Seismic Analysis of Multi Storied Building on Sloping Ground with Ground, Middle & Top Soft Stories

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Abstract— this project gives in brief, the theory behind the Seismic analysis of multi-storeyed building on a sloping ground with ground, middle & top soft storey using working stress method.

Keywords:

I. Introduction

In many part of world, hilly area are more liable to seismic action. The term earthquake may be describe as any quite unstable waves which can be either natural or initiated by humans that generate unstable waves. Earthquakes are caused normally by rupture of geologic faults. Mass destruction of the low and high rise buildings in the recent earthquakes leads to the need of investigation especially in a developing country like INDIA. In hilly region, old fashioned material like brunt brick, stone masonry bamboo, etc., which is locally available, is used for the construction of houses. Buildings constructed on slopes are different from those in plains, they are susceptible to severe damage when affected by earthquake ground motion. In hilly regions, engineering constructions is constrained by local topography the scarcity of plain ground in hilly regions compels construction activity on sloping ground.

II. Literature Review

Rayyan-Ul-Hasan Siddiqui, H. S. Vidyadhara[1]: They studied the model consisting of four bay in each direction twelve storey building, each bay is having width of 5m Results point out that infill panels have a huge consequence on the behavior of frames under earthquake excitation. The development of first hinge is not early in models with shear wall as compare with bottom soft storey and bare frame even base shear is also more for shear wall models.. In general, infill panels intensify stiffness of the structure. Provision of both external shear wall and internal shear wall effectively reduce large joint displacements found in bare frame.

Sripriya Arjun, Arathi S[2]: In this study, behavior of G+3 storied sloped frame building having step back set back configuration is analyzed for sinusoidal ground motion with different slope angles i.e., 16.7°, 21.8°, 26.57° and 30.96° using structural analysis tool STAAD Pro. By performing Response Spectrum analysis have been carried out as per IS:1893 (part 1): 2002. top storey displacement and base shear was only found out. Top storey displacement decreases with the increase in slope angles. The base shear acts more in longitudinal direction than in transversedirection.

Miss. PratikshaThombre, Dr.S.G.Makarande[3]: They analyzed 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, Maximum displacement in columns are analyzed with different configurations of sloping ground. A RCC medium rise building of 5 storeys' with storey height 3 m subjected to earthquake lading in zone V was considered. Effect of sloping effect of the ground on behavior of structural frames is analyzed. Displacements have been calculated foe five different column. The displacements value gets smaller as the slopes increases due to curtailment of column.

III. Analytical Modelling

In the present study lateral load analysis as per the seismic code for bare frame, infill frame , ground, middle & top soft storey , L type shear wall along with soft storey, C type shear wall along with soft storey including water pressure at top storey are done. Example Building Studied: The plan layout is deliberately kept similar i.e., 30x36 consisting of 5 bays in x direction and 9 bays in y direction. The bottom storey height is kept as 3.5 m and a typical height of 3.0 m is kept for all storey excluding top storey which is kept as 2.5 m. Study have to be carried out for different models of a seventeen storey building. The building is located in zone V and intended for commercial purpose.

Design Data: In the top storey swimming pool is modelled. Following data is used in the analysis of the RC frame building models. Thickness of masonry wall (tw) = 0.23m, thickness of slab (ts) = 0.15m Density of Reinforced Concrete 25kN/m³, Density of brick masonry 20kN/m³, E=3500000 kN/m² Poisson's Ratio of concrete 0.2, Floor finishes 1.0kN/m²,

IV. Member Properties

Imposed loads 3.5KN/ m², Roof live 1.5 KN/ m² , water pressure on slab = 24.525 kN/m² Thickness of shear wall 0.20m, Zone –V and 5 % damped response spectrum, Zone factor (Table2 of IS 1893-

Grade of concrete	Member	Size in MM	Storey
M40	Column	1200 x 1200	1st - 3rd
M40	Column	750 x 1000	4th -9th
M40	Column	550 x 750	10th - 17th
M30	Beam	230 x 600	All storey
M30	Slab	150	All storey

2002) – 0.36, Importance factor, I (Table 6 of IS 1893-2002) –1.0, Response reduction factor, R (Table 7 of IS 1893-2002) – 5.00, Soil type (figure 2 of IS 1893-2002) – Type II (Medium soil) . In the seismic weight calculations only 50 % of the floor live load is considered.

