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Research Paper Engineering

Comparative Study of Multistorey Rc Buildings Resting on Normal & Sloping Grounds By Seismic Analysis

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ABSTRACT

At present scenario, in urban Areas, Due to increase in population and scarcity of land, many buildings are constructing on sloping ground. But it is quite difficult to achieve such conditions, such as architectural requirements and functional needs. Most of the hilly regions in India are highly seismic. A building on hill slope differs in different way from normal buildings. Therefore, it is need of time to structurally analyse and design such hazards resisting structures so as to save human life and avoid property damage. In this research G+10 Storey building structure of size 15mx15m assumed to be located in seismic zone II, as per Indian standard code, is considered. Linear static and linear dynamic (response spectrum method) analysis has been performed using ETABS software for two building models and the dynamic response quantities such as fundamental time period, base shear, storey displacement and inter-storey drift were obtained for all the models.

KEYWORDS : ETABS, Inter-storey Displacement, Seismic analysis , Base Shear, Fundamental Natural Time Period, Storey Drift.

Introduction: Earthquakes are one of the most devastating natural hazards that cause great loss of life and livelihood. Structural design of buildings for seismic loading is primarily relate with structural safety against major earthquakes. Analysis of building resting on a hill is different from analysis of building on normal (i.e. plane) ground. Since, the column of hill buildings rest at different levels on sloping grounds in hilly areas. Also, buildings on hills have mass and stiffness varying along the vertical/ horizontal plane resulting in the centre of mass and centre of rigidity that do not coincide at various floor levels. Due to this, this irregular buildings experience torsion, in addition to bending and shear, during earthquake ground motion. When a building constructed on sloping ground experiences inertia force due to earthquake, all columns move horizontally by the same amount along with floor slab at a particular level (this is called rigid floor diaphragm action). If short and tall columns exist within the same storey level, than the short columns attract more earthquake force and suffers severe damage as compared to the taller ones. Thos is due to the fact during an earthquake. In the past, attempts had been made to study the seismic analysis of buildings either resting on normal ground or resting on sloping ground. But in the present work, analytical study has been carried out to investigate the seismic behavior of two building models resting on normal and sloping ground in seismic zone II. The results obtained in this study are presented and discussed in this paper.

In the multi story buildings damages due to earthquake are usually at the weak points. This weakness is due to strength, variation in stiffness etc [1]. Earthquake is generated by sudden release of energy in earth's crust that creates seismic waves. It has the capability for causing damages, by the natural hazards. In nature, earthquake forces are accidental and uncertain natural hazards. An Engineer requires the tools for analyzing structures under the effects of these types of forces [7]. The lateral load such as earthquake is to classified as live horizontal force acting on the structure depending on the building's geographic location, height, shape and structural material [3]

Case Study Details:

Dimension of beam	300 mm x 450mm
Dimension of column	450mm x 900mm
Thickness of Slab	150mm
Thickness of outside wall	230mm
Thickness of inner wall	150mm
Height of each storey	3.2m
Live Load	3kN/m^2
Floor Finish	1kN/m^2
Grade of reinforcing steel	Fe415
Grade of concrete	M 25
Density of concrete	25 kN/m^3
Density of infill	20kN/m^3
Seismic Zone	II
Importance factor	1
Zone factor	0.16
Damping ratio	5%

Results and Discussion:

1. Base shear: It can be seen from results given in table that base shear depends upon seismic zone, terrain nature, base condition and building height. Buildings resting on sloping grounds have higher base shear than building resting on normal ground. This is obviously due to lower time period for building resting on sloping ground. But, in the case of buildings with fixed base condition, the base shear for buildings resting on normal ground up to 4 storey height is higher than building resting on normal ground is lower than building resting on sloping ground. Plot of building height vs base shear for zone II are shown in figure.

