ANALYSIS OF HIGH RISE RCC BUILDING ON SLOPING GROUND USING ETABS

[1]Dr. V. A. Patil, [2]S. R. Takkalaki, [3]Ms. Snehal Chandrakant Gaikwad
Project guide and Principal B. R. Harne College of Engineering & Technology[1],
Assistant professor B. R. Harne College of Engineering & Technology[2], Student B. R. Harne College of Engineering & Technology[3]

ABSTRACT

Hill buildings are different from those in plains; they are very irregular in horizontal and vertical plains. Hence, they are susceptible to severe damage when affected by earthquake ground motion. Analysis of buildings in hilly region is somewhat different than the buildings on leveled ground, since the column of the hill building rests at different levels on the slope. The other problems associated with hill buildings are, additional lateral earth pressure at various levels, slope instability, different soil profile yielding unequal settlement of foundation. The scarcity of plain ground in hilly regions leads to construct structure on sloping ground in plain region to construct high rise structure is predominantly known condition, but in case of hilly region it is very difficult. In this study the 3D analytical model of G+25 storey building is to be generated for symmetric and asymmetric case with varying type of frame configuration. Building models are analyzed and designed by E-TABS software. We are analyzing the high rise structures for seismic load i.e. equivalent static lateral force method and response spectrum method on sloping ground or hilly regions with varying sloping angles, symmetric frames and step back and set back with step back configuration with varying positions of shear walls by using E-TABS.

Keywords: Framed structure, Behavior of foundation, ETABS, Equivalent static lateral force method, Response spectrum analysis

INTRODUCTION

Earthquake is the most disastrous due to its unpredictability and huge power of devastation. Earthquakes themselves do not kill people, rather the colossal loss of human lives and properties occur due to the destruction of structures. Building structures collapse during severe earthquakes, and cause direct loss of human lives. The economic growth and rapid urbanization in a hilly region has accelerated development of infrastructure and construction activities. Because of which, population density in the hilly region has increased. Therefore, there is popular and pressing demand for construction of multi-story building in hilly region. Hill buildings are different from those in plains; they are very irregular in horizontal and vertical plains. Hence, they are susceptible to severe damage when affected by earthquake ground motion. In sloping ground the height of the column is different at the bottom storey. It is asymmetric in plane and elevation. The short columns are most effects and damage occurs during the earthquake. Care should be taken for making this building earthquake resistance. The various methods are used for the analysis such as static and dynamic. Due to the asymmetry dynamic analysis must be used for seismic analysis of the building. These methods are time history and response spectrum method. In the response spectrum method the data such as zone factor, type of soil etc. are applied from I.S.-1893. In time history method the actual record of accelelogram is applied on the building and analysis of the building is carried out in software. Time history method gives more realistic result compared to the response spectrum method because in time history the actual acceleration data of earthquakes are applied and response of building is studied.

OBJECTIVES

- To determine the ground slope varying 0°, 10° and 20°

- To study the most effective configuration for base shear.
- To study the most effective configuration for time period.
- To study the most effective configuration for storey drift.
- To study the effectiveness of configuration of building frame on sloping ground such as set back with step back building and step back building.

METHODOLOGY

MODELING AND ANALYSIS

In a present study there are 3 group of building (i.e. configurations) are considered, out of which 1st is resting on 0° , 2nd is resting on 10° and 3rd is resting on 20° with set back and modeling and the analysis of building frames carried out using E-TABS software.

GEOMETRIC PROPERTIES AND MATERIAL PROPERTIES ARE GIVEN BELOW.

