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Analysis of Seismic Behaviour of Multistorey RCC Frame with Bracings

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Abstract: *The buildings situated on hill slopes in earthquake prone areas are generally irregular, torsional coupled and hence, susceptible to serve damage when affected by earthquake ground motion. Such buildings have mass and stiffness varying along the vertical and horizontal planes, result the center of mass and center of rigidity do not coincide on various floors. The dynamic analysis is carried out using response spectrum method. The dynamic response that's fundamental time period, storey displacement and base shear action induced in columns has been studied for buildings of various combinations. From some past results show that the performance of step back-set back building frames are more suitable as compared with step back building frames. However, after considering bracings to the step back building frames, a far better performance is observed in comparison with step back, and step back-set back building frames. Three dimensional space frame analysis is carried out for five different configurations of eight storey building with different types of bracing system resting on sloping ground. Building models are analyzed by Staad.pro V8i software to study the effect on time period, storey displacement and base shear by various positions of bracing system.*

Keywords*: Earthquake, Sloping Ground, Response spectrum method, step back frames, step back with bracings, XBS, VBS, DBS, KBS, Staad.pro V8i software*

1. Introduction

1.1 General

The analysis of earthquakes and the structure of the earth, by both naturally and artificially generated seismic waves. From the seismic history of our country it's observed that majority of the devastating earthquakes are occurred in northern and north-eastern states of India. In the past decade, all these regions have gone under quick changes due to economic development. Being the Border States rapid urbanization is going on these boundary of country, states with growing real estate development. Due to this, population density in hill region has increased enormously and every one sorts of construction practices are followed.

All in need of building materials that's adobe, burnt bricks, stone masonry, dressed stone, bamboo, timber and reinforcement concrete etc. are used dependent upon the locally available material.

The adobe burnt brick, stone masonry and dressed stone masonry buildings are generally remodeled level ground in hilly regions. Since plain ground in hilly region is extremely limited, therefore there's a pressing demand to construct buildings on hill slope. Hence construction of multistory R.C. frames buildings on hilly slope is that the only feasible option to accommodate rising demand for residential and commercial activities. Three major earthquakes of magnitude greater than 8, Kangra (1905) have occurred during this hilly track within the last century. The hilly seismic region of our country ranges from Jammu Kashmir, Himachal Pradesh, North Uttar Pradesh, North Bihar, Sikkim, North Bengal, Assam, Meghalaya, Nagaland, Arunachal Pradesh, Manipur, and Tripura and Mizoram.

It’s observed from the past earthquakes, buildings in hilly regions have experienced high degree of injury leading of

collapsed though they need been designed for safety of the occupants against natural hazards. Hence while adopting tradition of multi-storey buildings in these hilly and seismically active areas, utmost care should be taken making these buildings earthquake resistant.

1.2 Seismic Behavior of Buildings on Slopes in India

North and northeastern parts of India have large scales of hilly region, which are consider under seismic zone IV and V. through this region the construction of multistory RC framed buildings on hill slopes features a popular and pressing demand, because of its economic development and rapid urbanization. This development in construction activity is increasing population density.
While construction, it must be noted that hill buildings are different from those in plains that's they're very irregular and unsymmetrical in horizontal and vertical planes, and torsionally coupled. Since there is lack of plain ground in hilly areas, it necessitates the construction of buildings on slopes.

During past earthquakes reinforcement concrete frame buildings that have columns of different heights within one storey, experienced more damage in shorter columns as compared to taller columns within the same storey.

