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Effect of Earthquake on Multistoried Step back Building with and without bracing

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Abstract:
Buildings on slope are most vulnerable during earthquake due to formation of irregularity in structure. Hence, buildings with irregularity are generally avoided. But, as the topography of ground it is not all time plain or flat there may be the possibility of slope in the ground, construction of structures on slope since are unavoidable. Such buildings erected on slope known as Step back building. Failure of these buildings due to earthquake can be minimized by providing lateral force resisting members such as bracings, shear wall etc. In this study, bracing of V shape is provided along the outer periphery of step back building located on slope of 10^0, and with two different heights as 6 Storey and 8 Storey. These buildings are modeled in STAAD v8i structural software and then analyzed using Response Spectrum Method. The results are then concluding in terms of Storey drift, Base Shear and Fundamental Time Period. it shows the provision of V bracing improves the storey drift i.e. storey drift is minimized by providing bracing.
Keywords: Step back building, bracings, response spectrum method, storey drift.

1. INTRODUCTION

Due to change in features of the ground, or due to increasing residents and rapid growth of country, buildings are now built on slope. But during earthquake these building are more vulnerable as vertical irregularities are formed in the structures. Irregularity are in the form of short column effect tends to fail the structures very earlier. Thus by providing lateral load resisting members as V bracing the time of failure can be extended so that there may not be any loss of lives due to failure of building.

The focal significance of this work is to improve the behavior of Step back building by decreasing the storey drift, of building constructed on slope by providing of V bracings. As well as Base shear and fundamental time period are also compared.

2. METHODOLOGY

This study has been done in following steps which includes all the procedure from literature study up to result and conclusion on this study:

1. Literature Study.
2. Plan and some factors of building models has been decided.
3. Slope for these buildings were fixed as 10^0 on which building has modeled for two different storey heights as 6 storey and 8 storey.
4. Analysis has been performed using Response Spectrum method in STAAD v8i.
5. Results are presented in terms of storey drift, base shear and fundamental time period.

3. MODELING AND ANALYSIS

Models of two configurations, Step back building and Step back building with V bracing of two storey heights as 6 Storey and 8 Storey are modeled and analyzed using structural software STAAD v8i by response spectrum method for earthquake loading parameters. For this analysis the categorization of models are as given in table shown below:

Table 1: Model Details

Group	Model No.	Storey	Slope	Structure
I	Model 1	6 Storey	10^0	Step back building without bracing
	Model 2	8 Storey		
II	Model 3	6 Storey	10^0	Step back building with V bracing
	Model 4	8 Storey		

Plan of building models is same of size 30 X 30 m. Slope of building is decided as 10^0. Size of column and beam are taken as 700 X 700 mm and 230 X 700 mm respectively with slab thickness as 150 mm. The parameters required for response spectrum analysis are as below:

Storey Height:	3 m
Depth of Foundation:	1.75 m
Wall Thickness:	
a) External :	230 mm
b) Partition:	115 mm
Grade of Concrete:	M 25
Slab thickness:	0.15 m
Superimposed Load:	4 KN/m^2
Zone factor:	0.24
Importance Factor:	1.5
Response Reduction Factor (SMRF):	5
Damping Ratio:	0.05

