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Analysis of Set-back Vertical Irregular Building frame Structure By STAAD Pro Software

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ABSTRACT:

Although there are many other kinds of building structures in use today, the focus of this study is on regular and irregular building structures. Simple rectangular buildings are considered regular buildings in this study. There are many different kinds of irregularities in buildings, including vertical, horizontal, and geometric inconsistencies. This paper examines vertical irregularity. Consideration is given to setback frame building in vertical irregularity. The aesthetic appeal of these constructions is also superior. The G+14 regular building and the vertical irregular building (setback) structure are the subjects of this work. We use STAAD PRO Software to analyze these buildings while maintaining the built-up area and all other factors constant. The structure compares the results in terms of maximum seismic weight, base shear, natural time period, bending moment, shear force, and storey displacement after taking into account the response spectrum seismic load analysis and wind analysis. The structure is analyzed using IS 1893 Part 2016 for seismic analysis and IS 873-1987 Part 3 for wind design.

Keywords :- vertical irregularity, seismic weight, base shear, natural time period, bending moment, shear force and storey displacement etc.

INTRODUCTION :

Structural engineers currently have to deal with irregularly shaped architectural innovation because there isn't much space available for building development in urban regions. Consequently, this causes buildings to vary in height; these are known as irregular structures. Stiffness, mass, and geometric irregularities are examples of vertical irregularities that deteriorate a structure. When a structure fails during an earthquake, one of the main causes is vertical irregularities.

Spokes of weakness are where structural failure begins during an earthquake. The discontinuity in the structure's mass, rigidity, and geometry is the cause of this weakness. Irregular structures are those that exhibit this discontinuity. A primary cause of structural failures during earthquakes is vertical abnormalities. These buildings differ from "regular" buildings in terms of their dynamic characteristics due to variations in stiffness and mass with height. Vertically irregular structure defined by IS 1893: The uneven distribution of mass, strength, and stiffness throughout the building's height could be the cause of the irregularities in the building constructions. Setback is one kind of irregularity that can lead to other irregularities along a vertical direction, including irregularities of mass, stiffness, or geometry. Guidelines for seismic assessments of structures are provided by several seismic laws, and these can be used for both assessment and design purposes.

CRITERIA FOR VERTICAL IRREGULARITIES IN BUILDING CODES

Vertical irregularity in building frames was not mentioned in any of the previous iterations of IS 1893 (BIS, 1962, 1966, 1970, 1975, 1984). The latest edition of IS 1893 (Part 1)-2002 (BIS, 2002) has specifically described irregular building configurations. There are five different kinds of vertical irregularity. They are: discontinuity in capacity (weak story), in-plane discontinuity in lateral force-resisting vertical parts, mass irregularity, vertical geometric irregularity (set-back), and stiffness irregularity (soft narrative). Vertical irregularity categories in the NEHRP code (BSSC, 2003) are comparable to those in IS 1893 (Part 1)-2002 (BIS, 2002). This code states that a structure is considered irregular if the ratio of one of the quantities (mass, stiffness, or strength) between stories is greater than a minimum amount. The parameters that characterize the irregularity and these numbers (e.g., 70-80% for soft tale, 80% for weak story, and 150% for set-back structures) have been assigned based on subjective judgment. Furthermore, rather than utilizing equivalent lateral force (ELF) methodologies, a number of building codes recommend dynamic analysis—which can be either elastic time history analysis or elastic response spectrum analysis—to determine the design lateral force distribution for irregular structures.

MODELLING :

In this study, the analysis is conducted while maintaining the same built-up area and other criteria for each building. The G+14 storey three-dimensional RC frame building is taken into consideration. Several codes are used in the current study: IS 1893-2016 is used for seismic analysis, IS 456-2000 is used for frame design, and IS 875-1987 parts 1 and 2 are taken into consideration for dead load and live load, respectively. The analysis building software Staad Pro is utilized. This study's primary focus is on the analysis of frame model regular (rectangular) buildings and frame model irregular buildings with vertical setbacks. Next, contrast the outcomes with respect to seismic weight, base shear, bending moment, shear force, and storey displacement during the natural time period.