Number of storey	G+25
Floor Height	3m
No of bay in X direction	9
No of bay in Y direction	9
Spacing in X direction	4m
Spacing in Y direction	4m
Beam size	300X450mm
Column	300X550mm

Slab Thickness	150mm
Thickness of concrete shear wall	150mm
Live load	2kN/m²
Floor finish Load	1KN/M²
Concrete grade	M30
Steel	Fe415

➢ **Earthquake parameters :**

Type of frame	SMRF
Seismic zone	III
Response reduction factor	5
Importance Factor	1

According to the IS 1893 (part I)-2012 following methods have been recommended to determine the design lateral loads –

1. Equivalent Static Method
2. Response Spectrum Method

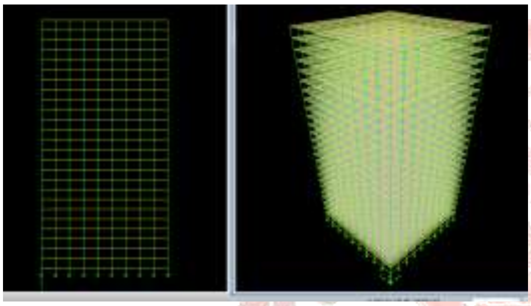


Fig 1. Symmetric plan configuration

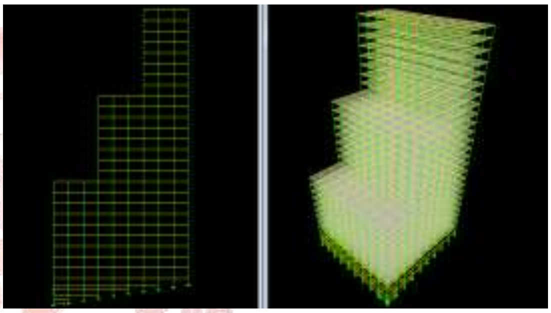


Fig 2. Asymmetrical plan configuration

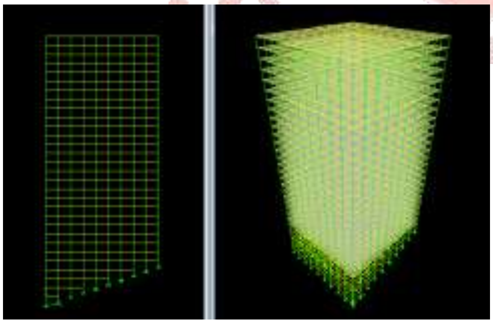


Fig 3. Step back configuration

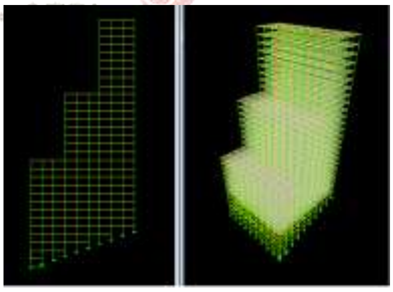


Fig 4. Set back with step back configuration

Defining various positions of shear wall :

