14. S.Varadharajan, V.K. Sehgal and Babita Saini, 2013, Review of different Structural irregularities in buildings, Journal of Structural Engineering Vol. 39, No. 5, December 2012 - January 2013 pp. 538-563

BIOGRAPHIES

Chetan J. Chitte obtained his M.Tech. in Structural Dynamics & Earthquake Engineering from VNIT, Nagpur and B.E. Civil from Sardar Patel College of Engineering, Mumbai. He has 4.5 Years experience in Structural Designing and more than 10 Years' experience in area of teaching.