A. Description of the Sample Building:

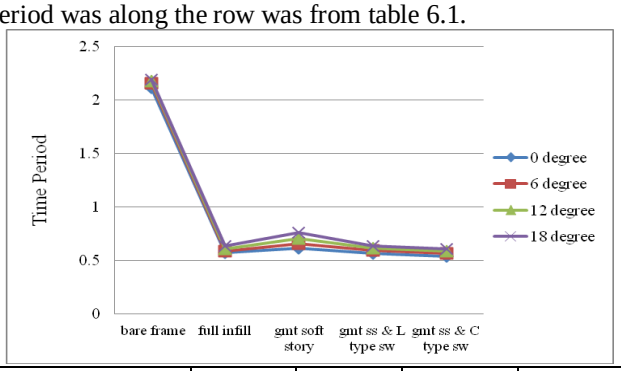
Model 1 - Bare frame model however masses of walls are included. Model 2 – Building has full brick masonry infill of 230 mm thick in all the stories .Model 3 – Building has no brick masonry infill Ground middle & top storey. Model 4 – Building model is same as model 3 further L type shear wall is provided in both X & Y direction at corners. Model 5 -

Building model is same as model 3 further C type shear wall is provided in both X & Y direction at corners.

V. RESULTS AND DISCUSSION

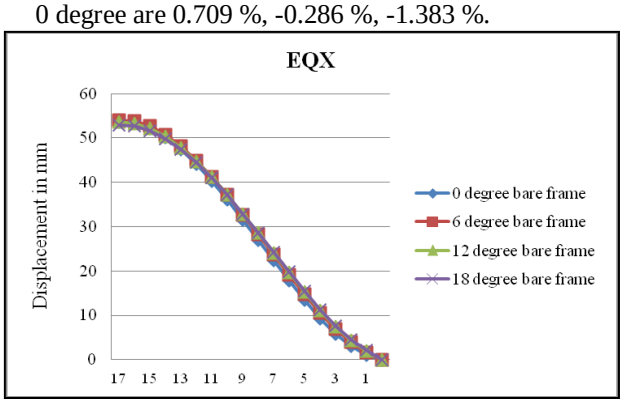
Displacement, drift, base shear, time period for 0 degree, 6 degree, 12 degree, 18 degree using equivalent static method & response spectrum method are discussed bellow.

Fundamental natural period Time Period Vs Model for different degree: As the angle of slope is increased the time period also increased. The percentage increase of time period was along the row was from table 6.1.

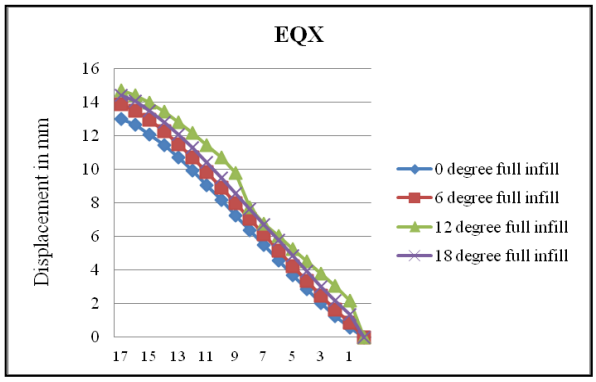


Models	0 degree	6 degree	12 degree	18 degree
bare frame	2.115	2.16	2.18	2.19
full infill	0.57	0.587	0.608	0.631
gmt soft storey	0.614	0.655	0.706	0.758
gmt ss & L type sw	0.564	0.591	0.615	0.636
gmt ss & C type sw	0.54	0.563	0.5845	0.6051