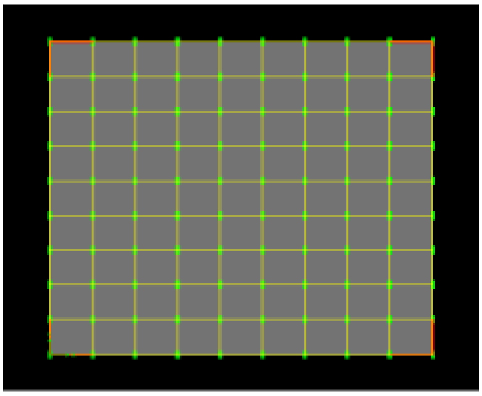


Fig 5 Shear wall at corner

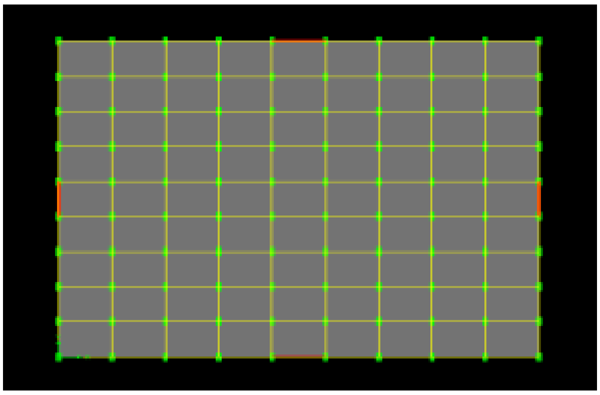


Fig 6. Shear wall at periphery

RESULTS AND DISCUSSION

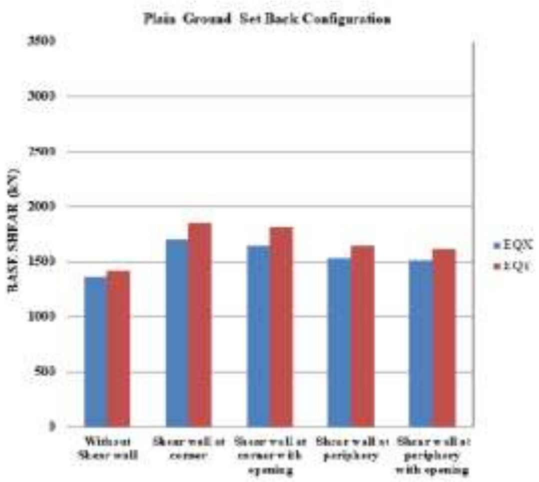


Fig. 3.1 Plain ground set back configuration base shear result.

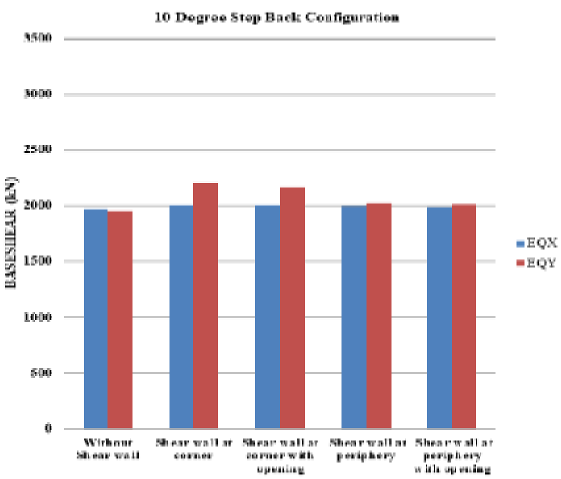


Fig. 3.2 10 Degree step back configuration base shear result.

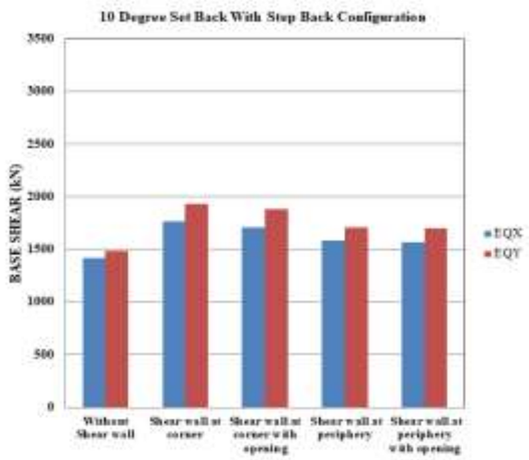


Fig. 3.3 10 Degree set back with step back configuration base shear result.

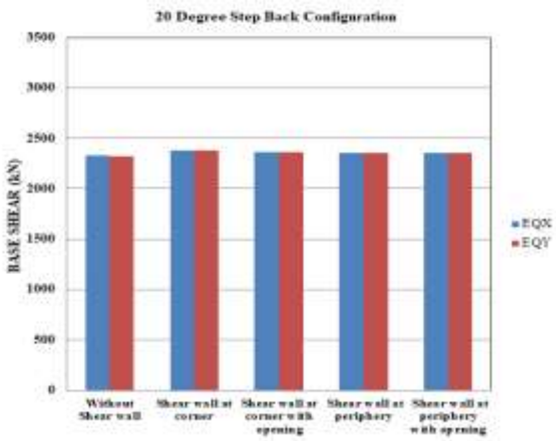


Fig. 3.4 20 Degree step back configuration base shear result.