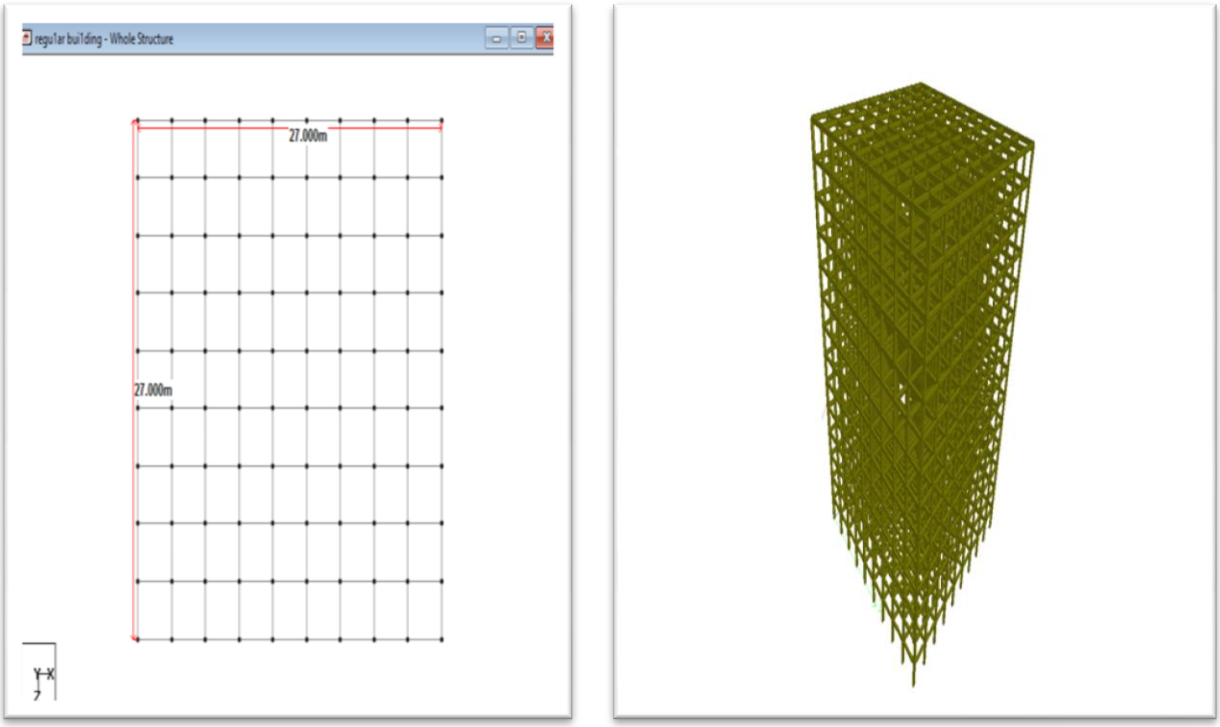


Figure 1 Plan and 3D View of R.C. Frame Rectangular Building

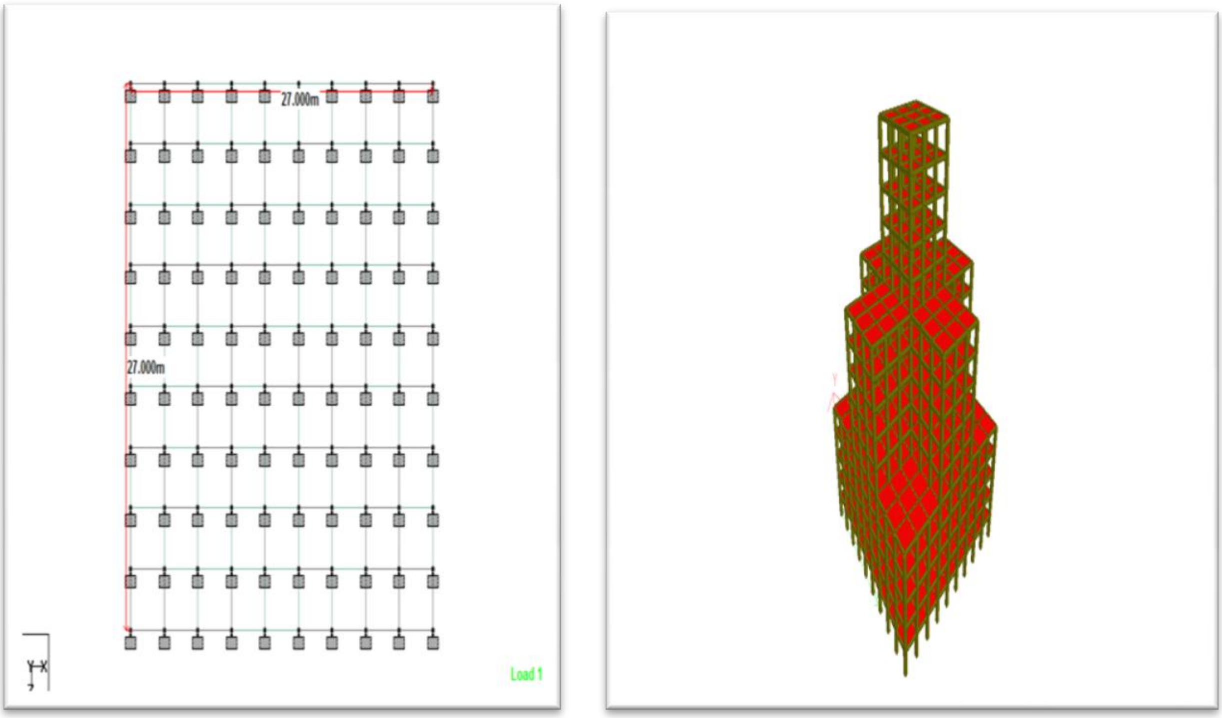


Figure 2 Plan and 3D View of setback vertical irregular building

` B, Geometrical Modeling

Table1: Specification data of Building structure

SPECIFICATION	DATA

Building Type	RC Frame structure
Building Shape	Rectangular, setback vertical irregular frame
Plan Area (built up area)	729 M^2
Number of Storey	G+14
Storey Height	3m
Beam Size	230mm x 400mm
Column Size	500mm x 500mm
Slab Thickness	180mm
Floor Finishing Load (Dead Load)	1.25 KN/m^2
Live load	3 KN/m^2
Zone of Seismic	IV
Zone Factor (Z)	0.24
Importance Factor (I)	1.5
Response Reduction Factor (R)	5
Type of Soil	II
Damping Ratio	0.05
Soil Bearing Capacity	150 KN/m^2
Basic wind speed	50 m/s
STAAD PRO SOFTWARE	