Bracing system
In step, back multistoried building configuration top at same level but base unequal of all bays. The floors of such buildings step back towards the hill slope. Center of mass of all floors does not lie on one vertical axis. Bracings hold the structure stable by transferring the loads sideways (not gravity, but wind or earthquake loads) down to the ground and are used to resist lateral loads, thereby preventing sway of the structure

Structural Configurations of the Tall Building
1. Bare frame (Step back building)
2. X-braced system (XBS)
3. Diagonal bracing system (DBS)
4. K bracing system (KBS)
5. V bracing system (VBS)

2. Results and Discussion

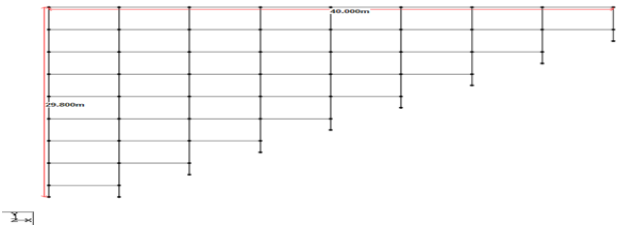


Fig. 1 Elevation of G+7 Bare frame

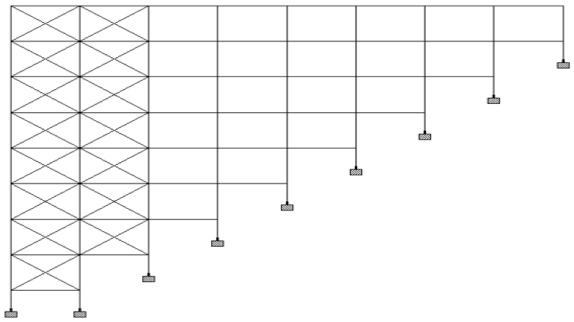


Fig. 2 Elevation of G+7 XBS

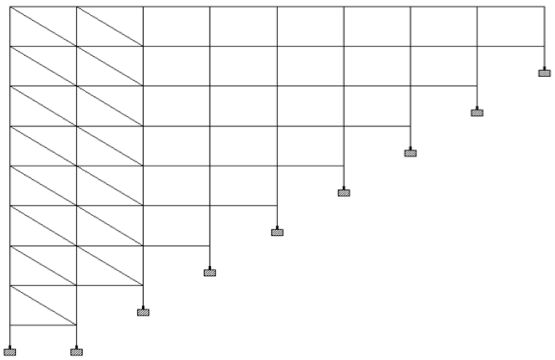


Fig. 3 Elevation of G+7 DBS

Table 1 Mode shapes for beam length 1200 mm and depth of 20 mm

Ranking	Configuration system	Lateral Displacement (mm)		Change in maximum displacement	
		UX	UZ	X-direction	Z-direction
1	XBS	39.77	87.73	27.53 %	44.53%
2	KBS	41.54	89.283	24.23 %	44.39%
3	DBS	42.58	89.3	22.41 %	44.38%
4	VBS	43.79	96.71	20.20 %	39.75%
5	BARE FRAME	54.88	160.316		