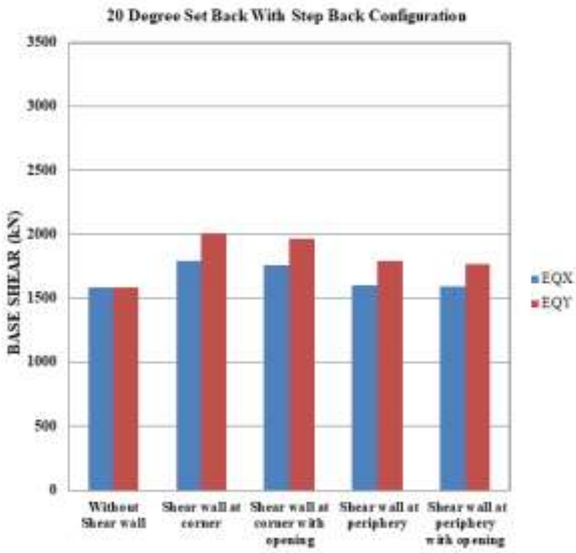


Fig. 3.5 20 Degree set back with step back configuration base shear result.

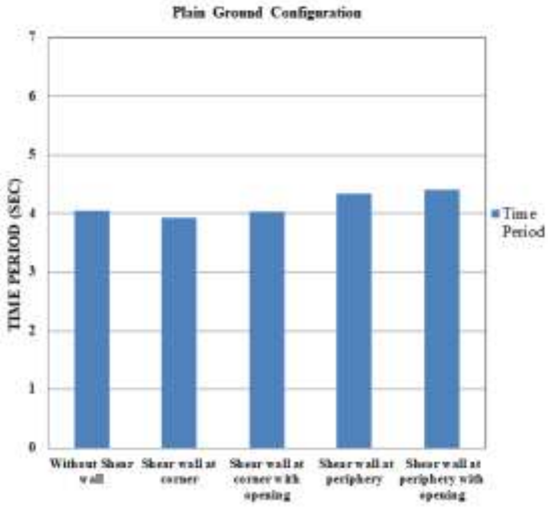
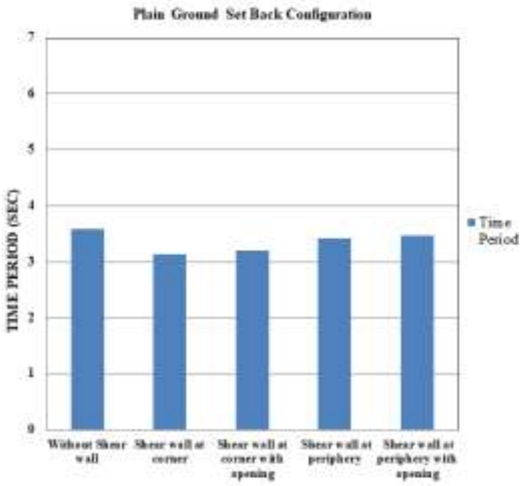


Fig. 3.6 Plain ground configuration time period result.