RESULT AND DISCUSSION

A. maximum Seismic weight

Table 2 Seismic weight comparison

Building Type	Seismic Weight (KN)
Rectangular (regular)	33784
Set back frame (irregular)	31623

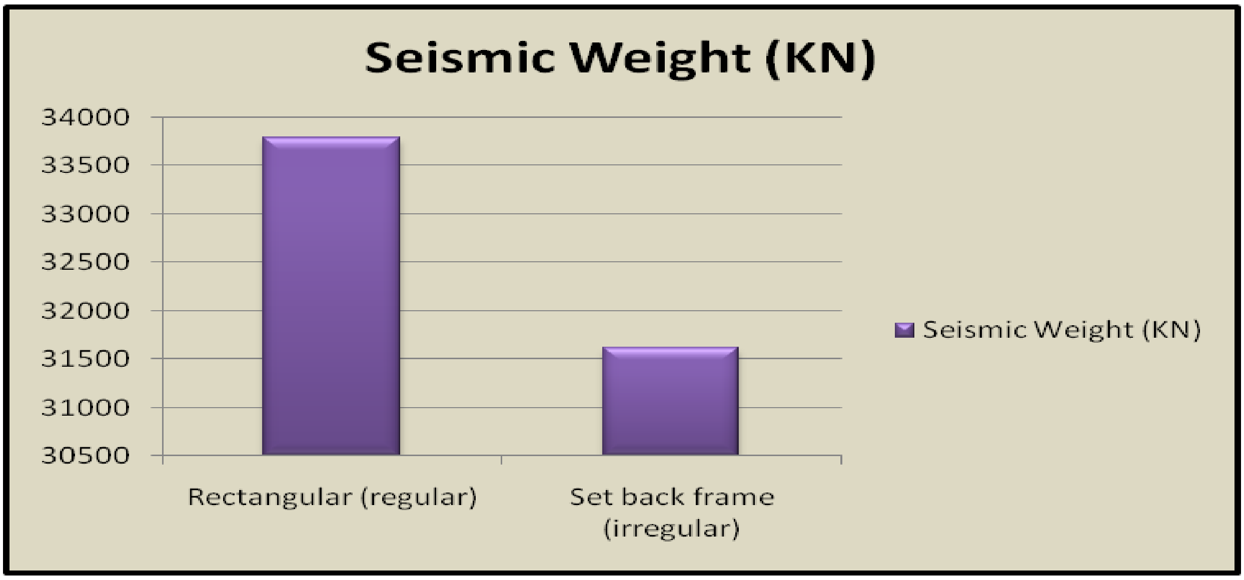


Figure 3 Seismic weight comparison of building

B. maximum Base shear

Table 3 Base shear comparison

Building Type	Base shear (KN)
Rectangular (regular)	2230.03
Set back frame (irregular)	2118.94

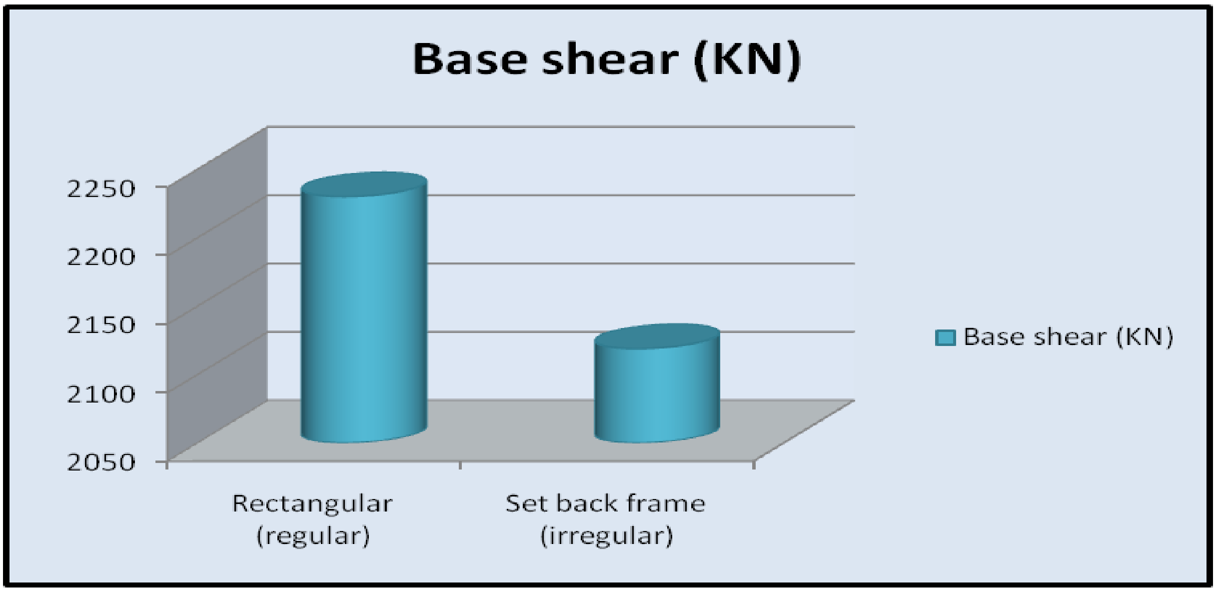


Figure 4 Base shear comparison

C. maximum natural time period

Table 4 Natural time period comparison

Building Type	Time period (sec)
Rectangular (regular)	1.841
Set back frame shape (irregular)	0.951

