Seismic Analysis of Building Resting on Sloping Ground

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Abstract—The hilly areas in north east India contained seismic activity. Due to hilly areas building are required to be constructed on sloping ground due to lack of plain ground. The buildings are irregularly situated on hilly slopes in earthquake areas therefore many damages occurred when earthquake are affected, this may be causes lot human disaster and also affect the economic growth of these areas... In this paper we analized using Staad Pro comparison between sloping ground, with different slope and plain ground building using Response Spectrum Method as per IS 1893-2000 The dynamic response, Maxmium displacement in columns are analized with different configurations of sloping ground.

Index Terms— Seismic, Multistoried building, Sloping ground

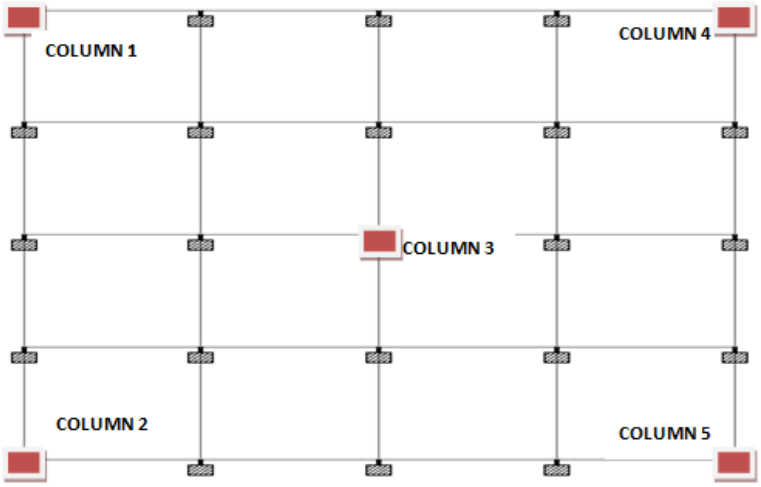
I. INTRODUCTION

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].

II. STRUCTURAL MODELLING

A RCC medium rise building of 5 storeyes with floor height 3 m subjected to earthquake lading in V has been considered. In this regard STAAD Pro V8i software has been considered as tool to perform. Effect of sloping effect of the ground on behaviour of structural frames is analysed. Displacements have been calculated foe five different column.

Fig 1.1. Plan of the Building



The plan for the above building shown in figure has been considered to carry out the study the dimension of the building are 12m x 12m. Generally in such cases the building is to be analysed for the earthquake force because maximum lateral force induced in building is due to eatthquake load. The structural effect of the building on various sloping ground is to be studied.

Case 1 – Regular building which having slope 0^o
Case 2 – Building having slope of 10^o
Case 3 – Building having slope of 20^o
Case 4 – Building having slope of 30^o
Case 5 – Building having slope of 40^o
Case 6 – Building having slope of 50^o

Loading consideration Dead Load (DL) and Live load (LL) have been taken. Seismic load calculation has been done based on the IS 1893 (Part 1) (2002)"s approach. Load combination 1.5(DL+EQX) along X direction and 1.5(DL+EQZ) along Z direction has been consider.

Table No. 1

Sr. No	Description	Dimensions
1	Storey height of building	3m
2	Dimension of column	0.45 x 0.3m
3	Dimension of beam	0.4 x 0.23m
4	Thickness of slab	0.150 m
5	Live load on building	3kn/m