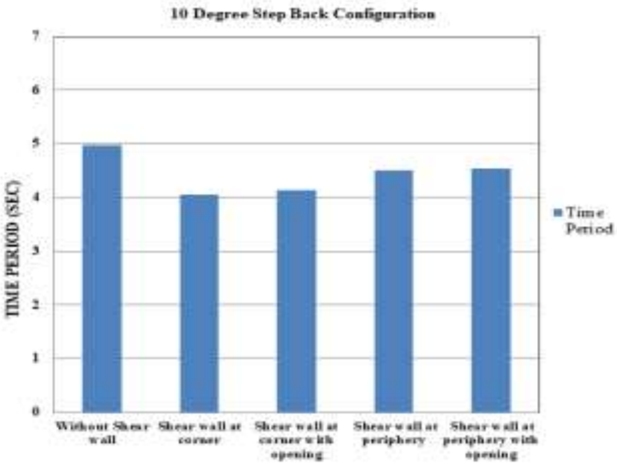
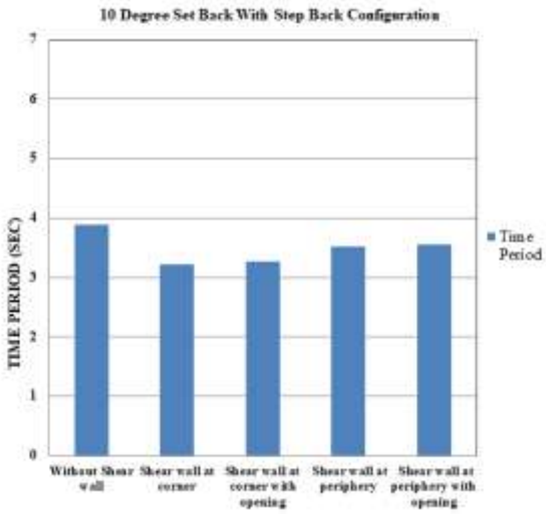


Fig. 3.7 Plain ground set back configuration time period result.

Fig. 3.8 10 Degree step back configuration time period result.



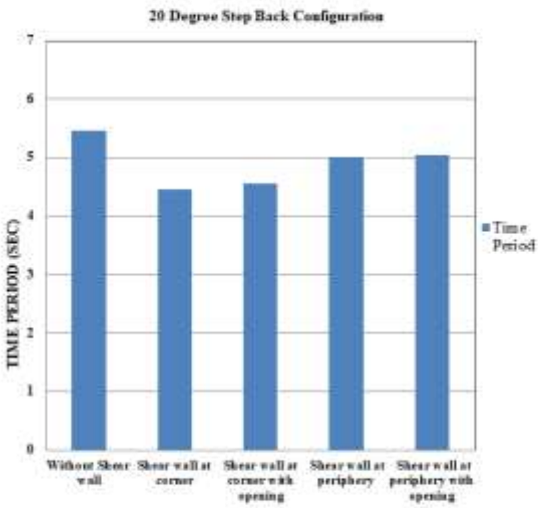


Fig. 3.9 10 Degree set back with step back configuration time period result.

Fig. 3.10 20 Degree step back configuration time period result.

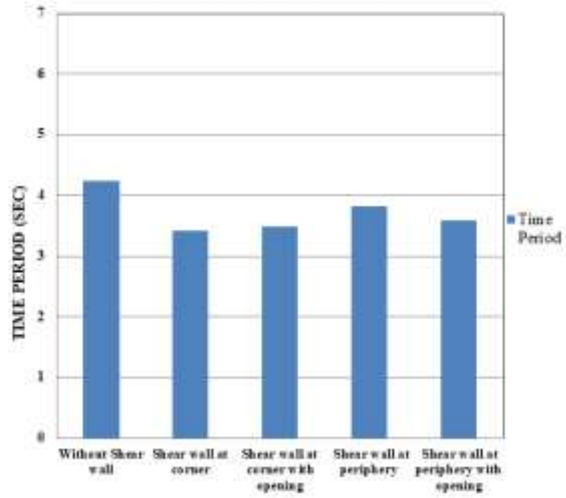


Fig. 3.11 20 Degree set back with step back configuration time period result.

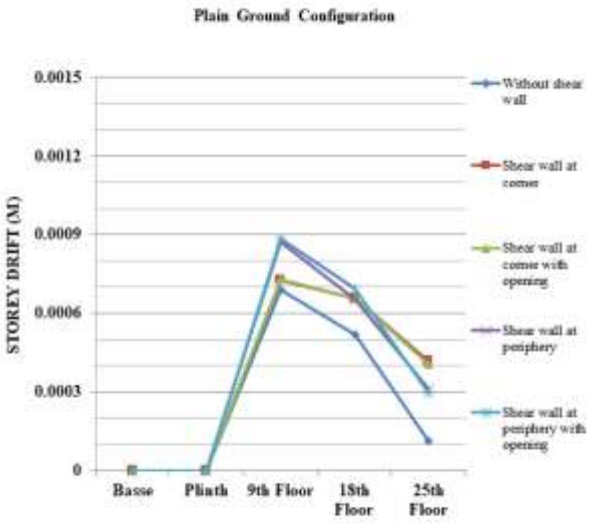


Fig. 3.12 Plain ground configuration storey drift result.