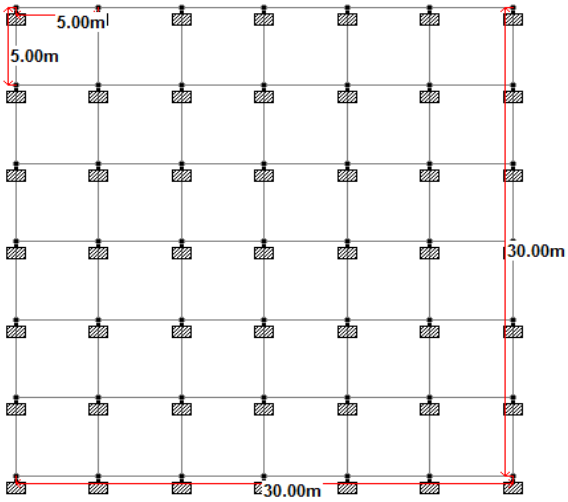
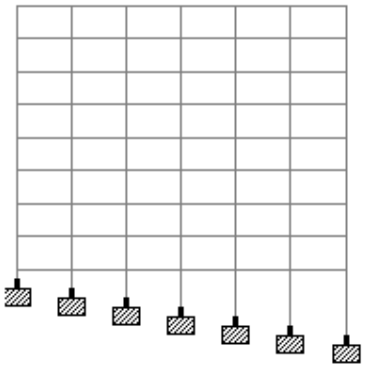
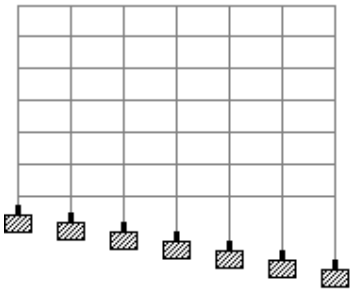


Figure 1: Plan of Building

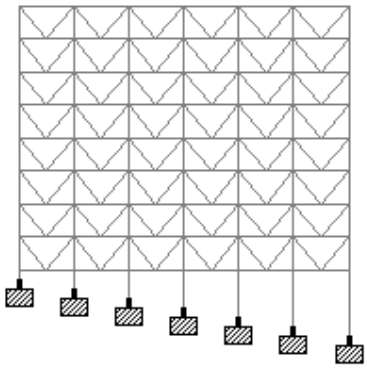


(a)



(b)

Figure 2 (a) & (b): Group I Model for Step back building without bracing



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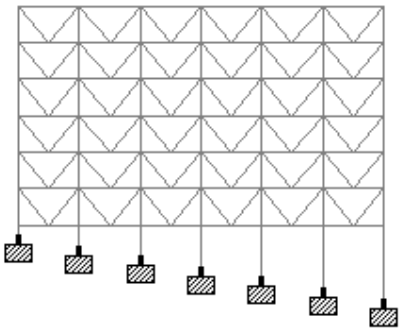

(b)

Figure 3 (a) & (b): Group II Model for Step back building with V bracing

4. RESULTS AND DISCUSSION

Above models are analyzed in STAAD v8i by response spectrum method. These models are Step back building without bracing and Step back building with bracing different storey are presented in tables and graphs for parameters Storey Drift, Base Shear and Fundamental Time Period.

1. Storey Drift:

Table. 2: Storey Drift for 8 Storey

Storey Height	8 Storey	
	Storey Drift of Step back building without bracing (cm)	Storey Drift of Step back building with V bracing (cm)
0	0.5457	0.4933
3	1.1478	0.7235
6	1.297	0.7714
9	1.2086	0.6983
12	1.0616	0.5947
15	0.9037	0.4873
18	0.7331	0.4186
21	0.5383	0.3247
24	0.3343	0.1939

Graphical representation:

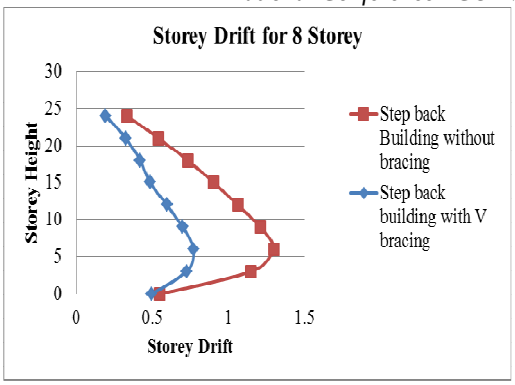

Figure 4: Storey Drift for 8 Storey

Table 3: Storey Drift for 6 Storey

Storey Height	6 Storey	
	Storey Drift of Step back building without bracing (cm) (cm)	Storey Drift of Step back building with V bracing (cm)
0	0.5111	0.3856
3	1.0653	0.6213
6	1.1846	0.6497
9	1.0647	0.5693
12	0.8608	0.4519
15	0.6151	0.3334
18	0.3681	0.195

