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Analysis of Multistoreyed Building (G+4) in Sloped Ground

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Abstract: In hilly areas, the buildings are built on sloping grounds. When the hilly areas come to under seismic zones, these buildings area highly vulnerable to earthquakes. The present study deals with analysis of multistoried building (G+4) on sloped ground. The study comprising of analysis of multistoried building (G+4) by considering gravity loads and seismic loads (response spectrum method used) and also includes slope stability analysis. The modeling has done by providing different elevations at foundation level and analysis of building has carried out by using finite element software such as ETABS. ETABS is a sophisticated and flexible to use, special purpose analysis such as gravity loads, earthquake analysis, P-δ analysis etc., and the programmers are integrated in the software in a well manner for the analysis of multistoried building. The material properties of concrete and steel has assigned according to the IS standards. The analysis has been carried out in the software. The reactions at the base of the building are taken from the software separately. The same reactions are further used for the analysis of slope to get the factor of safety by using GeoStudio software for different varying sloping angles (5^0 to 40^0). From the study, it observed that there is decrease in the factor of safety with increasing sloping angle and also noted that there is increase in the reactions with increase in sloping angle in both the cases i.e. gravity as well as seismic conditions.
Keywords: Earthquake, Sloping Ground, Response Spectrum Method, Stability of Slopes, ETABS and GEOSTUDIO Software.

I. INTRODCTION

The building rest on hilly areas have to be constructed differently from flat ground. Multi storide building on sloping ground are infrequent over level grounds were as on hilly slopes these are quite common. Disaster due to Earthquake, Landslide, Instability of slopes as always been the greatest natural thrust upon the mankind. Generally the structures are constructed on level ground in some areas the ground itself is a slope in that condition it is very difficult to excavation, leveling and it is very expensive. Due to the scarcity of level ground engineers started construction on sloppy ground itself. Some of the hilly areas are more prone to the earthquake. In that areas generally construction works carried out by locally available materials such as bamboo, timber, brick, RCC and also they gave more important to the lightweight materials for the construction of houses. As the population density increases at hilly region requirement of structure also increases. The popularity and demand of multistory building on hilly slope is also increases. Seismology is the study of vibrations of Earth, mainly caused by earthquakes. These are most commonly seen in North and Northeastern part of India have a large scales of hilly region, which are categorized under seismic zone IV and V. Most of the region in the hilly area which lies in the seismically active belt of Himalayan range.

Sujitkumar et al[2] (2014) has studied the, reinforced concrete (RC) frame buildings that have columns of different heights within one storey, suffered more damage in the shorter columns as compared to taller columns in the same storey. Buildings on the sloping ground are poor behavior of shorter column is due to the fact that in an earthquake, a tall and a short column of cross section move horizontally. Short column stiffer as compared to long column and it attracts large horizontal forces/earthquake forces. stiffer of a column means resistance to deformation, the larger is the stiffness, large force required to deform it. Hence shorter columns should be properly designed, or otherwise use bracing system to resist horizontal forces (wind load, seismic action) and to transmit to the foundation. Hence analysis of both building and sloped ground are requirement for safe design, this can be done by two methods, finite element method and finite differential method, for the analysis of building finite element analysis software, ETABS is used, and for the slope stability analysis GEOSTUDIO software.

Miss. PratikshaThombre et al[4](2014) has stated ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS features an intuitive and powerful graphical interface coupled with unmatched modelling, analytical, and design procedures, all integrated using a common database. Although quick and easy for simple structures, ETABS can also handle the largest and most complex building models, including a wide range of nonlinear behaviours, making it the tool of choice for structural engineers in the building industry. Even to this day, stability analyses are by far the most common type of numerical analysis in geotechnical engineering. This is in part because stability is obviously a key issue in any project. GEOSTUDIO is an application for geotechnical and geo environmental engineering. Includes the following products, SLOPE/W for slope stability analysis, SEEP/W for ground water seepage analysis, SIGMA/W for stress and deformation analysis, QUAKE/W for dynamic earthquake analysis, TEMP/W for thermal analysis, CTRAN/W for contaminant transport analysis, VADOSE/W for vadose and soil cover analysis, Speed 3D for groundwater modelling.