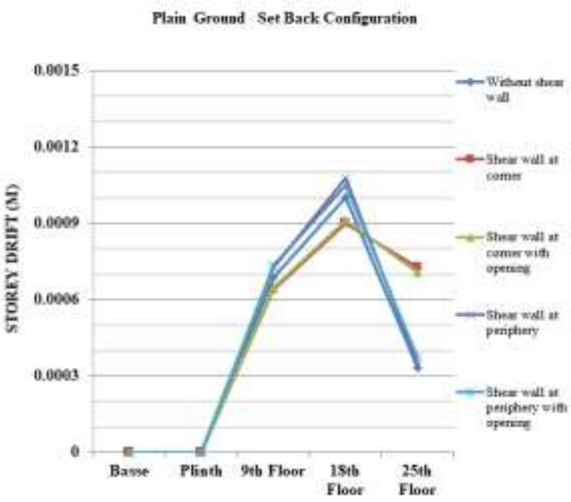


Fig. 3.13 Plain ground set back configuration storey drift result.

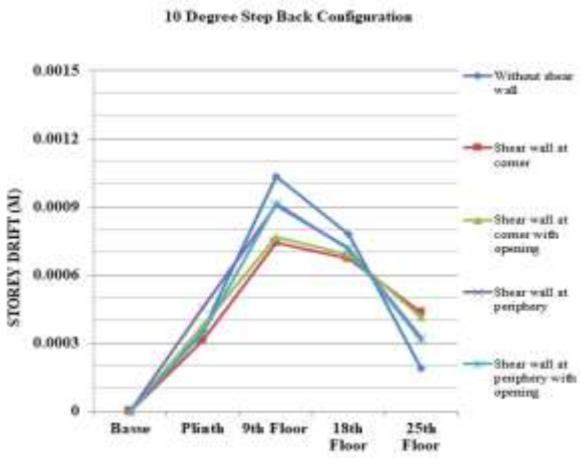


Fig. 3.14 10 Degree step back configuration storey drift result.