Graphical representation

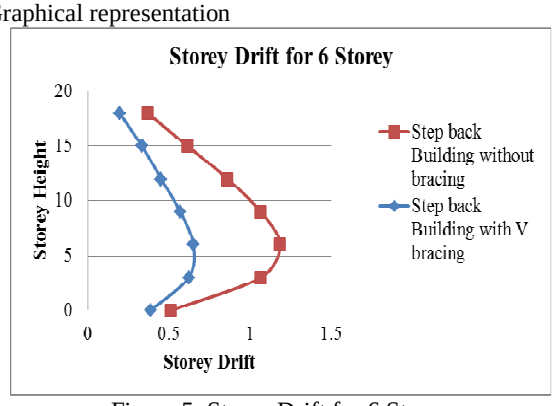

Figure 5: Storey Drift for 6 Storey

Results show that the storey drift decreases by providing V bracings to the building. It is about 45% reduction in drift compare to building on slope without bracing.

Base Shear:

Table 4: Base Shear for 10, 8 and 6 Storey

Storey Height	Step Back Building without bracing	Step Back Building with V braicng
8 Storey	9903.03 KN	9896.69 KN
6Storey	7875.86 KN	7905.18 KN

Table No. 4: Base Shear for 10, 8 and 6 Storey

Graphical representation of Base Shear:

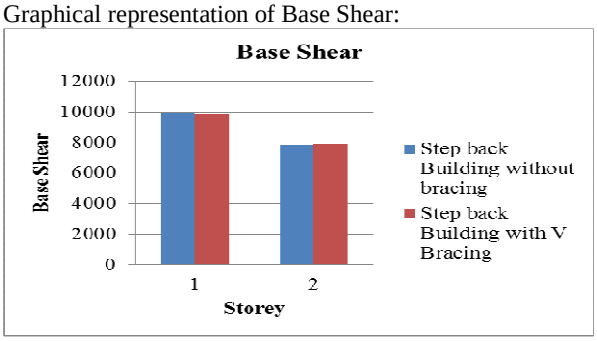

Figure 6: Base Shear for 8 and 6 Storey

Base shear is found more by providing V bracing as the weight of the building is increases.

2. Fundamental Time Period:

Table 5: Fundamental Time Period

Storey Height	Step Back Building without bracing	Step Back Building with V braicng
8 Storey	1.23829 Sec	1.1139 Sec
6Storey	0.97651 Sec	0.88753 Sec

Graphical representation;

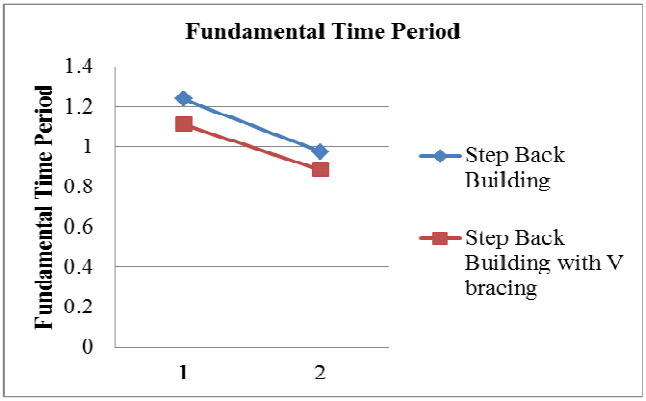

Figure No. 7: Fundamental Time Period

Likewise, fundamental time period is not much fluctuating in buildings on slope without and with bracing. Only small variation in fundamental time period is noted.

5. CONCLUSIONS

All results presented above in tabular and graphical form on analysis of building on slope i.e. on step back building

and step back building with V bracing, it can be concluded that,

1. Provision of bracing of v shape reduces the storey drift.
2. Base Shear is increases by providing bracing as it increases weight of building.
3. In the same way, fundamental time period for step back building with V bracing is more compare to without bracing.
4. Step back building is more prone to earthquake as irregularities are formed but if V bracing is provided it will behave more better compare to without bracing.

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