iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 Issue: VI Month of publication: June 2024

DOI: https://doi.org/10.22214/ijraset.2024.63334

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VI June 2024- Available at www.ijraset.com

Comparative Study of Seismic Analysis of Reinforced Concrete Framed Buildings on Hill Slopes

Mr. Vishal M. Sapate[1], Mr. Shubham J. Paturde[2]
[1]*Asst. Prof. Department of Civil Engineering G .H Raisoni University Amravati.* [2]*P G Students*

Abstract: In the northern and northeastern regions of India, hilly terrain is widespread, making buildings in these areas more susceptible to seismic activity compared to those in flat regions. The structural integrity of buildings on sloping ground differs significantly due to their irregular and asymmetrical nature, increasing vulnerability to torsional moments during earthquakes. Variations in column height on sloping ground further exacerbate these risk factors. This dissertation investigates the behavior of buildings with different configurations, including step back, step back set back, and set back buildings, using the structural analysis tool STAAD Pro. Dynamic analysis, specifically response spectrum analysis, is performed to assess their performance under earthquake conditions. The study reveals that certain building configurations exhibit more effective responses to seismic events depending on whether the ground is sloping or level. Given the varying column heights inherent in buildings on sloping ground, detailed analysis is essential to determine the most suitable building configurations for enhanced safety and stability in such environments. This research aims to provide insights into optimal design strategies for mitigating seismic risks in hilly regions, contributing to the development of safer, more resilient infrastructure.
Keywords: Seismic Analysis, Reinforced Concrete (RC) Buildings Hilly Terrain Sloping Ground Structural Integrity Torsional Moments

I. INTRODUCTION

Earthquakes are among the most dangerous and unpredictable natural disasters, causing significant structural and livelihood destruction. Recent major earthquakes in India and around the world have highlighted this threat. India has several active seismic zones, with the northeastern region, including the Himalayas, being particularly prone due to the movement of the Indian plate towards the Eurasian belt. The challenge of constructing buildings on hilly terrain is compounded by seismic effects, as these structures often feature irregular and unsymmetrical designs both vertically and horizontally, with non-coinciding centers of mass and stiffness. This makes them especially vulnerable to earthquake damage. To ensure the safety of structures and livelihoods in these areas, it is crucial to consider both seismic and sloping effects. This study examines various building configurations on sloping ground, such as step back, step back set back, and set back, using dynamic analysis with STAAD Pro to identify the most sustainable designs against earthquake damage. This research aims to find the best building configurations to minimize destruction in earthquake-prone hilly regions.

II. ANALYSIS OF RESULTS

In all 24 building structures seismic analysis have been done with earthquake loads with an effect of accidental eccentricity. The seismic load was applied in X and Z direction means along the structures and across the structures applies independently. The important got resultsare described in the following sections.

III. STEP BACK BUILDING

In this building configuration, total eight no. of structures models have been analyzed with varying height 15.75 m to 40.25 m from 4 to 11 storeys. This building rests on 27 degree angle of ground slope.

A. *Case a: When earthquake force in X-direction (along the slope line):*

The seismic response of each step back building in terms of natural time period, maximum top storey sway and base shear values in column base at ground level is presented in table 4.1(a). It was seen that there was linear increment in the top storey sway and time period value increases as the height of step building increases.

Though the building structure configuration is regular along the slope line and in X direction torsion effect is insignificant due to accidental eccentricity. It is observed that in the extreme left column shear force is significant higher as comparison to rest of the column at ground level for different heights of building. Comparatively, extreme right and adjacent to it like frame D and frame C at ground level, shear force is very less, it is about 5 to 7% of the extreme left columns normalized shear force.

Table 4 .1(a): Dynamic Response Properties of STEP BACK Building due toEarthquake Force in X- Direction.

