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Effect of Sloping Ground on Step- Back And Setback Configurations of R.C.C.Frame Building

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***Abstract*— Most of hilly regions in northern India where seismic activities are common, buildings are required to be constructed on sloping ground due to scarcity of plain land. The buildings situated on hill slopes in earthquake prone areas are generally irregular, torsionally coupled and hence susceptible to severe damage when affected by earthquake ground motion.. In this paper, some studies have been made on analysis of actual practiced building with stepback and stepback-setback configurations and ground conditions, i.e sloping ground and leveled ground, by using response spectrum method as per IS1893-2000. Effect of bottom ties on response of building when resting on sloping ground is also studied here. This study shows that for sloping and leveled ground, stepback-setback building gives effective response when earthquake occur.**

Keywords*— Stepback and Stepback-Setback,buildings, hill slopes, irregular, torsionally coupled, torsional analysis, lateral forces, response spectrum method , bottom ties.

INTRODUCTION

India has track record of catastrophic earthquakes, at various regions, which left behind loss of many lives and heavy destruction to property and economy. Analysis of buildings in hill region is somewhat different than the buildings on leveled ground, since the column of the hill building rests at different levels on the slope. Such buildings have mass and stiffness varying along the vertical and horizontal planes resulting the center of mass and center of rigidity do not coincide on various floors, hence they demand torsional analysis, in addition to lateral forces under the action of earthquakes. The unsymmetrical buildings require great attention in the analysis and design under the action of seismic excitation. Past earthquakes in which, buildings located near the edge of a stretch of hills or on sloping ground suffered serious damages. The shorter column attracts more forces and undergoes damage, when subjected to earthquakes. 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 [1],[2].

The objectives of this study are, to check the effect of bottom ties on building on sloping ground, to compare top storey displacement, base shear, torsional moment, time period for step back and set back configurations, compare response of step back, set back configurations on sloping and leveled ground.

Structural Modeling and Analysis

I. PRELIMINARY DATA

G+6 multistoried building [Fig.1] is analysised here with storey height of 3.1 m Hard Strata is available at 1.5 m below ground level, slope of ground are 26°,28°,30°.Building Configurations are consider here like Stepback Building on plain ground; Stepback Building on sloping ground; Stepback-Setback Building on plain ground; Stepback-Setback Building on sloping ground. Seismic analysis of buildings is carried out by Response Spectrum method as per IS1893-2000. In the analysis Zone III, SMRF and I=1 are considered. For this study Staad.Pro Software used.

II. LOADING CONSIDERATION

For analysis of structure following loads ate taken from IS875 Part I and II.

Live Load on typical floor = 2.5 kN/m^2
Live load on terrace = 1.5 kN/m^2
Live load on staircase = 3 kN/m^2
Water Proofing load = 0.5 kN/m^2
Floor Finish on typical floor = 1 kN/m^2
Earthquake force in X-direction [Fig 1]
Earthquake force in Z-direction [Fig 1]

In all, five different load combinations were considered as per the IS875-Part V requirements, which are as following:

Combination 1: 1.5(DL + LL)
Combination 2: 1.2(DL + LL $\pm$ EL)
Combination 3: 1.5(DL $\pm$ EL)
Combination 4: (0.9DL $\pm$ 1.5EL)
Combination 5: 1.2 DL+0.3LL$\pm$ EL

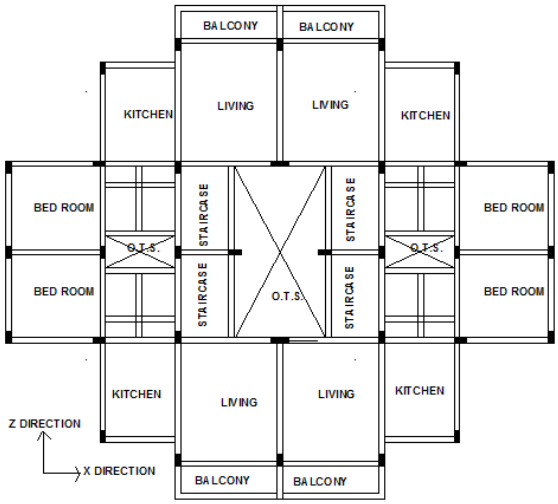


Fig.1: Plan of Building of proposed work (Auto CAD 2008)

Table No.1: Sizes of structural elements

Sr. No	Structural Member	Size
1	Columns on Ground	600mmX600mm
2	Columns on 1st to 6th floor	300mmX600mm
3	Beams on Typical Floors	230mmX500mm
4	Thickness of typical slab	150mm
5	Exterior and Internal wall thickness	230 mm

III. MODELING OF BUILDING

In this study, all analyses will carry out using software Staad Pro V8i.

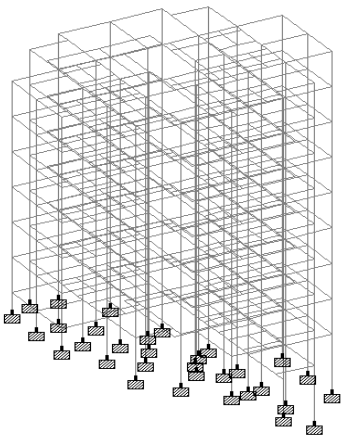


Fig.2: 3D model of Stepback building on sloping ground in Staad Pro V8i.

