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Seismic Analysis for Buildings with Step-Back, Step-Back Set-Back, And Set-Back

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***Abstract—* Earthquake is the shaking of the earth's surface, and it is one of nature's most destructive and unexpected phenomena. Plate tectonics movement, volcanic eruptions, or man-made explosions cause earthquakes, which last for a brief time, usually less than a minute. Aftershocks accompany larger earthquakes; this earthquake was the most violent and deadly, killing many people and destroying many important properties. Since the 1934 Nepal-Bihar earthquake, it has been a disaster-causing earthquake in India. These densely inhabited hilly areas, including remote settlements perched on hilly areas, experienced catastrophic property damage and many innocent lives were lost. This paper uses the seismic coefficient approach in ETABS v16 to try to explain the behaviour of hillside buildings. Three types of buildings are studied: step-back (SBB), step-back set-back (SBSB), and set-back (SB) buildings with three to five stories. The seismic susceptibility associated with their dynamic response qualities is investigated and contrasted. To fully comprehend the analysis result and configure the suitability of each structure, the comparison is presented in the form of charts. SBB is proven to be more lethal than other types of structures, and the usage of shear walls and bracing is found to be effective in improving building seismic performance.**

***Indexed Terms--* Sloping ground, static & dynamic behavior, , regularities and irregularities of building, set back and step back building.**

I. INTRODUCTION

The behaviour of buildings during earthquakes is influenced by a number of unknown elements. The current research examines and compares the seismic vulnerability of three building configurations, namely SBB, SBSB, and SB buildings, by comparing dynamic response properties such as fundamental time period, base reaction, base shear, displacement, and forces induced such as shear force, bending moment, and torsional effect on buildings.

SBB buildings have both regular and short columns of the same height down the slope, but SBSB buildings have all columns of varied heights. SB structures are structures that are similar to those built on flat ground and have regular-sized columns.

In Fig. 1 the plan which is made on AutoCAD is given. On which our project is based and we are going to analyze and design this structure by Etabs.

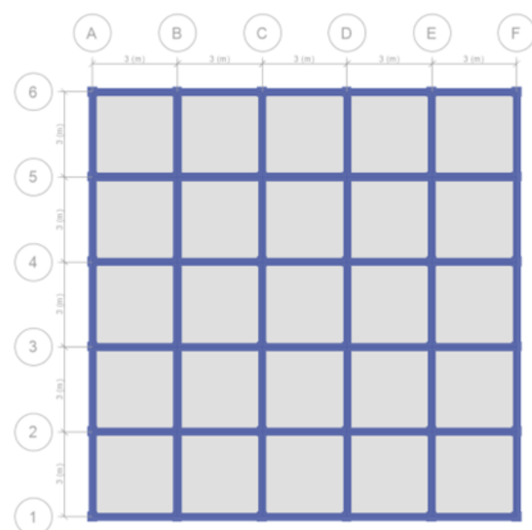


Fig 1: Plan

II. LITERATURE REVIEW

1. Seismic Response of Irregular Building On Sloping Ground.Authors: Anjeet Singh Chauhan (2021)

The behaviour of structures during earthquakes is determined by their mass and stiffness distribution in both horizontal and vertical planes. Buildings built in steep areas are vulnerable to major earthquakes. Under seismic loads, investigate the structural performance of multi-story step back RC buildings positioned on 20°, 30°, 40°, and 45° slopes.

2. Seismic Analysis of Multi-storeyed Building on Sloping Ground with Ground, Middle and Top Soft Storey Tanuja V Keneror 2020

The study is carried out using the response spectrum analysis method for a combination of four different slopes and different building configurations, and various parameters are tested against various limitations and findings derived from various construction scenarios. Investigate how shear walls can help soft storey RC buildings on perate better on sloping terrain

3. Effect of slope angle variation on the structures resting on hilly region considering soil–structure interaction Authors: Rahul Ghosh 2019

Examine the impact of varying slope angles on structures sitting on sloping terrain, taking into account both fixed and flexible foundation structures (SSI). The analysis is carried out using the equivalent static force technique (ESFM), the response spectrum method (RSM), the time history method (THM), the nonlinear static method (NLSM), and the nonlinear time history method (NTHM) (NLTHM). With and without SSI consideration, the criticality related with increasing slope angle. The significance of SSI in seismic analysis is also revealed.

