Available online at www.elixirpublishers.com (Elixir International Journal)

Electrical Engineering

Elixir Elec. Engg. 53 (2012) 11980-11982

ISSN: 2229-712X

Seismic performance of multi-storeyed building on sloping ground

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ARTICLE INFO

Article history:
Received: 28 March 2012;
Received in revised form:
7 December 2012;
Accepted: 7 December 2012;

Keywords
Seismic,
Building,
Sloping,
Ground.

ABSTRACT

The buildings situated on hill slopes in earthquake prone areas are generally irregular, torsionally coupled & hence, susceptible to serve damage when affected by earthquake ground motion. Such buildings have mass & stiffness varying along the vertical & horizontal planes, resulting the center of mass & center of rigidity do not coincide on various floors, hence they demand torsional analysis, in addition to lateral forces under the action of earthquakes. These unsymmetrical buildings require great attention in the analysis & design. Analysis of hill buildings is somewhat different than the buildings on leveled ground, since the column of hill building rests at different levels on the slope. The shorter column attracts more forces & undergoes damage, when subjected to earthquakes.

Introduction

The economic growth & rapid urbanization in hilly region has accelerated the real estate development. Due to this, population density in the hilly region has increased enormously. Therefore; there is popular & pressing demand for the construction of multi -storey buildings on hill slope in and around the cities.

The adobe burnt brick, stone masonry & dressed stone masonry buildings are generally made over level ground in hilly regions. Since level land in hilly regions is very limited, there is a pressing demand to construct buildings on hill slope. Hence construction of multi-storey R.C.Frame buildings on hill slope is the only feasible choice to accommodate increasing demand of residential & commercial activities.

Sinificance of Study

It is observed from the past earthquakes, buildings in hilly regions have experienced high degree of demand leading to collapse though they have been designed for safety of the occupants against natural hazards. Hence, while adopting practice of multi -storey buildings in these hilly & seismically active areas, utmost care should be taken, making these buildings earthquake resistant.

Scope of Study

Three dimensional space frame analysis is carried out for three different configurations such as

1) Step back
2) Step back-Setback
3) Setback

Height of buildings ranging from 15.2m to 52.6m (4 to 15 storey) resting on sloping & plain ground.

Dynamic response of these buildings, in terms of base shear & top floor displacement is presented & compared within the considered configuration as well as with other configurations. At the end, a suitable configuration of building to be used in hilly area is suggested.

Building Configuration

Three different configurations are considered,

1) Step back(Resting on sloping ground)
2) Step back –Setback(Resting on sloping ground)
3) Setback.(Resting on plain ground)

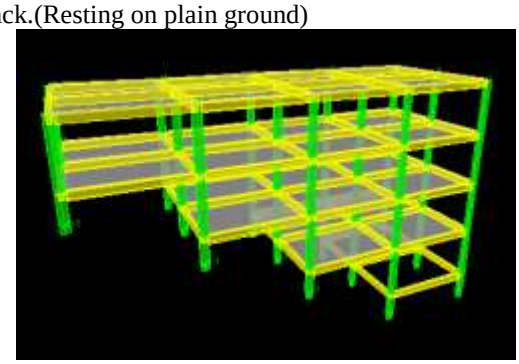

Fig.1 Stepback building

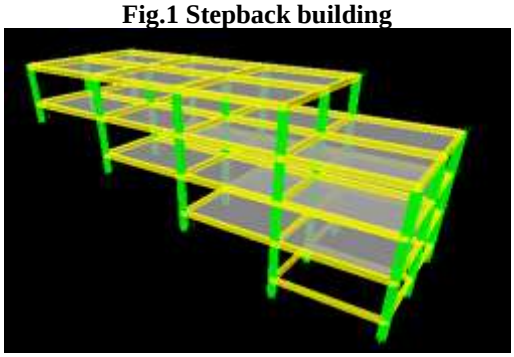

Fig. 2 Stepback-setback building

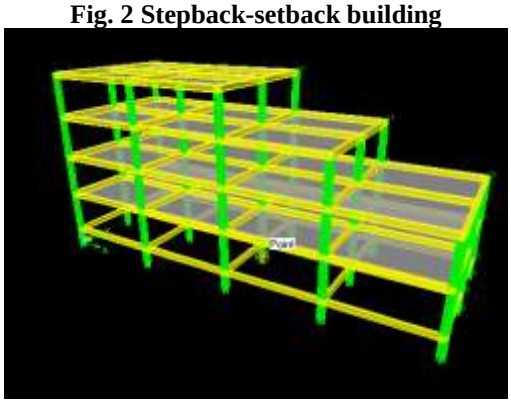

Fig.3 Setback Building

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The height & length of building in a particularpattern are, in multiple blocks, the size of block is being maintained at 7x5x3.4m. The depth of footing below ground level is taken as 1.6 m, where hard strata available.

The buildings shown in figure 4.1 having step back configuration are labeled STEP4 to STEP15. Step back-Setback configuration of buildings is shown in fig 4.2, are designed as STPSET4 to STPSET15. Setback buildings resting on plain ground& labeled SET4toSET15, as shown in fig 4.3.