II. PLAN AND SALIENT FEATURE OF BUILDING

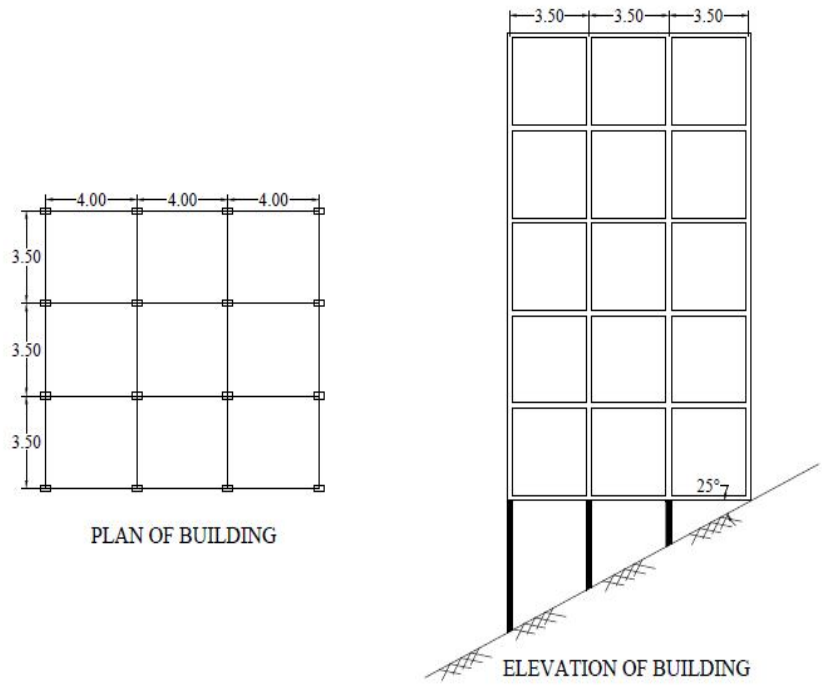

Figure.1 Plan and Elevation of building.

Table I Salient Feature of Building.

Sl. No	PARTICULAES	SIZES
1	Number of Story	G+4
2	Floor Height	3.5 m
3	Column Dimensioning	230 x 450 mm
4	Bean Dimensioning	230 x 375 mm
5	Slab Thickness	150 mm
6	Area	126 m^2
8	Column Spacing in X Direction	4 m
9	Column Spacing in Y Direction	3.5 m
10	Unit Weight of Soil	18 kN/m^3
11	Cohesion of Soil	4.5 kPa
12	Phi (ϕ)	26^0 (Assumed)