4. Analysis of 2d Frame(g+10) Building on Sloping Ground Authors: B.Rohini, Sagar Jamle 2018

The columns in the ground storey are of varying heights, with a short column on one end and a large column on the other. The dynamic characteristics of hill buildings differ from those of flat-ground structures. Because of the difference in stiffness and mass along the horizontal and vertical planes during ground motion, the torsion effect of such structures is harmed. The Response Spectrum Method was used to conduct an analysis that included storey displacement in the X and Z dimensions, as well as storey drift, storey shear, and time period.

5. Seismic Response of RC Framed Buildings Resting on Hill Slopes Authors: Zaid Mohammada,, Abdul Baqib, 2017

The height and length of hill structures vary geometrically. In total, eighteen analytical models were subjected to seismic forces along and across hill slope directions, and the Response Spectrum Method was used to assess the results. shear forces induced in foundation columns, fundamental time periods, maximum top storey displacements, storey drifts, and storey shear in buildings, all of which were compared within the hill building designs evaluated.

6. Performance evaluation of setback buildings with open ground story on plain and sloping ground under earthquake loadings and mitigation of failure Authors: Rahul Ghosh Rama Debbarma ,2017

Extreme responses for open ground storied setback buildings were recorded using three different methods: equivalent static force method, response spectrum method, and time history method. To mitigate this soft storey effect and the extreme responses, three different mitigation techniques were used, and the best solution among these three techniques was presented.

7. Lateral stability of multi-storey building on sloping ground Authors: Nagarjuna, Shiva Kumar B. Patil 2015

The top storey displacement and time period decrease as the slope angle increases in the equivalent static method and response spectrum method. In both step back and step back setback buildings, the maximum base shear is at 20 degrees.

8. Performance based seismic design of RCC buildings with plan irregularity Authors: Ashish R. Akhare, Abhijeet A. Maske 2015

Torsion is the most important component that causes substantial structural damage or full collapse. Torsion is commonly generated by eccentricity in irregular

9. Seismic analysis of buildings resting on sloping ground with varying number of bays and hill slopes Authors: Dr. S. A. Halkude, Mr M. G Kalyan Shetty, Mr V. D. Ingle 2013

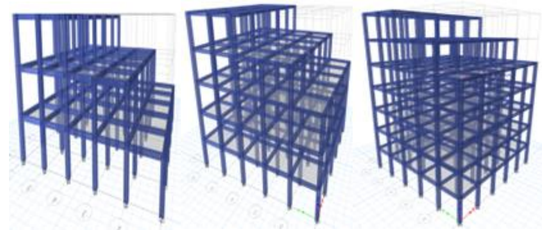
Step back frames may be more hazardous than other building frame types during earthquake performance. Time duration and top storey displacement decrease as hill slopes increase. Time duration and top storey displacement decrease as the number of bays increases. As a result, it is established that under seismic conditions, a larger number of bays is better. When compared to step back and set back frames, step back and set back frames produce less torsion effects.

10. Influence of soil-structure interaction in seismic response of step backset back buildings Authors: Prabhat Kumar, Sharad Sharma and A.D. Pandey 2012

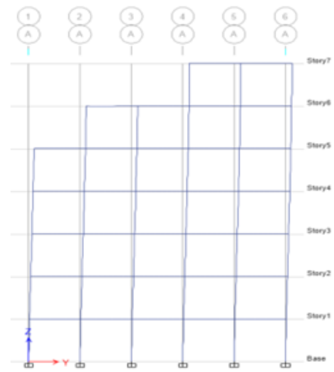
The dynamic shear ratios in the X and Y directions show a trend that differs from the static shear ratios. In dynamic analysis, the ratio of shear force in columns at ground level increases with increasing height in both directions for all types of soils from high point columns to low point columns (X and Y).).

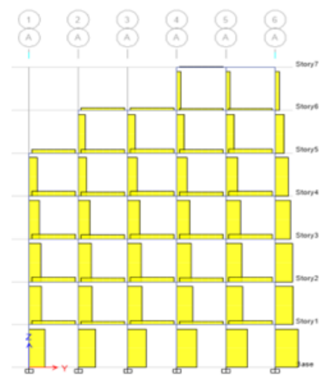
III. STRUCTURAL MODELLING

S. No.	Parameter	Values
1	Live Load	2 kN/m2
2	Density of RCC considered:	25 kN/m3
3	Thickness of slab	150-200mm
4	Depth of beam	500mm
5	Width of beam	300mm
6	Dimension of column	300x500mm
7	Density of infill	20kN/m3
8	Thickness of outside wall	225mm
9	Thickness of inner partition wall	125mm
10	Height of each floor	3.0m
11	Earthquake Zone	V
12	Time period in X-direction	1.10sec
13	Time period in Y-direction	0.9sec
14	Importance factor	1.5
15	Type of structure	OMRF
16	Response reduction Factor	3