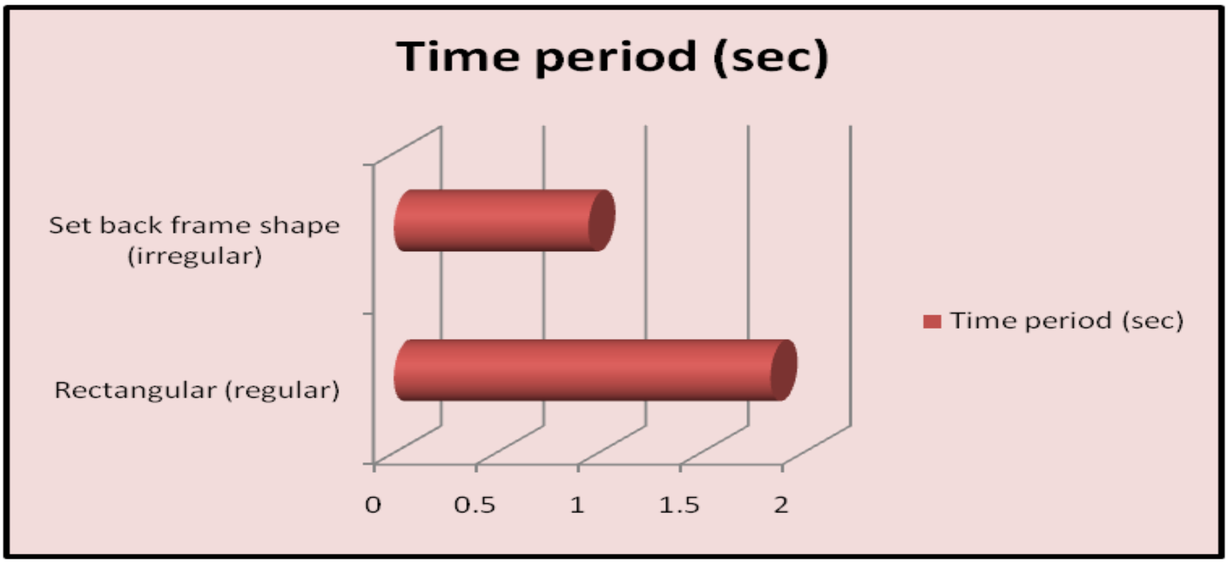


Figure 5 natural time period comparison

D. maximum bending moment

Table 5 Comparison of maximum bending moment for regular and vertical irregular building in KN-m

Storey	Rectangle KN-m	Set back frame KN-m
storey 14	11.56	6.24
storey 13	23.87	11.68
storey 12	35.01	23.48
storey 11	43.70	35.25
storey 10	65.10	49.63
storey 9	75.11	65.84
storey 8	86.99	76.87
storey 7	94.05	82.08
storey 6	105.18	98.20
storey 5	125.32	101.24
storey 4	132.11	116.43
storey 3	147.27	125.87
storey 2	155.69	131.54
storey 1	173.31	150.78
base	192.27	164.75