A. ETABS Model

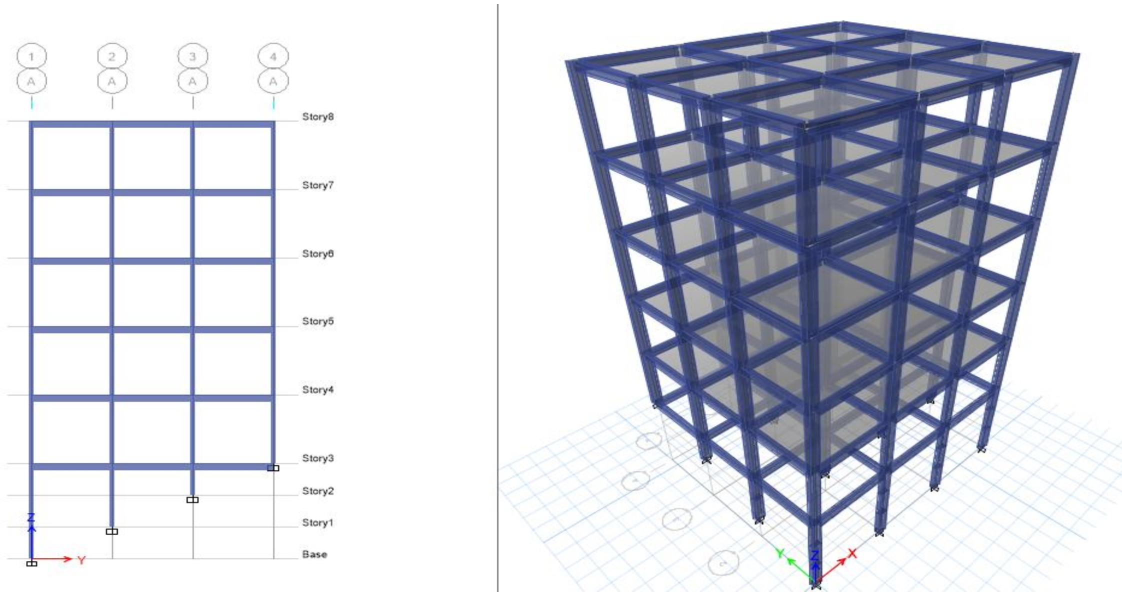

Figure. 2 Sample model in ETABS

B. Geostudio Model

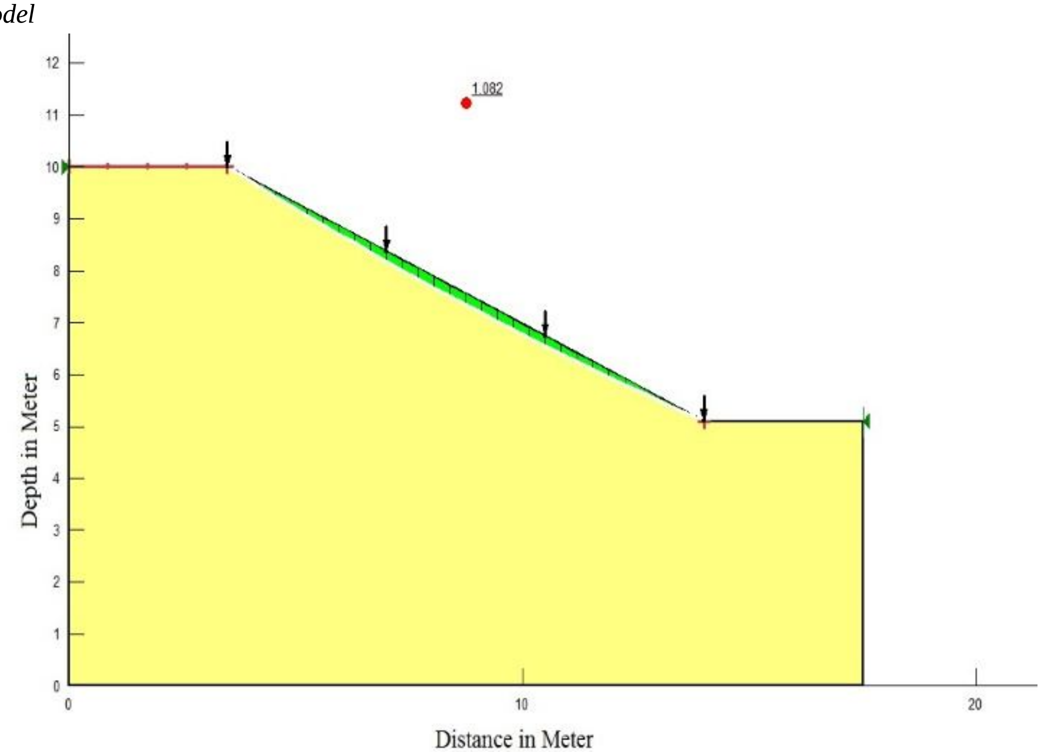

Figure. 3 Sample model in GeoStudio

III.RESULTS AND DISCUSSIONS

The present study involves the analysis of multistoried building (G+4) in sloped ground by using ETABS and GeoStudio. The modelling and detailed analysis has been done in ETABS. The reactions at the base of the building were taken for the analysis of slope. The following are the results obtained from the analysis.

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A. Result of ETABS

Slope: 5 Degree Gravity Load

Table I

Reaction in kN of 5^0 Slope for Gravity Load.

Grid Line	A	B	C	D
1	772.85	1209.28	1209.28	772.85
2	1214.64	1807.12	1807.12	1214.64
3	1213.35	1809.42	1809.42	1213.35
4	770.15	1212.45	1212.45	770.15

Dynamic Load

Table II

Reaction in kN of 5^0 Slope for Dynamic Load.

Grid Line	A	B	C	D
1	1406.05	1135.2	1135.2	1406.05
2	1780.23	1582.81	1582.81	1780.23
3	1764.18	1583.56	1586.56	1764.18
4	1355.1	1139.18	1139.18	1355.1

Slope: Degree Gravity Load

Table III

Reaction in kN of 10^0 Slope for Gravity Load**.**

Grid Line	A	B	C	D
1	781.16	1211.81	1211.81	781.61
2	1216.9	1802.92	1802.92	1216.9
3	1215.91	1809.37	1809.37	1215.91
4	771.14	1214.53	1214.53	771.14

Dynamic Load

Table IV

Reaction in kN of 10^0 Slope for Dynamic Load.