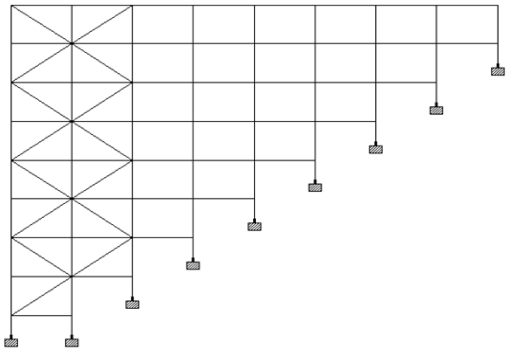


Fig. 4 Elevation of G+7 KBS

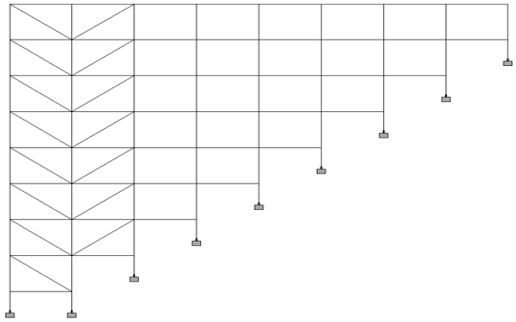
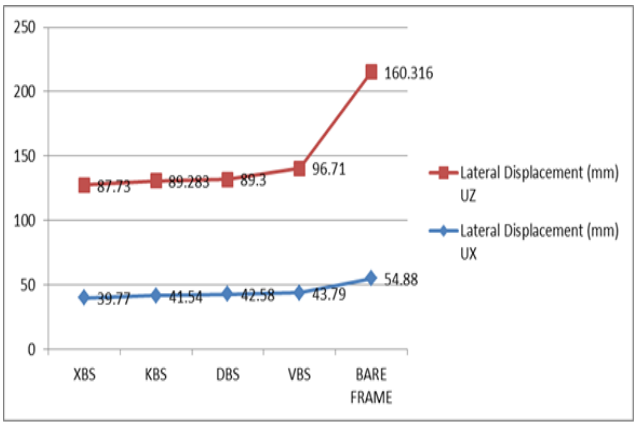


Fig. 5 Elevation of G+7 VBS

Performance based ranking of lateral displacement in all configuration



Graph-1 Performance based ranking of lateral displacement in all configuration

Table 2 Performance based ranking of base shear in all configuration

Ranking	Configuration system	Base Shear in kN	Change in Base shear
1	XBS	2423.653	0.94%
2	KBS	2412.349	0.44%
3	DBS	2412.349	0.44%
4	VBS	2411.769	0.43%
5	BARE FRAME	2401.02	

Table 3 Performance based ranking of Maximum bending moment in all configuration

Ranking	Configuration system	Bending moment in kN-m	Change in B.M.
1	XBS	694.76	24.37%
2	KBS	722.15	21.39%
3	DBS	752.12	18.12%
4	VBS	787.45	14.2%
5	BARE FRAME	918.53	

Comments- From the above table the maximum bending moment decreases in XBS are more than other Bracing systems.
From above analysis, it is found that overall performance of XBS is better than other configurations.
However, as number of members in XBS is double as compare to other models the economical design would be for K-bracing system in step back building on sloping ground.

3. Conclusion, Limitations and Future Scope of the Research

The buildings situated on hill slopes in earthquake prone areas are generally irregular, torsional coupled and hence, susceptible to serve damage when affected by earthquake ground motion. Such buildings have mass and stiffness varying along the vertical and horizontal planes, result the center of mass and center of rigidity do not coincide on various floors. The present investigation was conducted on the effect of structural configuration on seismic behavior on G+7 RC framed structures resting on sloping ground by analyzing and evaluating different types of bracing systems to assess the Changes in lateral displacement, bending moment and base shear compare to bare frame structure. Based on the results obtained the following conclusion are drawn.
The structural configurations investigated are found to be effective in reducing the BM in columns. For instance, the

highest BM in column is 918.53kN-m was obtained in the Bare Frame

For the bracing configuration system, the XBS reduced the BM in the column about25% compared with Bare Frame system. The KBS reduced the bending moments in column about 22%, while DBS and VBS reduced the bending moment in column around 19% & 15% respectively.

All the bracing systems analyzed in this study are effective in reducing displacement in Z-direction by 39-46% in compare of bare frame, however in X-direction were found well effective in the reducing the displacement by about 21-28% in compare of the bare frame.

Among the all bracing system minimum displacement in X-direction is shows 39.77mm in XBS and in Z-direction is 87.23mm in XBS.

The present investigation was conducted on the effect of structural configuration on seismic behavior on typical 8 storey RC framed structure on sloping ground by analyzing and evaluating different types of bracing systems to assess the reduction in lateral displacement, bending moment and shear force compare to bare frame structure. Based on the results obtained the following conclusion are drawn.

For bracing configuration systems, the XBS, KBS systems are found to be most effective configurations and resulting in substantial reduction of lateral displacement (43-45%) & column bending moments (22-25%) in compare to bare frame system.

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