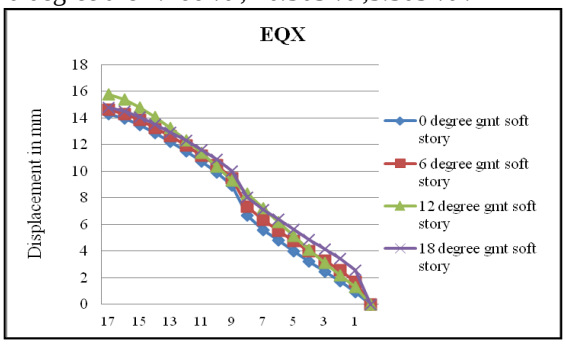
1) Storey displacements: Bare frame model shows highest storey displacement values. The displacement was found to be linearly increasing from ground to top storey.
2) 2. Storey Displacement Vs storey for different degree of bare frame: The % ↑ or ↓ of maximum displacement w.r.t 0 degree are 0.709 %, -0.286 %, -1.383 %.



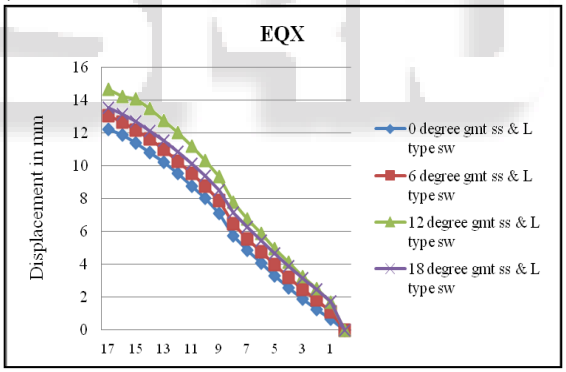
3) Storey Displacement (EQX) full infill for different degree: The % ↑ of maximum displacement w.r.t 0 degree are 6.78 %, 13.40 %, 11.073 %.



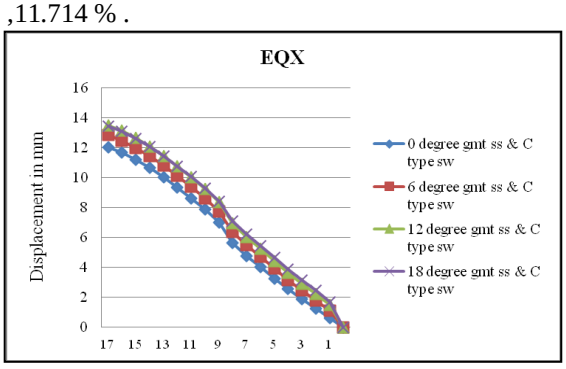
4) Storey Displacement Vs storey for different degree of gmt soft storey: The % ↑ of maximum displacement w.r.t 0 degree are 2.266 % , 10.305 % ,3.505 % .



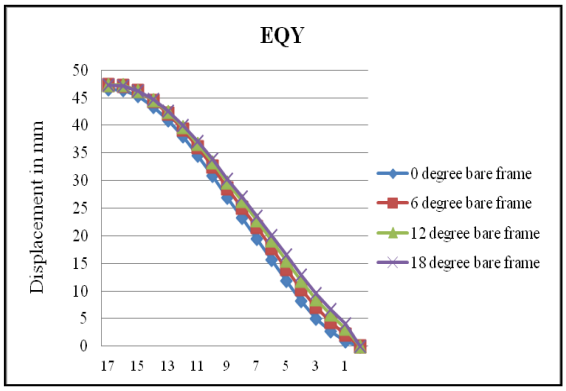
5) Storey Displacement Vs storey for different degree of gmt soft storey & L type sw: The % ↑ of maximum displacement w.r.t 0 degree are 6.62 % , 20.067 % ,10.692 % .