Grid Line	1160.62	**B**	**C**	**D**
1	1403.79		1160.62	1403.79
2	1793.04	1577.33	1577.33	1793.04
3	1765.74	1582.7	1582.7	1765.74
4	1340.92	1161.17	1161.17	1340.92

Slope: 15 Degree Gravity Load

Table V.
Reaction in kN of 15^0 Slope for Gravity Load.

Grid Line	A	B	C	D
1	789.57	1214.63	1214.63	789.57
2	1219	1798.7	1798.7	1219
3	1218.75	1809.22	1809.22	1218.75
4	772.15	1216.66	1216.66	772.15

Dynamic Load

Table VI.
Reaction in kN of 15^0 Slope for Dynamic Load

Grid Line	A	B	C	D
1	1379.42	1183.42	1183.42	1379.42
2	1794.55	1571.28	1571.28	1794.55
3	1753.8	1581.36	1581.36	1753.8
4	1321.0	1181.37	1181.37	1321.0

Slope: 20 Degree Gravity Load

Table VII
Reaction in kN of 20^0 Slope for Gravity Load.

Grid Line	**A**	**B**	**C**	**D**
1	789.41	1217.77	1217.77	798.41
2	1221.07	1794.4	1794.4	1221.07
3	1221.69	1809.03	1809.03	1221.69
4	773.16	1218.81	1218.81	773.16

Dynamic Load

Table VIII
Reaction in kN of 20^0 Slope for Dynamic Load.

Grid Line	A	B	C	D
1	1342.59	1201.25	1201.25	1342.59
2	1789.3	1564.93	1564.93	1789.3
3	1736.12	1580.07	1580.07	1736.12
4	1300.5	1197.84	1197.84	1300.5

Slope: 25 Degree Gravity Load

Table IX
Reaction in kN of 25^0 Slope for Gravity Load.

Grid Line	A	B	C	D
1	807.8	1221.21	1221.21	807.8
2	1223.35	1789.98	1789.98	1223.35
3	1224.74	1808.83	1808.83	1224.74
4	774.18	1221.02	1221.02	774.18

Dynamic Load

Table X
Reaction in kN of 25^0 Slope for Dynamic Load.

Grid Line	A	B	C	D
1	1300.96	1213.41	1213.41	1300.96
2	1778.52	1558.42	1558.42	1778.52
3	1719.3	1578.99	1578.99	1719.3
4	1284.63	1209.9	1209.9	1284.63

Slope: 30 Degree Gravity Load

Table XI
Reaction in kN of 30^0 Slope for Gravity Load.

Grid Line	A	B	C	D
1	817.9	1225.01	1225.01	817.9
2	1225.64	1785.38	1785.38	1225.64
3	1227.97	1808.58	1808.58	1224.97
4	775.24	1223.35	1223.35	775.24

Dynamic Load

Table XII
Reaction in kN of 30^0 Slope for Gravity Load.

Grid Line	A	B	C	D
1	1330.35	1351.06	1351.06	1330.35
2	1896.22	1802.4	1802.4	1896.22
3	1842.52	1836.6	1836.6	1842.5
4	1342.36	1349.86	1349.86	1342.36

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Slope: 35 Degree Gravity Load

Table XIII
Reaction in kN of 30^0 Slope for Gravity Load.

Grid Line	A	B	C	D
1	828.96	1229.28	1229.28	828.96
2	1228.34	1780.54	1780.54	1228.34
3	1231.47	1808.25	1808.25	1231.47
4	776.37	1225.88	1225.88	776.37

Dynamic Load

Table XIV
Reaction in kN of 30^0 Slope for Gravity Load.

Grid Line	A	B	C	D
1	1217.8	1225.36	1225.36	1217.8
2	1737.76	1545.86	1545.86	1737.76
3	1693.67	1576.68	1576.68	1693.67
4	1270.88	1224.12	1224.12	1270.88

Slope: 40 Degree Gravity Load

Table XV
Reaction in kN of 30^0 Slope for Gravity Load.

Grid Line	A	B	C	D
1	841.27	1234.16	1234.16	841.27
2	1231.48	1775.36	1775.36	1231.48
3	1235.36	1807.81	1807.81	1325.36
4	777.63	1228.69	1228.69	777.63

Dynamic Load

Table XVI
Reaction in kN of 30^0 Slope for Gravity Load.