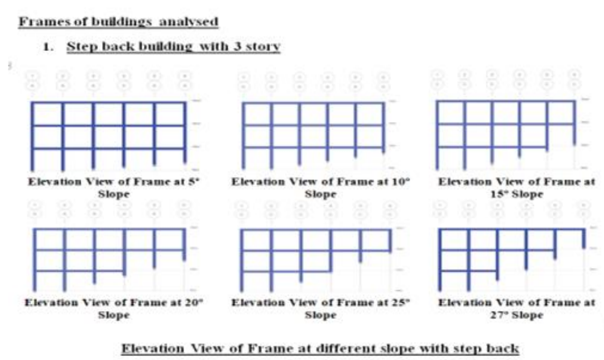


3-D model in ETABS 2016

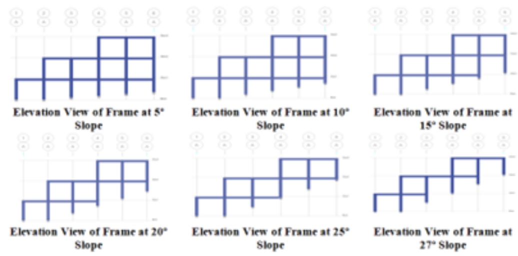




Deform shape and Shear force in SBSB building due to seismic load only

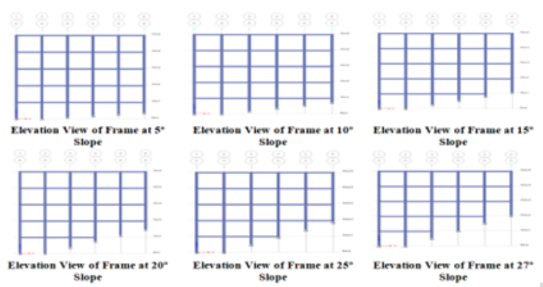


2. Step back Set back building with 3 story



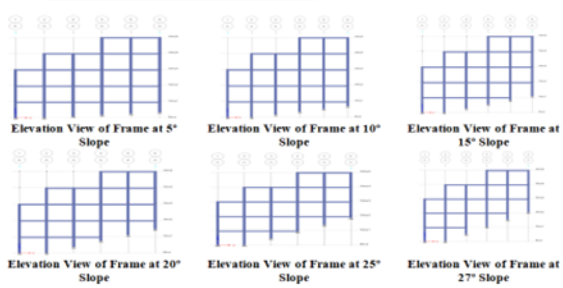
Elevation View of Frame at different slope with setback step back

1. Step back building with 5 story



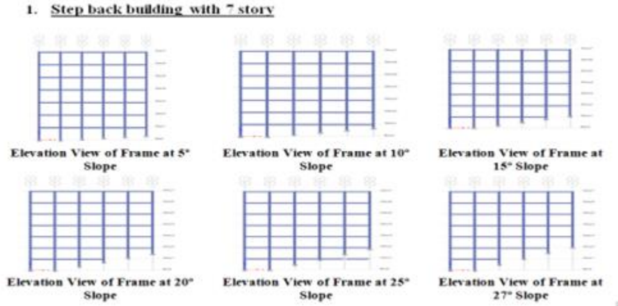
Elevation View of Frame at different slope with step back

2. Step back Set back building with 5 story



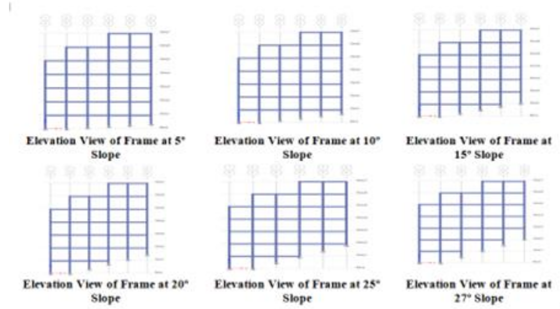
Elevation View of Frame at different slope with setback step back