Designation	Storey no.	Storey height (m.)	Max.- displacement(mm)	Base shear force at ground level(kN)			
				FrameA	FrameB	FrameC	FrameD
Step 4	4	15.75	9.75	131.1	45.7	8.6	9.1
Step 5	5	19.25	19.86	175.5	58.1	11.3	10.9
Step 6	6	22.75	24.07	224.2	48.3	9.7	10.1
Step 7	7	26.25	31.45	247.9	51.9	10.5	10.5
Step 8	8	29.75	36.78	274.7	48.5	10.7	10.9
Step 9	9	33.25	44.54	287.9	52.5	11.3	12.5
Step 10	10	36.75	47.54	346.2	59.2	17.6	16.7
Step 11	11	40.25	57.05	360.3	61.0	15.4	15.5

Table 4.1(b) shows the dynamic characteristics of each step back building structure for excitation in zdirection. When earthquake force is in Z direction, the effect of static and accidental eccentricity is reduced

B. Case b: when Earthquake force in Z – direction (across the Slope Line)

Table 4.1(b): Seismic Response Properties of STEP BACK Building due to Earthquake Force in z-direction

Designation	Storey no.	Storey height(m.)	Max.- displacement(mm)	Base shear force at ground level(KN)			
				FrameA	FrameB	FrameC	FrameD
Step 4	4	15.75	44.29	64.7	52.1	21.4	30.6
Step 5	5	19.25	48.57	59.6	44.8	18.8	26.6
Step 6	6	22.75	50.87	71.5	48.3	17.3	22.5
Step 7	7	26.25	64.41	77.6	49.3	17.2	24.7
Step 8	8	29.75	57.92	82.2	49.8	13.3	22.4
Step 9	9	33.25	66.98	86.2	50.1	14.5	23.6
Step 10	10	36.75	74.99	101.2	51.8	13.4	17.7
Step 11	11	40.25	78.97	108.4	63.2	25.1	32.5

Torsion moment is maximum in Z – direction due to the effect of eccentricity generated, the normalized value of base shear force in extreme left column (frame A) at ground level is comparative less from the normalized value of base shear in X – direction. From design consideration special attention should be given to the size (strength) of the beam element, orientation of element (stiffness) and ductility and extreme left column at ground level should be in safety condition under worst load combination in X and Z direction

IV. CONCLUSION

1) There was a linear increase in top storey sway and natural time period with the building height.
2) Torsional effects due to accidental eccentricity were insignificant.
3) The extreme left column experienced significantly higher shear forces compared to other columns at the ground level, with frames D and C showing much lower shear forces (5-7% of the extreme left column's normalized shear force).