Grid Line	A	B	C	D
1	1183.39	1228.88	1228.88	1183.39
2	1714.85	1540.73	1540.73	1714.85
3	1684.76	1575.14	1575.14	1684.76
4	1274.83	1228.93	1228.93	1274.83

The above tables show the reactions at the base of the building in both the cases i.e. gravity loading and seismic loading. It can be observed that, in 5^0 slope under gravity loading the reactions varied from 772.85kN to 1213.35kN in grid A and D. Grid B and C are the interior grids so that the reactions are maximum and it varied from 1209.28kN to 1809.42kN. The same trend has been continued for remaining sloping angles.

For seismic cases the same models have been analyzed by considering seismic zone IV and obtained the reactions at the base of the building. From the table it is clearly noted the reaction were increased due to seismic loading and it varies for grid A and D from 781.61kN to 1216.9kN, for grid B and C reactions varies from1211.81kN to 1809.37kN. The same trend has been continued for remaining sloping angels (5^0 to 40^0). It is also noted that the reactions are increases with increasing sloping angle.

B. Results of GeoStudio

The obtained results from the ETABS i.e., reactions at the base are further used for stability analysis. The reactions for different sloping angel are taken separately for all grids and these values are further used to get the factor of safety in GeoStudio software. The following figures shows factor of safety of slopes for different sloping angle.

Table17.
Factor of Safety of Slope.

Angle of Slope	For Gravity Loading	For Dynamic Loading
5	5.748	5.634
10	2.853	2.814
15	1.873	1.854
20	1.384	1.365
25	1.084	1.067
30	0.875	0.862
35	0.724	0.713
40	0.607	0.596

The reactions are obtained for grid A and D for gravity loading are varies from 772.85kN to 1214.64kN and for grid B and C are 1209.28kN to 1809.42kN. these values are used for stability analysis and the corresponding factor of safety for gravity loadings are 5.748 and 5.693 respectively so it can be concluded that the 5^0 slope will be safe (FOS>1) under gravity loading.

The reactions for seismic loading for grid A and D are varying from 781.61kN to 1216.9kN and grid B and C are 1214.53kN to 1809.37kN. The corresponding factor of safety are 5.634 and 5.373 respectively, anyway slope will be safe but there is decrease in the FOS for seismic condition.It is observed that from 5^0 to 25^0 there is decrease in FOS with increase in sloping angle in both the cases of loadings. Anyway the FOS is greater than 1, so the slope will be safe.

The sloping angle from 30^0 to 40^0 there is decrease in FOS with sloping angle and that leads to failure of slopes(FOS<1) and in both the cases i.e. gravity and seismic loading. So it can be concluded that 25^0 slope is the optimum sloping angle for this case

IV. CONCLUSIONS

The sloping ground buildings possess relatively maximum reactions which may give to critical situations than the flat ground. It is found that there will be maximum reactions at 400 slope.

From the analysis it can be concluded that there will be increase in reactions on the sloping ground, when the slope is subjected to the gravity as well as earthquake loading.

The factor of safety of slope has varied in greater range, i.e in the beginning from 5^0 to 25^0 there will be decrease in factor of safety under both gravity loading (5.748 to 1.082) and for seismic loading (5.634 to 1.067). After 25^0 to 40^0 it is found that the factor of safety is less than 1. So it can be concluded that the factor of safety which less than 1 leads to failure of slopes.

REFERENCES

[1] S.M.Nagargoje and K.S.Sable (2012) "Seismic performance of multi-storeyed building on sloping ground" Elixir International Journal, 53 (2012) 11980 – 11982

[2] Sujitkumar, Dr.VivekGarg and Dr.Abhay Sharma (2014) "Effect of sloping ground on structural performance of RCC building under seismic load" International Journal Of Science, Engineering And Technology- Volume 2 Issue 6

[3] D.J. Misal, M.A. Bagade (2016) "Study of Seismic Behaviour of Multi-storied R.C.C. Building Resting on Sloping Ground and Considering Bracing System" International Journal Of Engineering research - Volume 5 Issue: Special 3 pp: 690-697