1. Step back building with 7 story



Elevation View of Frame at different slope with step back

2. Step back Set back building with 7 story



Elevation View of Frame at different slope with setback step back

IV. RESULTS FROM LINEAR ANALYSIS

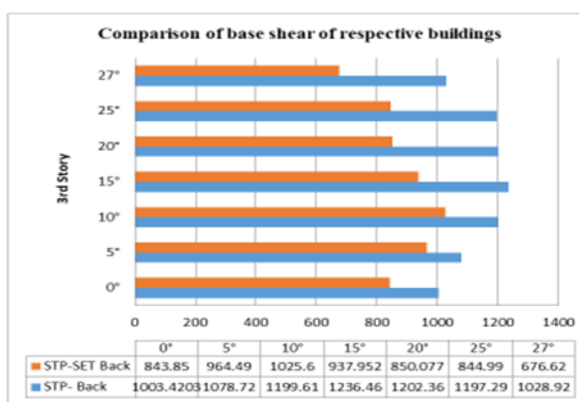
To understand the seismic behaviour of respective buildings comparison of their dynamic response property is being done, to research the seismic vulnerability associated with each of them. The results are presented within the form of table and chart to thoroughly understand the behaviour and draw conclusion for their suitability.

4.1 Comparison of results of respective buildings

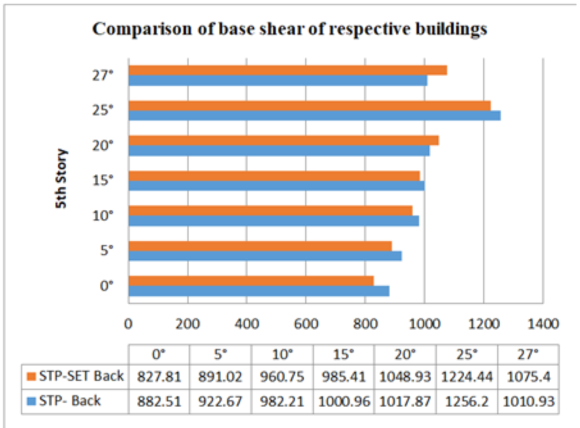
4.1.1 Comparison of base shear

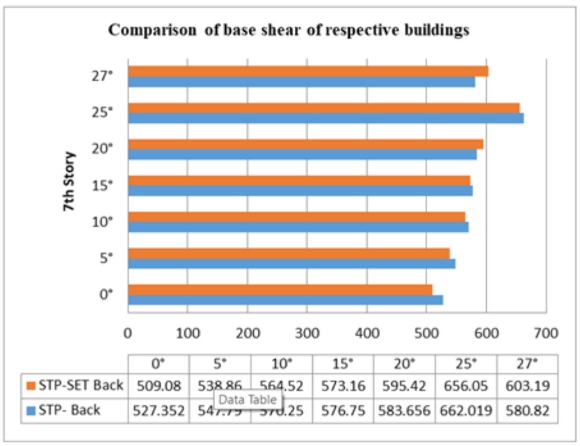
Base shear is that the total design lateral force at the base of a structure. It is often calculate based on the procedure as mentioned in previous chapter. Since base shear is associated with seismic weight, so higher the seismic weight higher are going to be the base shear. Thus as shown in figure below, base shear related to SBB base shear is greater than SBSB for every story. Higher the amounts of story greater are going to be the total design lateral force.

EQ. force in X direction (along the slope line)

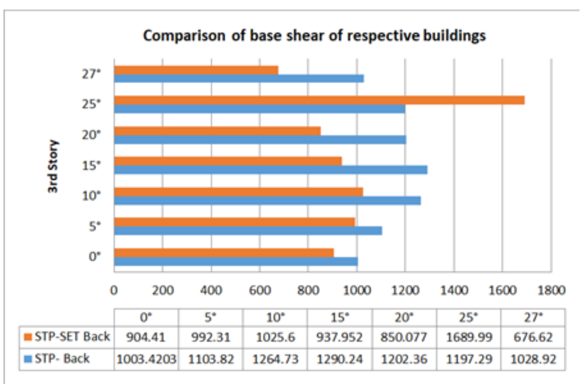


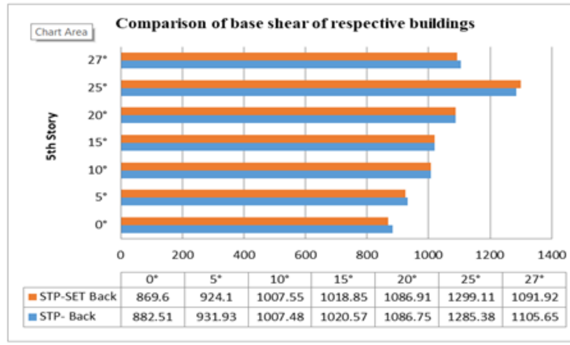
	0°	5°	10°	15°	20°	25°	27°
STP-SET Back	843.85	964.49	1025.6	937.952	850.077	844.99	676.62
STP- Back	1003.4203	1078.72	1199.61	1236.46	1202.36	1197.29	1028.92