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Table No - 1

	Base Shear in X Direction		Base Shear in Y Direction	
Storey level	Normal Ground	Sloping Ground	Normal Ground	Sloping Ground
10	66	88.78	58.1	62.3
9	150.02	200.42	129.35	148.26
8	202	275.61	177.05	207.96
7	235.53	335.74	209.78	251.77
6	262.92	386.28	234.27	288.95
5	288.57	429.7	256.28	323.98
4	316.24	461.49	279.76	355.31
3	347.58	26.31	305.11	101.62
2	373.46	26.8	328.98	69.28
1	383.19	27.37	341.72	23.58

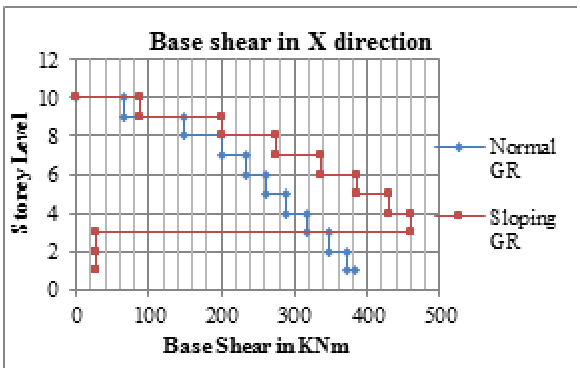

Chart No – 1 (a)

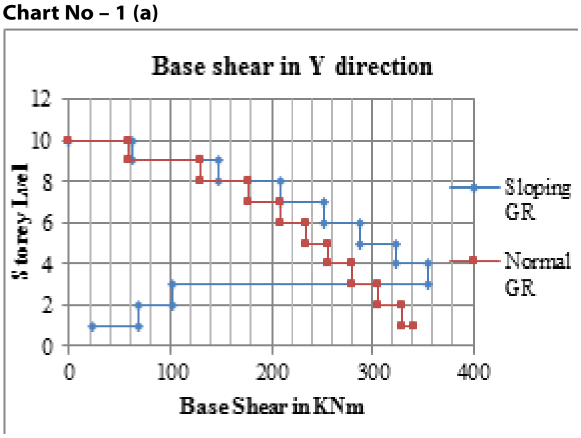

Chart No – 1 (b)

2. Time period: It can be seen from the results that the time period depends upon the terrain nature, building height and does not depend upon seismic zone. I t can also be seen that time period for normal ground is more than sloping for their respective mode. This increase in time period decreases lateral inertia force developed in the building due to earthquake significantly.

Table No - 2

No of Modes	Time Period (Sec)	
	Normal Ground	Sloping Ground
1	1.9694	1.4474
2	1.704	1.1288
3	1.559	1.0744

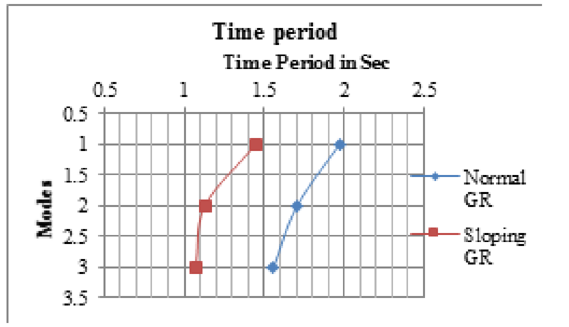

Chart No – 2

3. Storey displacement: It can be seen from the results that the displacement increases with increase in floor level of building. It can also be seen that the storey displacement is more in normal ground as compare to sloping ground.

Table No -3

	Storey Displacement in X Direction		Storey Displacement in Y Direction	
Storey level	Normal Ground	Sloping Ground	Normal Ground	Sloping Ground
10	12.52905	10.57397	13.98524	13.80917
9	11.89501	9.667096	13.55512	13.1936
8	11.05794	8.454157	12.82841	12.13629
7	9.983257	6.907674	11.79257	10.61243
6	8.678296	5.100235	10.47945	8.673263
5	7.167157	3.194176	8.916227	6.397817
4	5.489604	1.482376	7.120219	3.952576
3	3.717685	0	5.115597	2.429251
2	1.992648	0	2.982657	1.217658
1	0.586633	0	0.986237	0.308256

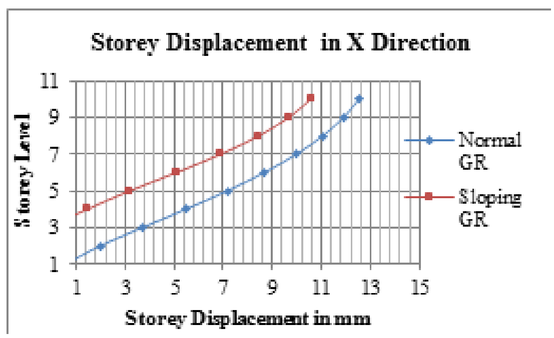

Chart No –3 (a)