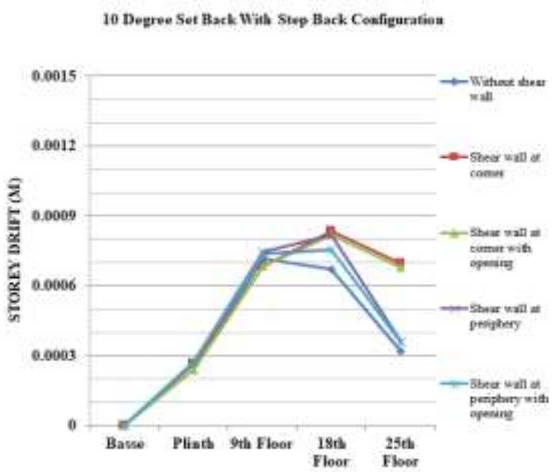


Fig. 3.15 10 Degree set back with step back configuration storey drift

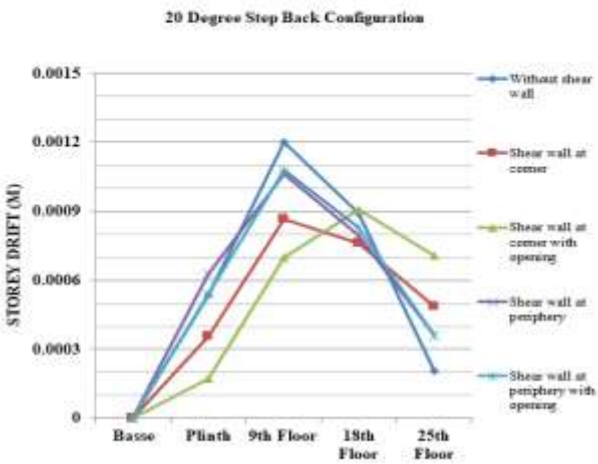


Fig. 3.16 20 Degree step back configuration storey drift

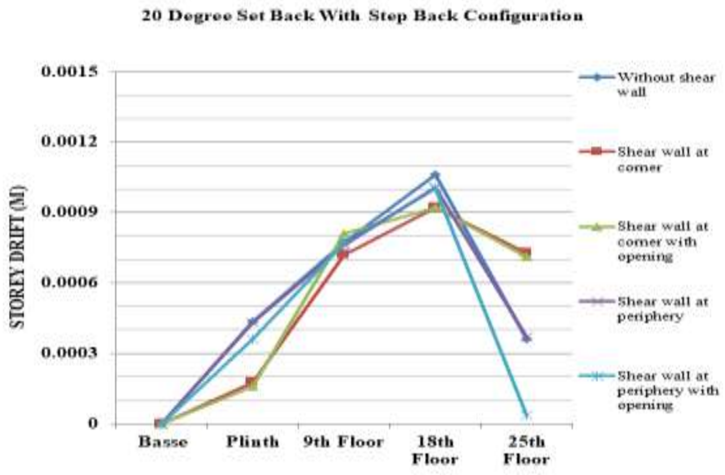


Fig. 3.17 20 Degree set back with step back configuration storey drift

DISCUSSION

- **i.** The base shear for plain ground configuration without shear wall is less as compared to other cases of plain ground configuration i.e. EQX=1216.21KN and EQY=1578.28KN.
- **ii.** The base shear for plain ground set back configuration without shear wall is less as compared to other cases of plain ground set back configuration i.e. EQX=1390.63KN and EQY=1314.66KN
- **iii.** The base shear for 10 degree step back configuration without shear wall is less as compared to other cases of 10 degree step back configuration i.e. EQX=1991.57KN and EQY=1989.78KN.
- **iv.** The base shear for 10 degree set back with step back configuration without shear wall is less as compared to other cases of 10 degree set back with step back configuration i.e. EQX=1467.15KN and EQY=1489.82KN.
- **v.** The base shear for 20 degree step back configuration without shear wall is less as compared to other cases of 20 degree step back configuration i.e. EQX=2326.34KN and EQY=2326.34KN.
- **vi.** The base shear for 20 degree set back with step back configuration without shear wall is less as compared to other cases of 20 degree set back with step back configuration i.e. EQX=1480.82KN and EQY=1589.12KN.
- **vii.** The time period for plain ground configuration with shear wall at periphery with opening is more as compared to other cases of plain ground configuration i.e. 4.5seconds.
- **viii.** The time period for plain ground set back configuration without shear wall is more as compared to other cases of plain ground set back configuration i.e. 3.6seconds.
- **ix.** The time period for 10 degree step back configuration without shear wall is more as compared to other cases of 10 degree step back configuration i.e. 5.1seconds.
- **x.** The time period for 10 degree set back with step back configuration without shear wall is more as compared to other cases of 10 degree set back with step back configuration i.e. 3.8seconds.
- **xi.** The time period for 20 degree step back configuration without shear wall is more as compared to other cases of 20 degree step back configuration i.e. 5.7seconds.
- **xii.** The time period for 20 degree set back with step back configuration without shear wall is more as compared to other cases of 20 degree set back with step back configuration i.e. 4.6seconds.

xiii. The storey drift for plain ground configuration without shear wall is less as compared to other cases of plain ground configuration i.e. 0.0006895meters.

xiv. The storey drift for plain ground set back configuration with shear wall at corner with opening is less as compared to other cases of plain ground set back configuration i.e. 0.000912meters.