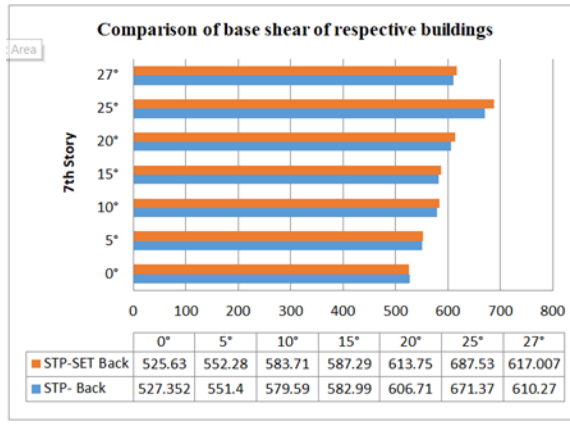




EQ. force in Y direction







V. CONCLUSION

In the present study, the following consideration is concluded between structure figure in
flat pitch to that figure in leaning terrain of different angele .

1. SBB Building is most seismic vulnerable structure in Hilly areas as compared to SBSB and SB structures.
2. In SBB and SBSB erecting it's observed that short columns is the worst affected during seismic action.
3. Top story relegation in SB structures are advanced than other two set of structures due to further mass associated with it also others, which increase side force.
4. SB structure are less affected by torsion, as they satisfy the codal criteria of torsion, whereas SBB and SBSB structure shows inordinate torsion, with SBB erecting absorbing further torsion.
5. underpinning demand of SB Building is satisfactory; that's within maximum theoretical Admissible of 6, whereas in SBB and SBSB needs lesser quantum of underpinning.

6. In the present study both bracing and shear wall is set up to reduce the effect of short column effectively and ameliorate the overall seismic performance of structure.
7. Comber support in way is set up to be less effective to ameliorate seismic geste , as the relegation are high and more force are generated in regular columns, although it reduces short column effect.
8. Combination of comber support and bracing improves seismic performance of Erecting making them more seismic resistance, but with increase in perpendicular loads in column. thus, it's recommended that, for hillside- structures use of shear wall in foundation should be in practice, to shear the column loads in an effective way to reduce seismic vulnerability associated with hillside structures.

REFERENCES

[1] Er. Anjeet Singh Chauhan "Seismic Response of Irregular Building on Sloping Ground" Science, vol. 294, Dec. 2001, pp. 2127-2130, doi:10.1126/science.1065467.

[2] Tanuja V Keneror, Vaijanath Halhalli "Seismic Analysis of Multistoried Building on Sloping Ground with Ground, Middle and Top Soft Storey".

[3] Rahul Ghosh1 · Rama Debbarma "Effect of slope angle variation on the structures resting on hilly region considering soil–structure interaction" https://doi.org/10.1007/s40091-019-0219-3.

[4] B.Rohini,C.Lakshmi Gowri, T.Jyothirmayee "Analysis Of 2d Frame(G+10) Building On Sloping Ground"

[5] Zaid Mohammada,, Abdul Baqib, Mohammed Arif "Seismic Response of RC Framed Buildings Resting on Hill Slopes" Peer-review under responsibility of the organ

[6] Agarwal, P. K. and Shrikhande, M. "Earthquake Resistant Design of Structure" Fourth Edition, Prentice Hall 2006.

[7] Ashwani, K., Pushplata, "Building Regulations for Hill Towns of India", HBRC Journal, 2014.

[8] Babu, N. J. and Balaji, K.Y.G.D, "Pushover analysis of unsymmetrical framed structures on sloping ground" International Journal of Civil, Structural,Environmental and Infrastructure Engineering Research and Development (IJCSEIERD) ISSN 2249-6866 Vol. 2 Issue 4 Dec - 2012 45-54.

[9] Bathe, K. J., "Finite Element Procedures in Engineering Analysis", Prentice-Hall, (1982).

[10] Birajdar, B. G. and Nalawade, S. S., "Seismic analysis of buildings resting on sloping ground", 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, Paper No. 1472, 2004.

[11] Chatpan, C. and Chopra, A.K., "Evaluation of modal pushover analysis using generic frames", Earthquake Engineering and Structural Dynamics, vol. 32, No.3, pp. 417-442, 2003.

[12] IS 456 (2000): Plain and Reinforced Concrete - Code of Practice