No of Modes	Time Period (Sec)	
	Normal Ground	Sloping Ground
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2	1.704	1.1288
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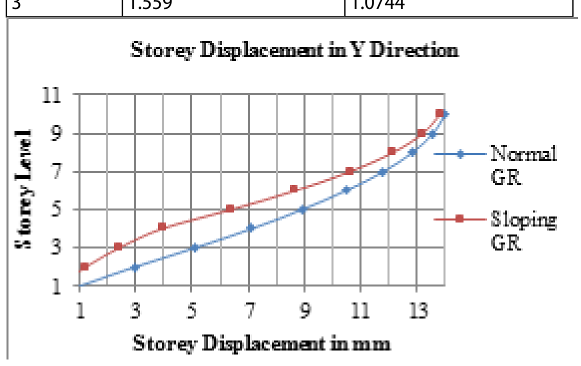

Chart No –3 (b)

4. Inter-storey Drift: Drift is the lateral displacement of a storey. Storey drift is the drift of one level of a multistory building relative to the level below. Inter storey drift is the difference between the roof and floor displacement of any given storey as building sways during the earthquake, normalized by the storey height. The greater the drift, the greater likelihood of damage. As a result shows the storey drift in sloping ground is less than that of normal ground.

Table No -4

	Storey Drift in X Direction		Storey Drift in Y Direction	
Storey level	Normal Ground	Sloping Ground	Normal Ground	Sloping Ground
10	0.000237	0.000304	0.000181	0.000234
9	0.00031	0.000403	0.000297	0.000386
8	0.000385	0.000503	0.000402	0.00053
7	0.00045	0.000577	0.000481	0.000645
6	0.000502	0.000603	0.000543	0.000731
5	0.000541	0.000537	0.000596	0.00077
4	0.000561	0.000463	0.000643	0.00048
3	0.000541	0	0.000672	0.000382
2	0.00044	0	0.000624	0.000286
1	0.00196	0	0.000329	0.000103

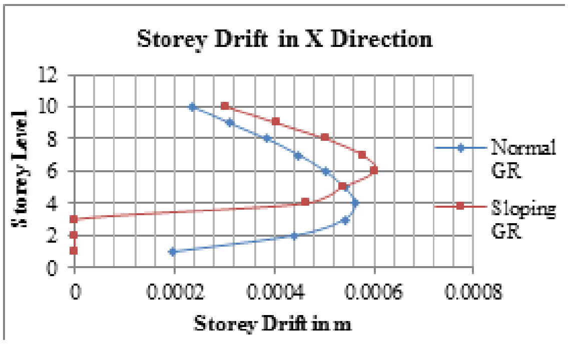

Chart No –4 (a)

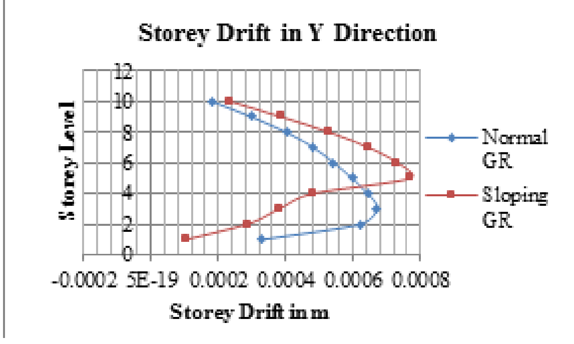

Chart No –4 (a)

Conclusion: Based on the seismic analysis carried out in this study, the following conclusions can be drawn. The results as obtained in zone II using ETABS for the static and dynamic analysis are compared for different terrain conditions viz..normal and sloping ground,

It can be seen from results given in table that base shear in seismic zone II the Buildings resting on sloping grounds have higher base shear than building resting on normal ground. This is obviously due to lower time period for building resting on sloping ground.

It can be seen from the results that the time period . It can also be seen that time period for normal ground is more than sloping for their respective mode. This increase in time period decreases lateral inertia force developed in the building due to earthquake significantly.

It can be seen from the results that the displacement increases with increase in floor level of building. It can also be seen that the storey displacement is more in normal ground as compare to sloping ground.

As a result shows the storey drift in sloping ground is less than that of normal ground. Drift is the lateral displacement of a storey. . The greater the drift, the greater likelihood of damage.

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