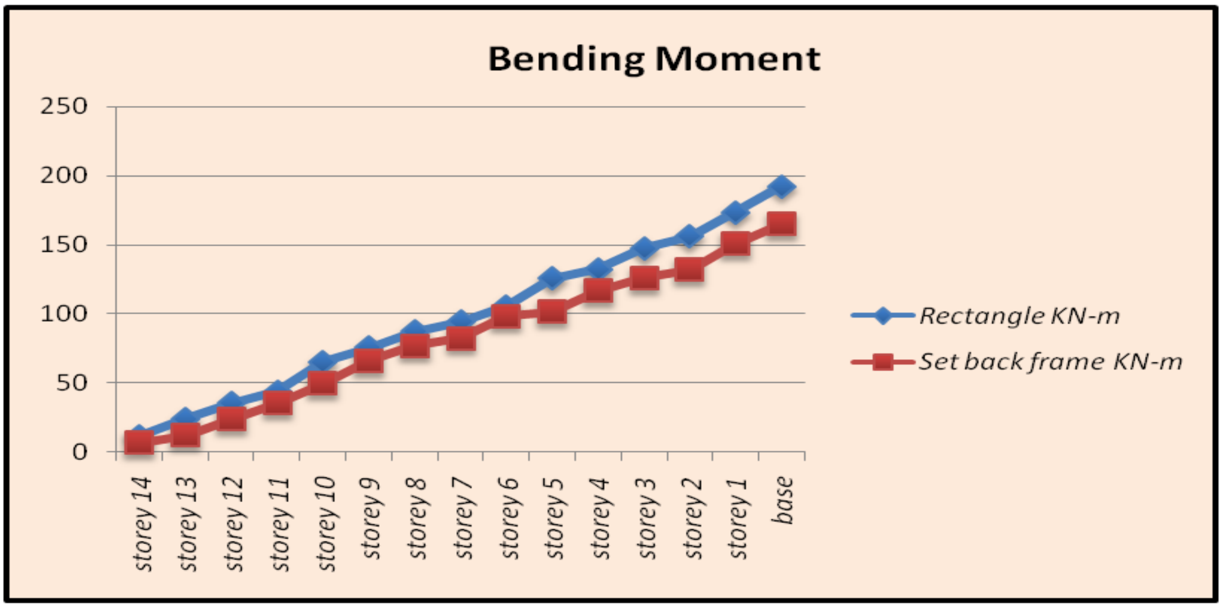


Figure 6 Comparison of bending moment

E. Maximum shear force

Table 6 Comparison of maximum shear force for regular and vertical irregular building in KN

Storey	Rectangle KN	Set back frame KN
storey 14	50.99	39.51
storey 13	50.52	39.09
storey 12	50.11	39.42
storey 11	49.85	38.39
storey 10	49.73	38.45

storey 9	49.32	37.52
storey 8	48.92	37.57
storey 7	48.80	37.50
storey 6	48.51	36.08
storey 5	47.16	36.41
storey 4	47.20	36.38
storey 3	47.34	36.44
storey 2	47.51	36.51
storey 1	47.70	36.57
base	48.05	36.72

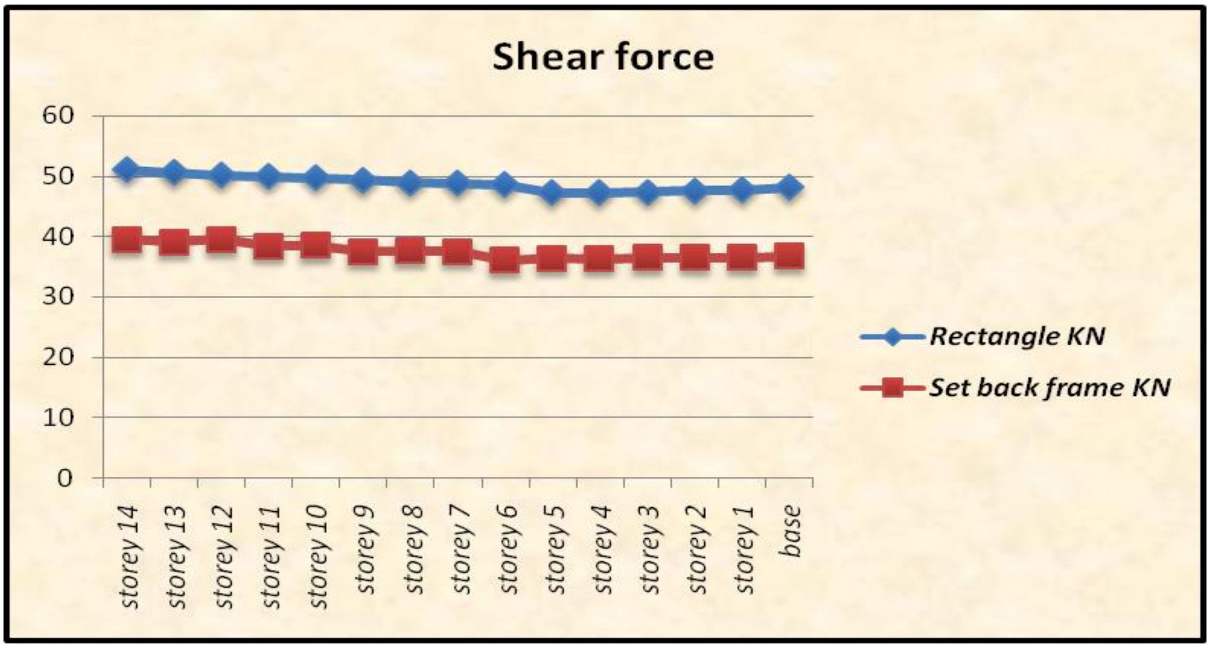


Figure 7 Comparison of Shear force

F. Maximum displacement

Table 7 Comparison of maximum storey displacement for regular and vertical irregular building in mm

Storey	Rectangle in mm	Set back frame in mm
storey 14	21.8	40.1
storey 13	20.0	39.2
storey 12	19.0	38.8
storey 11	18.4	38.0
storey 10	17.0	37.4
storey 9	16.9	35.6
storey 8	14.1	35.0
storey 7	14.7	33.0
storey 6	13.3	32.8
storey 5	13.0	30.0
storey 4	12.0	27.9
storey 3	10.0	23.4
storey 2	8.2	18.5
storey 1	5.0	12.0
base	2.1	5.2