xv. The storey drift for 10 degree step back configuration without shear wall is less as compared to other cases of 10 degree step back configuration i.e. 0.0007414m

xvi. The storey drift for 10 degree set back with step back configuration without shear wall is less as compared to other cases of 10 degree set back with step back configuration i.e. 0.0007184meters.

xvii. The storey drift for 20 degree step back configuration without shear wall is less as compared to other cases of 20 degree step back configuration i.e. 0.0008669meters.

xviii. The storey drift for 20 degree set back with step back configuration with shear wall at corner with opening is less as compared to other cases of 20 degree set back with step back configuration i.e. 0.0009216meters.

CONCLUSIONS

- For base shear plain ground without shear wall configuration is most effective as compare to other configurations of plain ground,10 and 20degree sloping ground.
- For time period 20 degree step back configuration without shear wall is most effective as compare to other configurations of plain ground,10 and 20degree sloping ground.
- For storey drift plain ground configuration without shear wall is most effective as compare to other configurations of plain ground,10 and 20degree sloping ground.
- For sloping ground case set back with step configuration is most effective.

REFERENCES

1. A. V. Kulkarni, Mohammed Umar Farooque Patel, (2014), "A performance study and seismic evaluation of RC frame building on sloping ground"(1), IOSR e-ISSN: 2278-1684,p-ISSN: 2320-334X, PP51-58.
2. B.G. Birajdar, S. S. Nalawade, (August 2004) "Seismic Analysis of Building resting on sloping Ground"(2), 13WCEE, Paper no. 1472.
3. Chaitrali Deshpande, (October-2014) "Effect of Sloping Ground on Step Back and Setback Configuration of R.C.C. Frame Building"(3), (IJERT), Vol. 3 Issue 10, ISSN: 2278-0181.
4. H.S. Vidyadhara, Hassan Siddiqui, (October-2013) "Seismic Analysis of Earthquake resistance Multi Bay Multi Storied 3D –RC Frame"(4), (IJERT) Vol. 2, Issue 10, ISSN: 2278-0181.
5. Mohammad Abdul Imran Khan, (April-2015) "Siesmic Effect on Rc Building Resting on Sloping Ground"(5), (IJSRT), Vol. 4, Issue 4, ISSN No. 2277-8179 .
6. Miss Pratiksha Thombre, Dr. S.G.Makarande, (June-2016) "Seismic Analysis of Building Resting On a Sloping Ground"(6), (JETIR), Vol. 3, Issue 06, ISSN: 2349-5162.
7. Narayan Kalsukar and Satish Rathod. (June-2015) "Siesmic Analysis of RCC Building Resting on Sloping Ground with Varying Number of Bays and Hill slopes"(7), (IJCET), Vol.5, Issue No.3, E-ISSN 2277-4106, P-ISSN 2347-5161.
8. Nagarjuna, (July-2015) "Lateral Stability of Multistory Building On Sloping Ground"(8) ,(IRJET), Vol. 02, Issue 4, e-ISSN:2395-0056, p-ISSN 2395-0072.

9. Shivanand B. and H. S. Vidyadhara, (August 2014) "Design of 3D RC frame on sloping ground[9] (IJRET)" Vol. 03, Issue 08, e-ISSN: 2319-1163, p-ISSN: 2321-7308.
10. Dr. T.V. S. Varalakshmi, (May 2016), "Comparison Study of Zone II and zone IV by Considering Different Angles of Sloping Ground For The Analysis of Multi-storey Building by Using E-Tabs" [9], (IJSETR), Vol. No. 05, Issue No. 10, ISSN: 2319-8885, Page No. 2107-2119.

IS CODES:-

1. IS Code:1893-2012, "Criteria for Earthquake Resistant Design of Structures (Part I) General Provision and Buildings, Bureau of Indian Standards.
2. IS 456-2000, "Plain and Reinforced Concrete-code of Practice, Bureau of Indian Standards
3. IS 13920-1993,"Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces-code of Practice", Bureau of Indian Standards.