Fig.1.2 Building on slope of 0^o

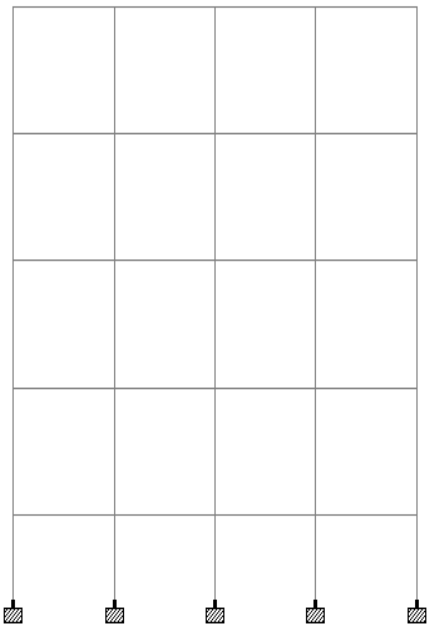


Fig.1.3 Building on slope of 10^o

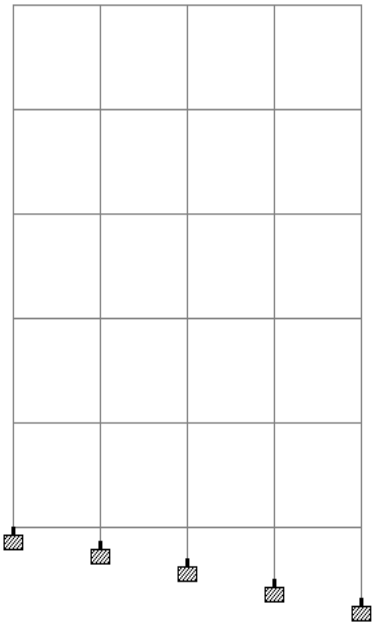


Fig.1.4.Building on slope of20^o

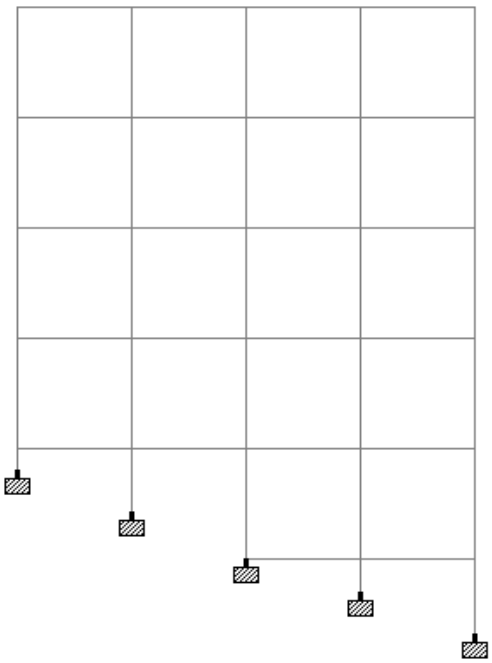


Fig.1.5Building on slope of20^o

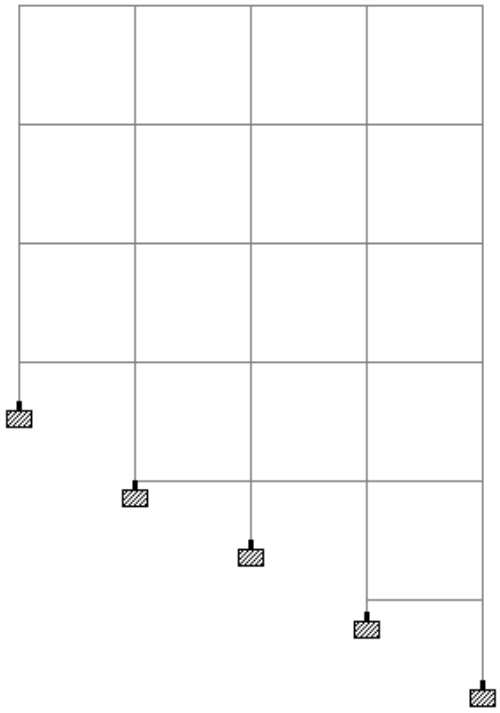


Fig.1.6Building on slope of 40°

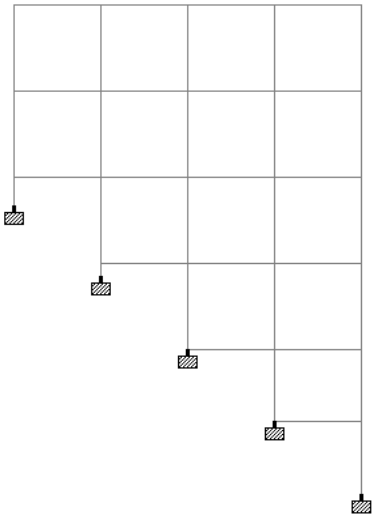
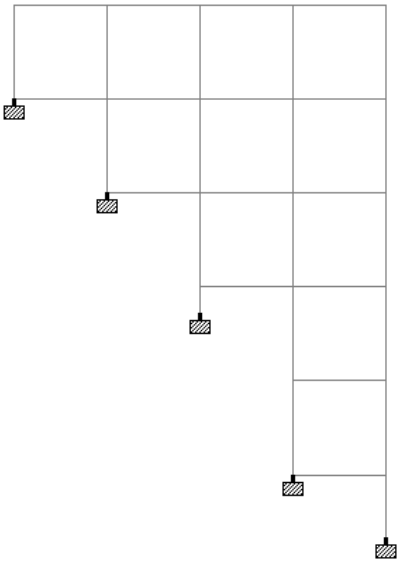


Fig.1.7Building on slope of 50°



III ANALYSIS OF STRUCTURE

The RCC Structure is to analyze on sloping for studying purpose. There are 6 cases for studying case 1 for building on 0°, Case 2 Building on 10o slope, Case 3 Building on 20° slope, Case 4 Building on 30° slope, Case 5 Building on 40° slope, Case 6 Building on 50° slope. The results of displacement are to be calculated.