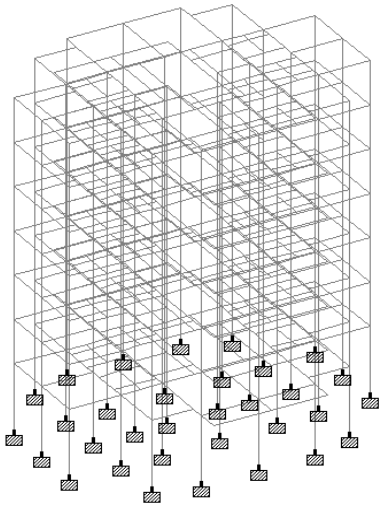


Fig.3: 3D model of Stepback building on plain ground in Staad Pro V8i.

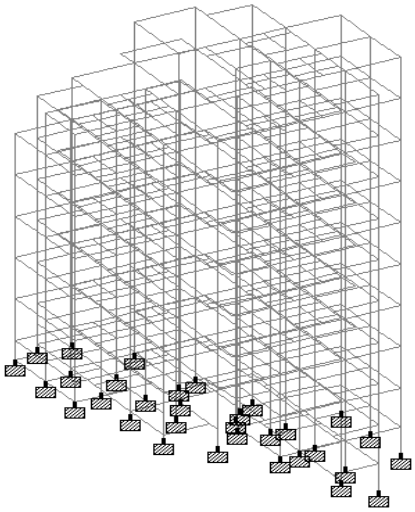


Fig. 4: 3D model of Stepback-Setback building on sloping ground in Staad Pro V8i.

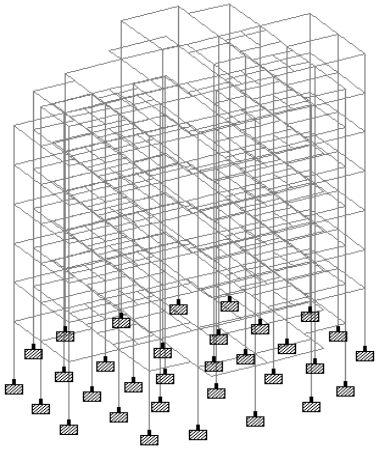


Fig. 5: 3D model of Stepback-Setback building on plain ground in Staad Pro V8i.

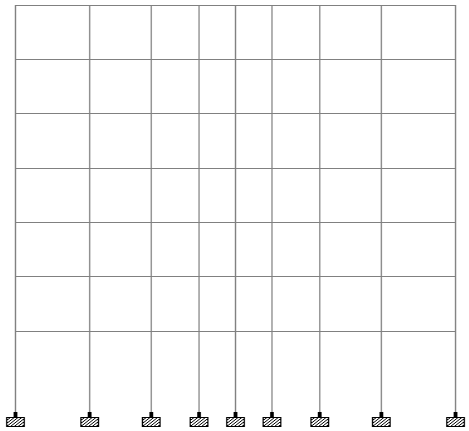


Fig. 4: Building resting on plain ground

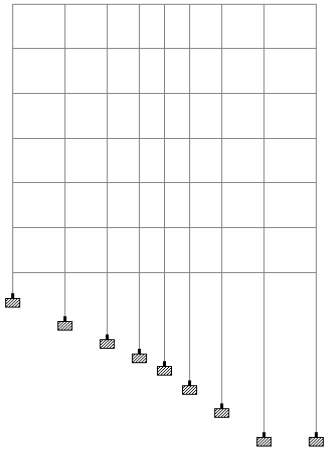


Fig. 5: Building on sloping ground without bottom ties

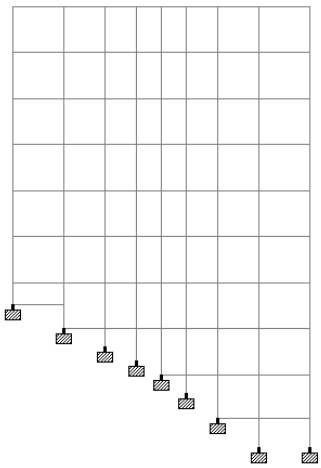


Fig. 5: Building on sloping ground without with bottom ties

RESULTS

I.COMPARISON OF RESPONSES OF STEPBACK BUILDING AND STEPBACK-SETBACK WITH AND WITHOUT BOTTOM TIES

For constant slope of ground, for stepback building with bottom ties axial force, shear force, torsion, major bending moment, minor bending moment in bottom columns decreases by 22.71%, 33.51%, 4.12%, 12.98%, and 48.1% respectively for zone III as compare to building without bottom ties, For stepback-setback building with bottom ties axial force, shear force, torsion, major bending moment, minor bending moment in bottom columns decreases by 3.2%, 30.95%, 11.03%, 4.40%, and 20.24% respectively for zone III as compare to building without bottom ties. For all slope of ground taken into consideration nearly same behavior of axial force, shear force, torsion, major bending moment and minor bending moment has been found.