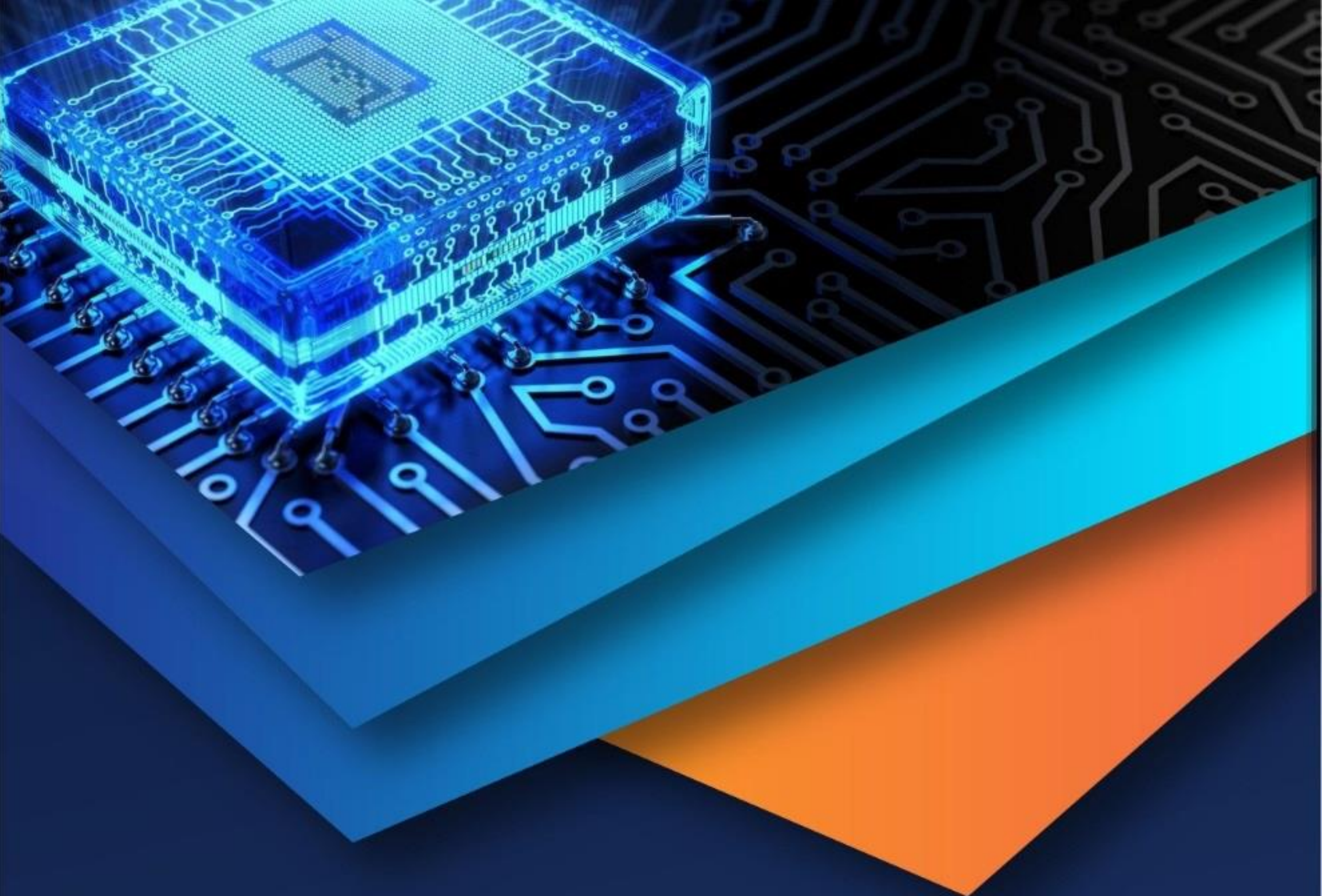
[4] Miss.PratikshaThombre, Dr.S.G.Makarande (2016) "Seismic Analysis of Building Resting on Sloping Ground" Journal of Emerging Technologies and Innovative Research Volume-3 Issuse 6 (ISSN-2349-5162).

[5] S.D.Uttekar, C.R.Nayak (2016) "A Review on Seismic Response of RC Building on Sloping Ground" International Journal of Engineering research - Volume 5 Issue: Special 3 pp: 701-704

[6] Sripriya Arjun, Arathi S (2016) "A Study on Dynamic Characteristics of RC Buildings on Hill slopes" International Journal of Science and research Volume 5 Issue 7

[7] Nagarjuna, Shivakumar B patil (2016) "lateral stability of multistorey building on slopingground" International Research Journal of Engineering and Technology Volume: 02 Issue: 4

[8] B.Arif Basha, ABS Dada Peer (2016) "Seismic Analysis of Buildings Resting on Sloping Ground and Considering Bracing System**"** International Journal Of Science, Engineering And Technology Research - Volume 5 Issue 12.



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