Table 4.1 Properties of members of different configurations of building

Building Configuration	Size of column	Size of beam
Step back Buildings	STEP4 to STEP5 230x500mm STEP6to STEP7 230x650mm STEP8to STEP9 300x650mm STEP10to STEP11 300x850mm STEP12to STEP15 350x900mm	230x450mm
Stepback&Setback Building	STEPSET4 to11 230x475mm STEPSET12 to 15 350x900mm	230x450mm
Setback Building	SET4to11 230x475mm SET12to15 350x900mm	230x450mm

Method of analysis

The seismic analysis of all buildings are carried out by Seismic coefficient method by using

IS 1893(part I) -2002. The other parameters used in seismic analysis

1) Moderate seismic zone III
2) Zone Factor 0.16.
3) Importance Factor 1
4) Response Reduction Factor 5

For each building case minimum six modes were considered.

Analyses of results

In all, thirty six buildings have been analyzed for seismic load. The seismic force was applied in X & Y direction independently. Important results are presented in subsequent sections.

Table 6.1 Top Storey Displacement & base shear of Step back Building.

BUILDING CONFIGURATION	BASE SHEAR (KN)		TOP STOREY DISPLACEMENT(MM)	
	EQX	EQY	EQX	EQY
STEP4	398.43	181.07	07.27	10.21
STEP5	326.11	173.22	11.78	15.13
STEP6	343.29	192.79	13.73	18.40
STEP7	314.42	185.30	18.00	23.01
STEP8	309.34	221.60	21.02	22.46
STEP9	296.15	217.57	25.31	26.34
STEP10	320.61	233.66	26.94	28.61
STEP11	305.60	228.56	31.17	32.39
STEP12	310.17	250.11	33.94	33.40
STEP13	302.77	246.35	38.19	37.02
STEP14	295.35	242.35	42.57	40.71
STEP15	290.25	232.81	47.07	44.48

Table 6.2 Top Storey Displacement & base shear of Step back -Setback Building.

BUILDING	BASE SHEAR (KN)		TOP STOREY DISPLACEMENT (MM)	
	EQX	EQY	EQX	EQY
STEPSET4	341.32	199.73	9.75	9.91
STEPSET5	408.83	219.62	10.60	9.99
STEPSET6	473.89	224.29	11.49	9.54
STEPSET7	432.79	221.18	10.92	8.81
STEPSET8	385.51	214.27	10.60	8.10
STEPSET9	353.04	207.96	10.74	7.49
STEPSET10	330.70	202.75	11.18	6.99
STEPSET11	312.44	198.53	11.85	6.56
STEPSET12	490.26	352.52	2.85	2.79
STEPSET13	457.69	342.73	2.90	2.55
STEPSET14	441.23	339.19	2.68	2.25
STEPSET15	414.84	326.43	3.21	2.21

Table 6.3 Top Storey Displacement & base shear of Setback Building

BUILDING	BASE SHEAR (KN)		TOP STOREY DISPLACEMENT(MM)	
	EQX	EQY	EQX	EQY
SET4	188.56	124.25	15.93	22.85
SET5	189.93	127.70	19.18	28.04
SET6	191.84	128.78	22.43	33.21
SET7	191.06	130.25	25.70	38.40
SET8	190.73	130.98	28.98	43.65
SET9	190.57	131.56	32.25	48.96
SET10	190.03	146.66	35.51	60.46
SET11	189.78	161.15	38.74	73.41
SET12	257.80	216.71	34.64	42.68
SET13	255.29	217.25	37.48	46.41
SET14	252.76	219.71	40.31	51.14

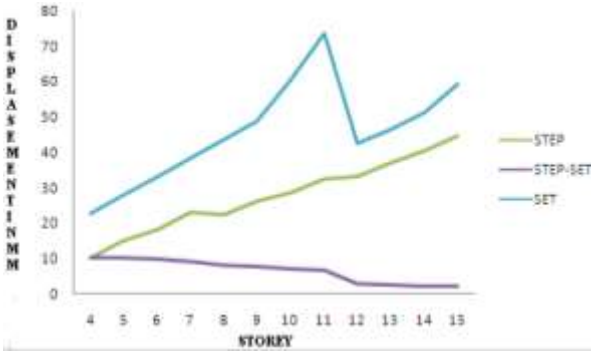

Fig.6.2 Relation Between Displacement & Storey Of Step, Step-Set & Set Buildig

Conclusions

Analysis of three configurations of buildings is carried on sloping & leveled ground. The following conclusions may be drawn from this study.

1) The maximum base shear is induced in Step back-Setback building& least in Setback building on leveled ground.

2) Top storey displacement of Step back building is quite high as compared to Step back-Setback building resting on sloping ground.

3) Stepback-Setback building may be Favored on sloping group

References

1)D.K.Paul "Simplified seismic analysis of framed buildings on hill slopes Bulletin of Indian Society of earthquake technology, Vol 30, no4,paper 335,Dec 1993, pp 113-124

2) Satish Kumar & D.K.Paul , Hill buildings configurations from seismic considerations, Journal of Structural engineering, vol 26,no3, oct.1999, pp 179-185
3)Satish Annigeri ,Ashok k Jain "Torsional Provisions for asymmetrical multi-storey buildings in I.S.1893 ," International Journal of structures, vol14, no 2, paper no 139 ,dec 94,pp 115-142.
4) Satish kumar & D.K.Paul 3.D.Analysis of Irregular Buildings with Rigid Floor Diaphragms Bulletin of Indian Society of earthquake technology, Vol 31, no4, paper no 335, Sept 1994, pp 141-154
5)D.S.R.Murthy & K.Latha Journal of Structural Engineering , Vol 37,No 4,Octomber-November 2010 pp256-262
6) Murthy C.V.R. Learning earthquake design
7) IS 1893 (Part I) 2002 8) IS 13920 – 1993 9) IS 4326 -1993 10) IS 456-2000