II.COMPARISON OF BASE SHEAR, TOP STOREY DISPLACEMENT AND TIME PERIOD OF STEPBACK AND STEPBACK-SETBACK BUILDING ON LEVELED AND SLOPING GROUND IN ZONE III [TABLE NO1,2]

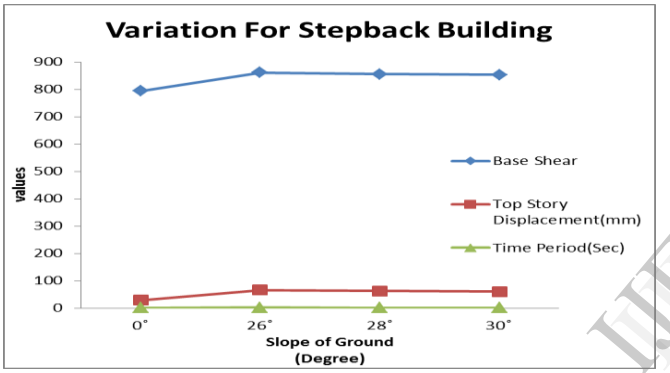
Table No 2: Comparison of base shear, top storey displacement and time period of stepback and stepback-setback building on leveled ground in zone III

Parameters	*Stepback Building*	*Stepback-Setback Building*
Ground Condition	Plain Ground	
Base Shear (kN)	794.39	696.844
Top Storey Displacement (mm)	29.126	24.894
Time Period (sec)	1.38353	1.25301

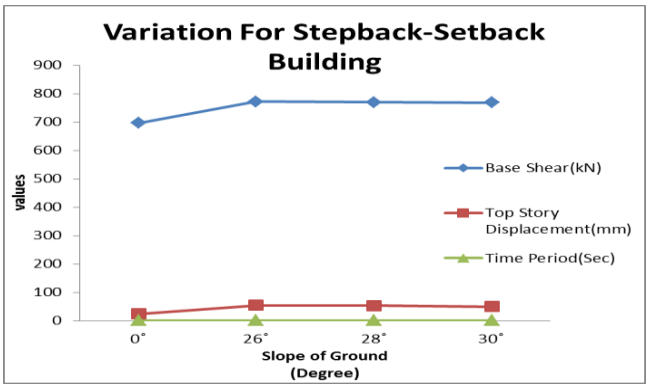
Table No 3: Comparison of base shear, top storey displacement and time period of stepback and stepback-setback building on sloping ground in zone III

Parameters	Sloping Ground					
Ground Condition	Stepback Building with bottom ties			Stepback-Setback Building with bottom ties		
Slope of ground	26°	28°	30°	26°	28°	30°
Base Shear (kN)	860.85	855.36	853.1	771.76	768.97	767.9
Top Storey Displacement (mm)	65.87	62.34	60.51	54.64	53.23	50.68
Time Period (sec)	1.96	1.89	1.87	1.83	1.82	1.79

Graph No. 1: Variation for Stepback Building



Graph No. 2: Variation for Stepback-Setback Building



For stepback building resting on sloping ground, as the slope of ground increases from 26º to 28º the base shear and top story displacement decreases by 0.5% , and time period decreases by 0.3% ,as the slope of ground increases from 28º to 30º base shear and top story displacement decreases by 0.3% and time period decreases by 0.1%

For stepback-Setback building resting on sloping ground, as the slope of ground increases from 26º to 28º base shear decreases by 0.4%,top story displacement decreases by0.3% and time period decreases by 0.5% ,as the slope of ground increases from 28 to 30 base shear decreases by 0.1% , top story displacement decreases by 0.5% and time period decreases by 0.2%

CONCLUSION

From above study it has been concluded that,

1. Base shear of building resting on plain ground is less than that of building resting on sloping ground. For building resting on sloping ground base shear increased by 7.3% in X direction and 13% in Z direction. Base Shear of stepback- setback building is less than that of stepback building.
2. As the slope of ground increases base shear, top storey displacement and time period decreases mildly.
3. Time period of stepback building resting on plain ground increases by 5 % than that of stepback-setback building and for sloping ground it is 6.1 %. Time period of building resting on sloping ground is increased by 28.9% than building resting on plain ground
4. Top storey displacement of setback-stepback building is less than that of stepback building.
5. Use of bottom ties gives effective response of hilly building.

From above it can be concluded that base shear, top story displacement and time period, torsion in bottom column of Stepback-Setback building are less than that of Stepback building resting on sloping as well as plain ground therefore Stepback-Setback building configuration is suitable on plain and sloping ground. From this study it can be recommended that use of bottom ties at 3.1 m height interval gives effective response of building when it is resting on sloping ground. These bottom ties should be connected up to the short column

ACKNOWLEDGMENT

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[2] Dr. S. A. Halkude, Mr. M. G. Kalyanshetti, Mr. V. D. Ingle "Seismic Analysis of Buildings Resting on Sloping Ground with Varying Number of Bays and Hill Slopes", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 2 Issue 12, December – 2013.