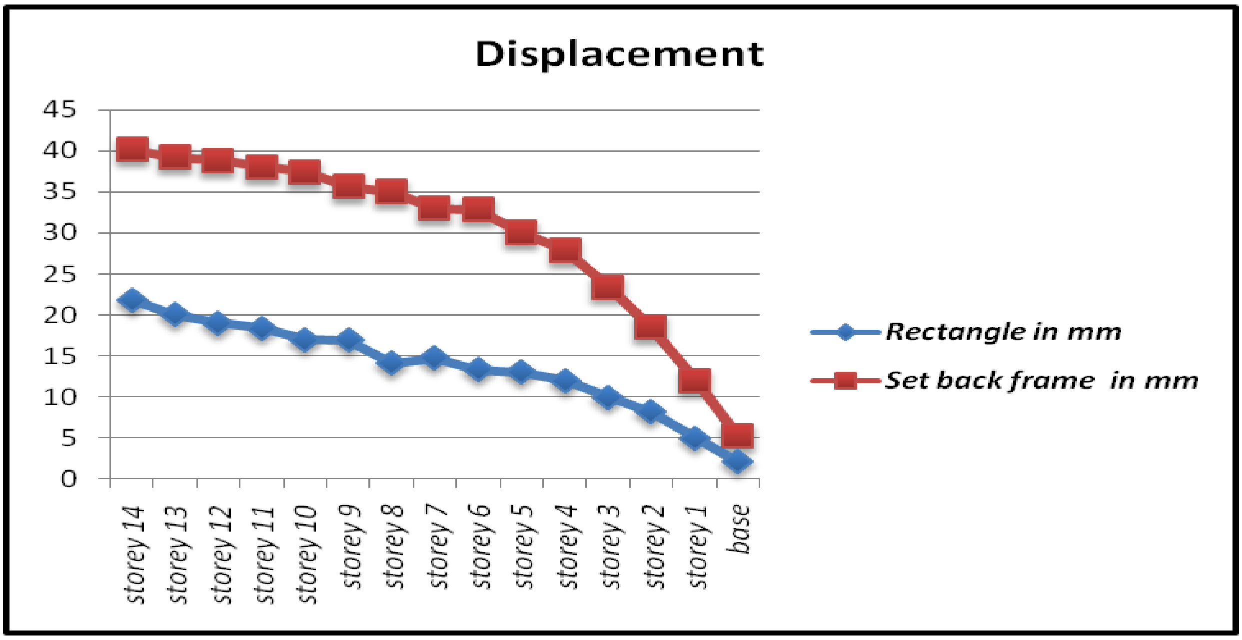


Figure 8 Comparison of storey displacement

G. Some deform models of analyzed building

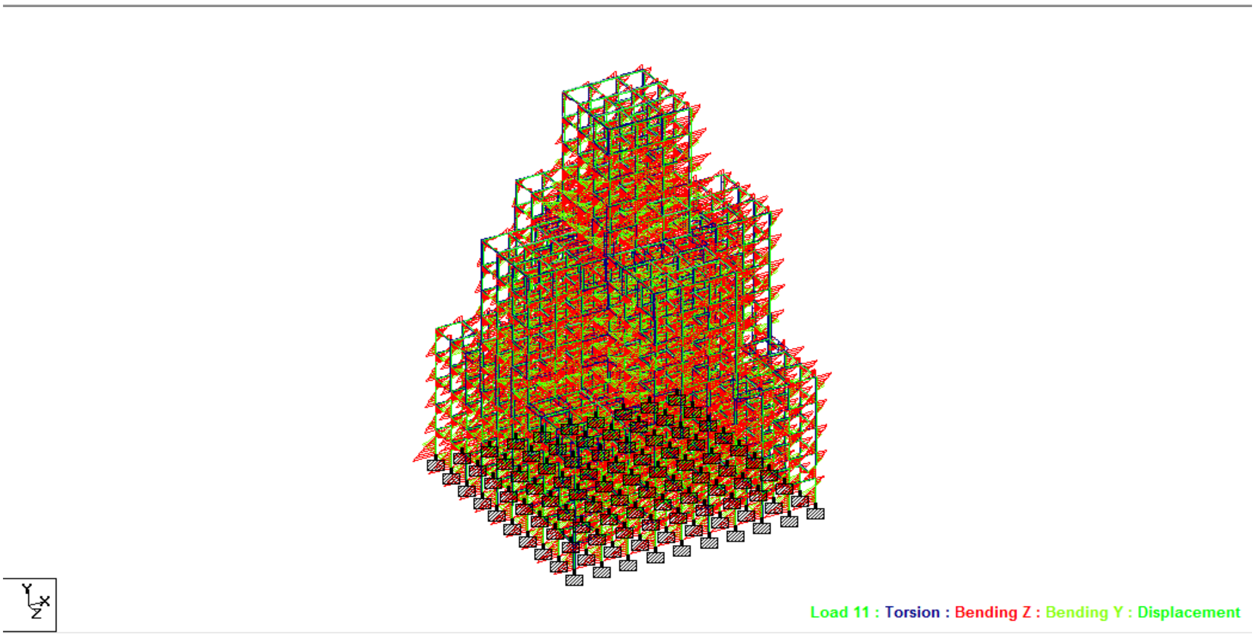
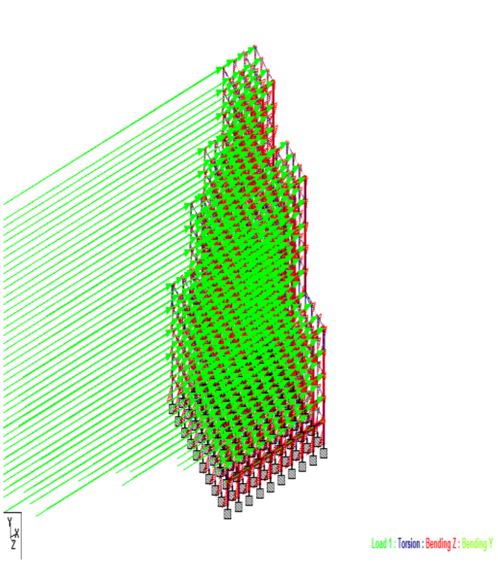