Graphical results and table of Column for Displacement:-

The displacements are to be found in structure for different cases and they are represented as graph in a given table.

Table Number 1.1 Column 1

Column	Floor	0 DEG	10 DEG	20 DEG	30 DEG	40 DEG	50 DEG
1	0	2.015					
1	1	8.879	5.131	0.207			
1	2	16.15	12.64	4.956	0.461		
1	3	22.53	19.31	10.3	4.966	0.35	
1	4	27.41	24.22	14.38	9.158	3.555	0
1	5	30.43	27.05	16.74	11.64	5.972	0.76

Fig.Number 1.8.Column 1

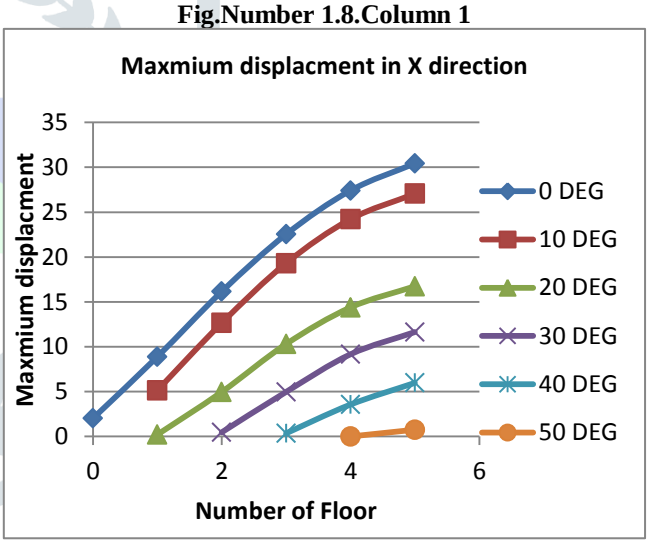


Table Number 1.2 Column 2

Column	Floor	0 DEG	10 DEG	20 DEG	30 DEG	40 DEG	50 DEG
2	0	1.959	2.765	2.3	1.88	2.21	1
2	1	9.07	12.25	10.44	8.68	6.34	5.162
2	2	17.05	22.3	19.42	16.40	12.74	10.12
2	3	23.80	30.95	27.39	23.51	18.91	14.48
2	4	28.66	37.27	33.34	28.96	23.76	17.76
2	5	31.73	40.9	36.78	28.96	26.66	19.52

Fig. Number 1.9 Column 2

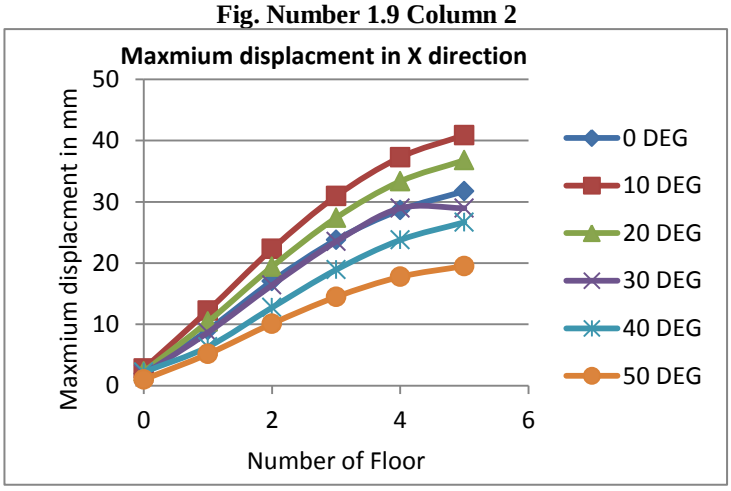


Table Number 1.3 Column 3

Column	Floor	0 DEG	10 DEG	20 DEG	30 DEG	40 DEG	50 DEG
5	0	2.289	0.553				
5	1	10.14	7.72	4.915	1.299		
5	2	18.33	16.02	12.35	8.042	4.25	0.36
5	3	25.16	23.23	19.16	14.7	10.13	4.56
5	4	30.32	28.52	24.24	19.7	14.87	8.42
5	5	33.67	31.56	27.16	22.56	17.64	10.53