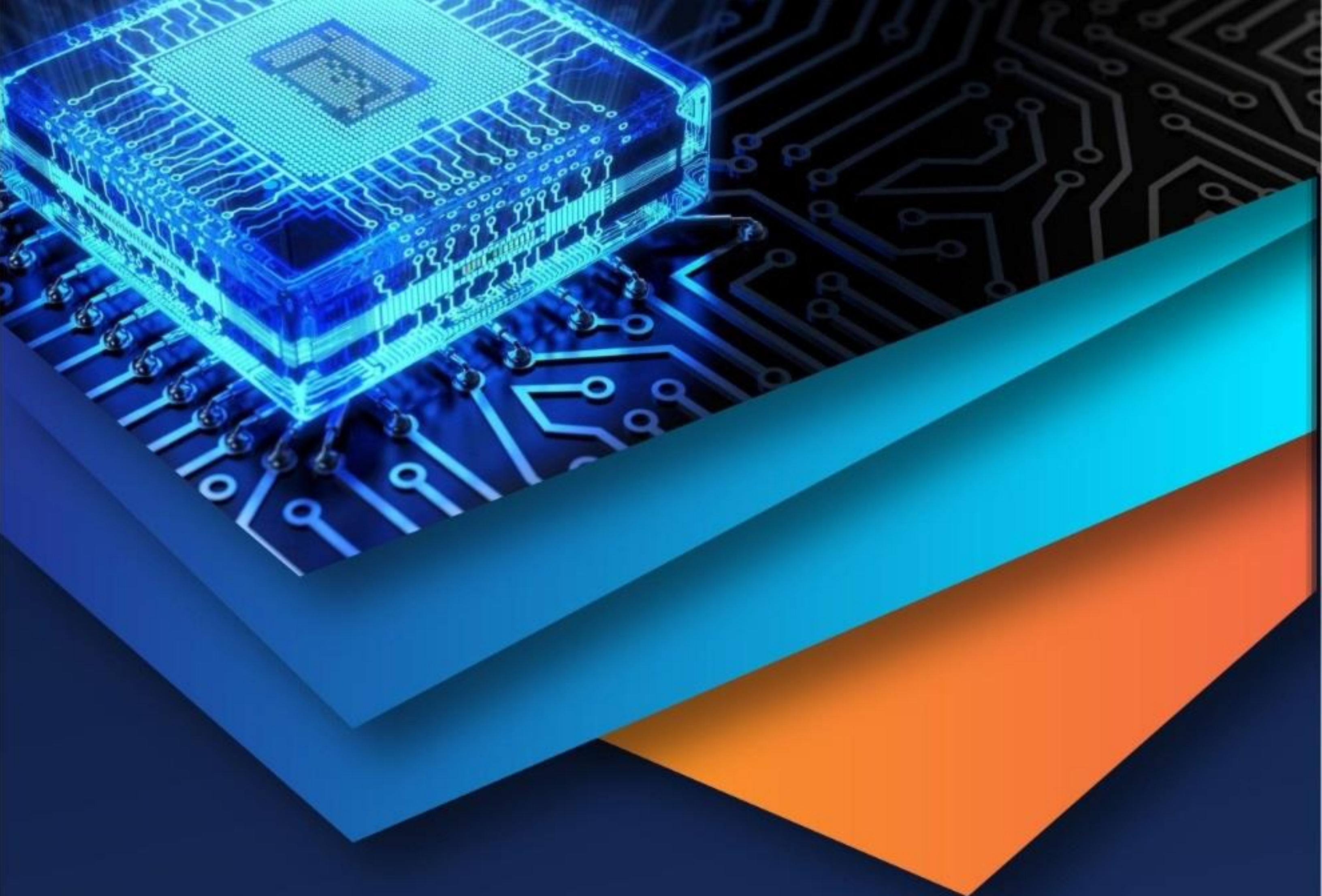
V. ACKNOWLEDGMENT

I express my sincere thanks to the Hon. Vice Chancellor, Dean Student Affairs, Dean Academics, for providing the necessary facilities for carrying out the research work and for providing me with their timely suggestions. I express my sincere thanks, to Dean, School of Engineering and Technology.

REFERENCES

[1] 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1- 6, 2021,Paper No.1472.
[2] Dynamic Analysis OF Sloped Building: Experimantal & Numerical Studies research paper ISSN: 2349-6002.
[3] International Journal of Innovative Technologies' ISSN 2321-8665 ,Vol.04, issue, October-2022 on Experimental & Numerical Studies on Dynamic analysis of Sloped Buildings.
[4] Analysis & Design Software Staad pro, Bentley used.
[5] R.B. Khadiranaikar, & A. Masali, "Seismic performance of buildings resting on Ground- A review", IOSR Journal of Mechanical & Civil Engineering, e-ISSN: ISSN: 2320- 334X, Volume 11, Issue 3 Ver. III (May- Jun. 2021), PP 12-19.
[6] Y Singh,. & G Phani, ., "Seismic Nature of Buildings Located on Sloping-Ground" – An Analytical Study & Some Observations From Sikkim Earthquake of September 18, 2011. 15th World Conference on Earthquake-Engineering Journal,2021.
[7] D. Prashant, K.G Jagadish., "Seismic Response of one- way slope RC-frame With soft-storey" International-Journal of Emerging Trends in Engineering & Development Issue 3, Vol.5 (Sept- 2023).
[8] S. M. Nagargoje, & K. S Sable,., "Seismic Analysis of multi-storied building On sloping-ground", Elixir International-Journal, December 7, 2021
[9] IS 1893-2002 (Part-1), "Criteria for Earthquake-resistant design of structures, General- provisions & buildings", Bureau of Indian Standards, New Delhi 110002.

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)