Figure 9 Deformed shape of irregular setback building (displacement in all direction)



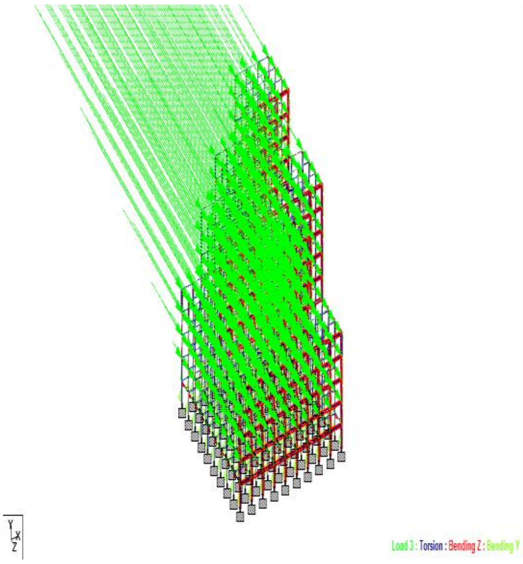
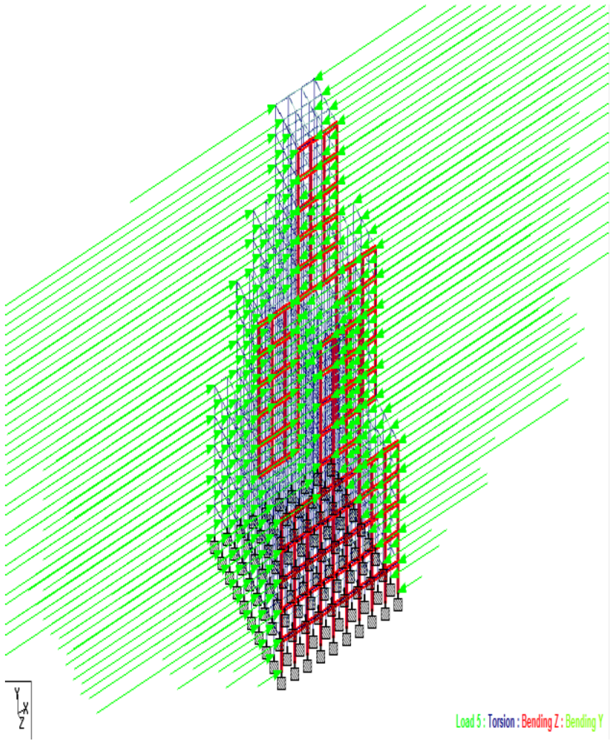


Figure 10 Deformed shape of irregular setback building (seismic load in X and Z direction)



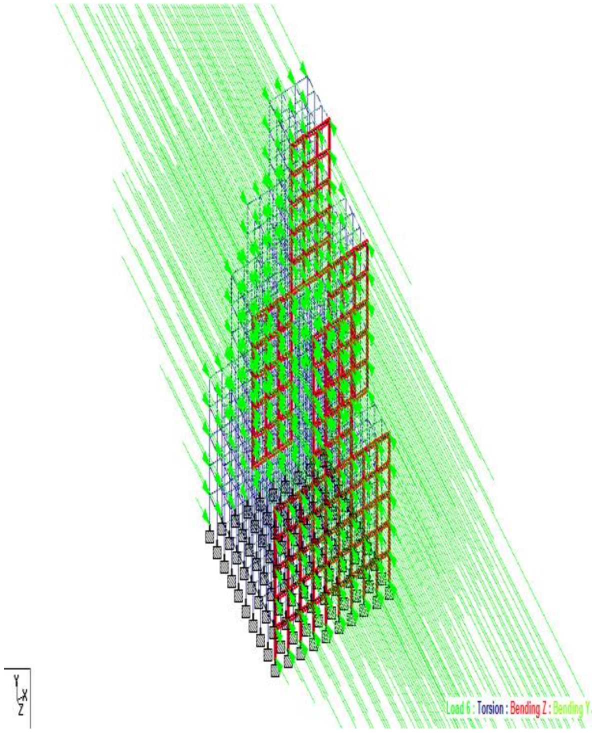


Figure 11 Deformed shape of irregular setback building (wind load in X and Z direction)

CONCLUSION :

Finally, certain conclusions are made by contrasting the outcomes of regular versus irregular construction. The six sorts of conclusion forms in this case are: base shear, maximum bending moment, maximum shear force, maximum deflection, maximum bending weight, and natural time period. The study work's conclusions are as follows:-

1. Conclusion based on seismic weight

The analysis shows that the seismic weight of regular rectangular building is 6.39% more than vertical setback irregular building .