Fig. Number 2.0 Column 3

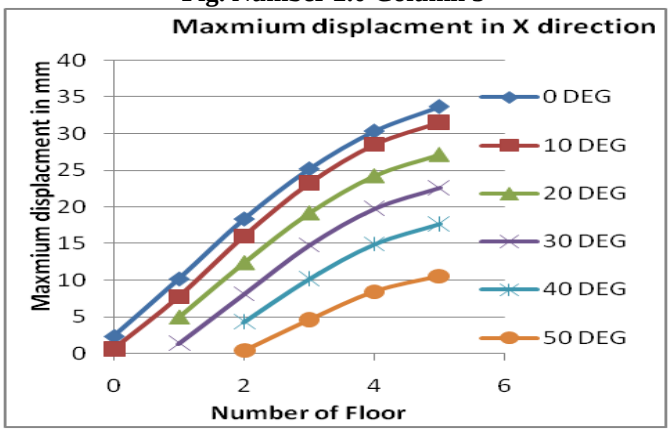


Table Number 1.4 Column 4

Column	Floor	0 DEG	10 DEG	20 DEG	30 DEG	40 DEG	50 DEG
3	0	2.015					
3	1	8.879	5.131	0.21			
3	2	16.15	12.64	4.96	0.461		
3	3	22.53	19.31	10.3	4.966	0.35	
3	4	27.41	24.22	14.4	9.158	3.56	0
3	5	30.43	27.05	16.7	11.64	5.97	0.76

Fig. Number 2.1 Column 4

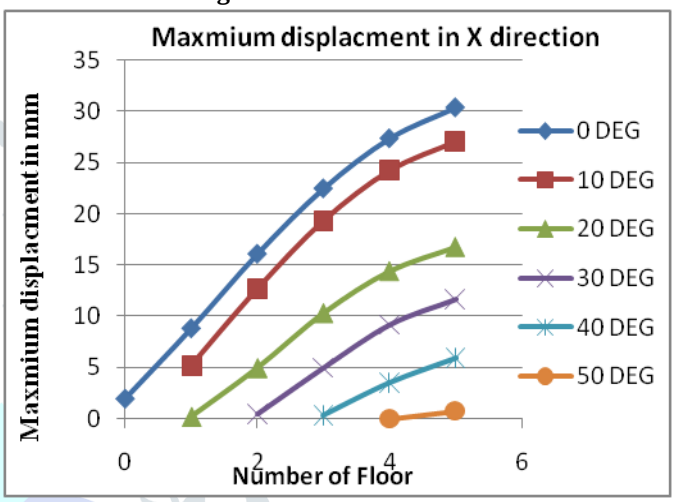
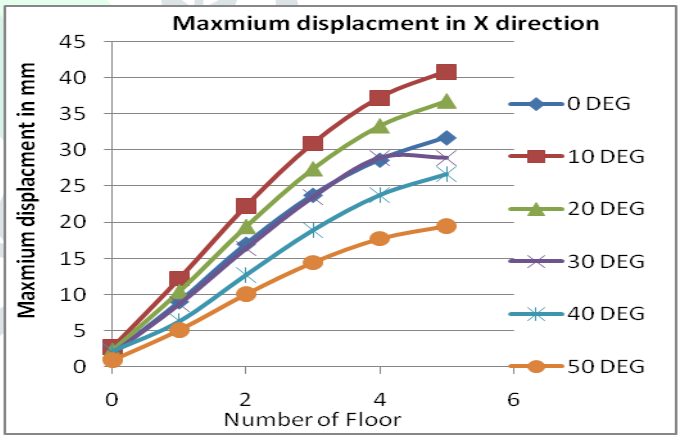


Table Number 1.5 Column 5

Column	Floor	0 DEG	10 DEG	20 DEG	30 DEG	40 DEG	50 DEG
4	0	1.959	2.765	2.3	1.88	2.216	1
4	1	9.078	12.25	10.44	8.68	6.34	5.162
4	2	17.06	22.3	19.42	16.4	12.75	10.12
4	3	23.8	30.95	27.4	23.5	18.92	14.48
4	4	28.66	37.27	33.34	29	23.77	17.76
4	5	31.74	40.9	36.79	29	26.66	19.52

Fig. Number 2.2 Column 5



IV OBSERVATIONS

1. For easy comparison of the lateral displacement of the structure the graphs are plotted displacement vs storey levels for the given cases and result interpreted

2. In Column 1 it is found that Displacement are slightly more for plain ground than other slope angle building.

3. In case of Column 2 displacement are less for plain building than gradually increase in slope angle building.

4. In Column 3 it is found that the displacement is slightly more than other observed columns and also gradually decrease with increase in slope angle

5. In Column 4 & 5 are having the displacement are nearly same as the column 1 & 2 in which the displacement is gradually decreasing as the slope of ground increases.

V CONCLUSIONS

Analysis of different configuration of buildings is carried on sloping and level ground. The behavior of the structure on sloping ground to be studied.

1. On sloping ground the displacement of building shows the same behavior as of regular building.
2. The displacements value gets smaller as the slopes increases due to curtailment of column.

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