2. Conclusion based on base shear

The base shear of regular rectangular building is also 4.98% more than vertical setback irregular building.

3. Conclusion based on natural time period

Natural time period value of regular building is increase by 48.34% from vertical setback irregular building.

4. Conclusion based on maximum bending moment

The analysis shows that the maximum bending moment of regular frame building is 46.02 % more than the vertical setback irregular frame building.

5. Conclusion based on maximum shear force

The analysis shows that the maximum shear force of rectangular regular frame building is 22.51% more than the vertical setback irregular building.

6. Conclusion based on maximum storey displacement

The maximum storey displacement in Y direction due to response spectrum analysis of Regular rectangular is 83.90% less than the vertical setback irregular frame building.

REFERENCES :

1. Jack P. Moehle (1984) " Seismic Response Of Vertically Irregular Structures" J. Struct. Eng., 1984,
2. 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
3. Himanshu BansaL and Gagandeep (2012) " Seismic Analysis and Design of Vertically Irregular RC Building Frames ". International Journal of Science and Research (IJSR)
4. Nonika. N and Gargi Danda De (2015) " Seismic Analysis Of Vertical Irregular Multistoried Building" IJRET: International Journal of Research in Engineering and Technology
5. Shaikh Abdul Aijaj Abdul Rahman (2016) " Seismic analysis of vertically irregular buildings" Current Science Association Vol. 111, No. 10
6. Aijaz Shaikh (2016) " Seismic Analysis of Vertically Irregular Building" ResearchGate https://www.researchgate.net/publication/305471676

7. Adapa N (2017) " Static Analysis and Design of Multi- Storied (G+4) Residential Building Using Staad-Pro 2007" International Journal of Advanced Technology and Innovative Research Volume. 09, IssueNo.03.
8. Ravindra N. Shelke (2017) " Seismic Analysis Of Vertically Irregular Rc Building Frames " International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 1
9. Oman Sayyed (2017) " Seismic Analysis of Vertical Irregular RC Building with Stiffness and Setback Irregularities https://www.researchgate.net/publication/313816841
10. Kolukula Sai Kiran (2018) Seismic Analysis And Design Of Vertically Irregular RC Building Frames " (IJITR) International Journal Of Innovative Technology And Research Volume No.6, Issue No.6
11. Kumar R (2018) " Analysis of Vertically Regular and Irregular Buildings Subjected to Seismic Load using Pushover Analysis" International Journal of Engineering Research & Technology (IJERT) Vol. 7 Issue 05.
12. Shridhar Chandrakant Dubule and Darshana Ainchwar (2018) " Seismic Analysis And Design Of Vertically Irregular R.C. Building Frames " International Journal of Research and Analytical Reviews (IJRAR) Volume 5, Issue 4.
13. Latip Kumar Sharma (2018) " Comparative Study On Design Results Of A Multi-Storied Building Using Staad Pro And Etabs For Regular And Irregular Plan Configuration" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 01.
14. Dobule S (2018) " Seismic Analysis And Design Of Vertically Irregular R.C. Building Frames" International journal of advance research in science and engineering volume 7.
15. Raw A and Verma A (2019) " Seismic Analysis and Design of Vertically Irregular Mutistoried RC Concrete Building using Staad Pro V8i" International Journal of Trend in Scientific Research and Development (IJTSRD) Volume 4 Issue 1.
16. Yogita K. Kalambe and Sanjay Denge (2019) " Seismic Analysis of R.C.C. Building With Plan Irregularities" www.ijsart.com Volume 5 Issue 6.
17. Rashmi Agashe, Marshal Baghele, Vaishanvi Deshmukh, Sharad Khomane and Gaurav Patle (2020) To Study Analysis and Design of Multi-Storey building using STAAD-pro. and Comparing with Manual Calculations" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 04.
18. Pavani S and Rao M (2020) " Seismic Evalution Of Irregular Structure Using Staad Pro" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 07.
19. Smita and Juhi (2020) " Study of irregular multi-storey RC frame subjected to seismic condition analysis with STAAD Pro V8i software" International Journal of Advance Research, Ideas and Innovations in Technology.
20. Md Ali Akber (2021) " Impact Of Regular And Irregular Reinforced Concrete Structure Under Seismic Conditions" ResearchGate.
21. Mohamed Hamud Mohamed, Hanad Muse Ali and Abdikadir Hassan (2021) " A Review On Design And Analysis Of Multi-Storey Building By Staad.Pro" Journal of Emerging Technologies and Innovative Research (JETIR) ISSN-2349-5162.
22. K venketash (2021) " Design and Analysis of Irregular Building Using STAAD Pro Without Earthquake Load" International Journal of Recent Advances in Multidisciplinary Topics Volume 2, Issue 11
23. Basu Dhakal and Richika Rathore (2022) "Seismic Analysis of Vertically Irregular RC Building Frame With and Without Shear Wall Using NBC 105:2020" International Journal of Innovative Research in Engineering & Management (IJIREM) ISSN: 2350-0557, Volume-9, Issue-5