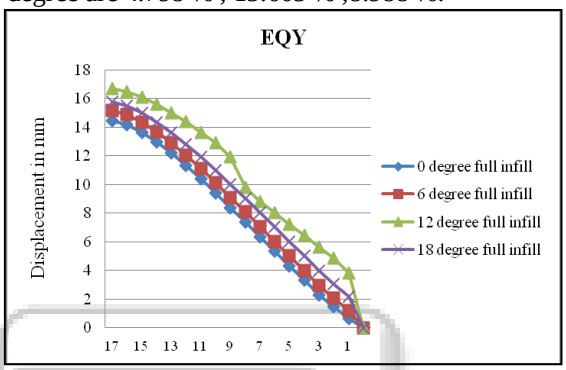
6) Storey Displacement Vs storey for different degree of gmt soft storey & C type sw : The % ↑ of maximum displacement w.r.t 0 degree are 6.696 % , 12.146 % ,11.714 % .



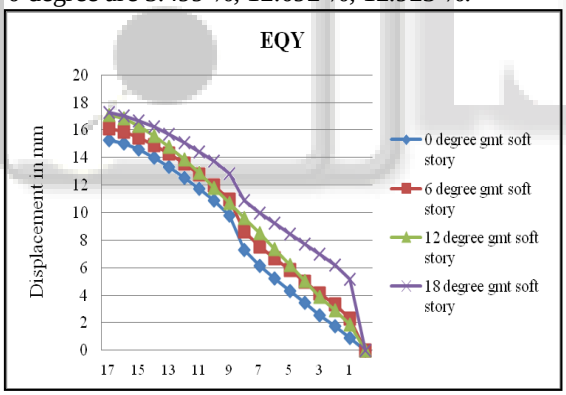
7) Storey Displacement Vs storey for different degree of bare frame: The % ↑ of maximum displacement w.r.t 0 degree are 1.794 %, 1.925 %, 1.794 % .



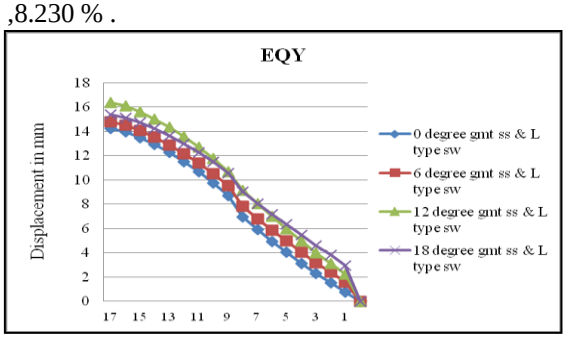
8) Storey Displacement Vs storey for different degree of full infill: The % ↑ of maximum displacement w.r.t 0 degree are 4.798 % , 15.605 % ,8.988 %.



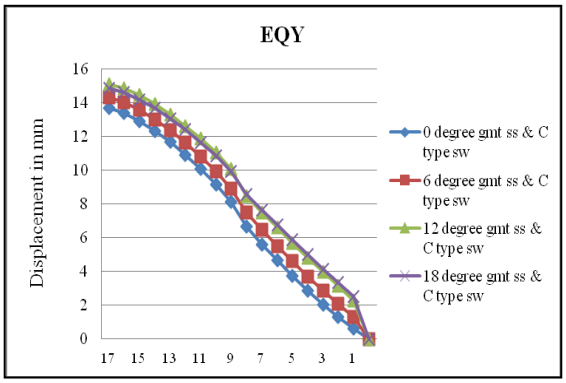
9) Storey Displacement Vs storey for different degree of gmt soft storey: The % ↑ of maximum displacement w.r.t 0 degree are 5.499 %, 12.092 %, 12.923 %.



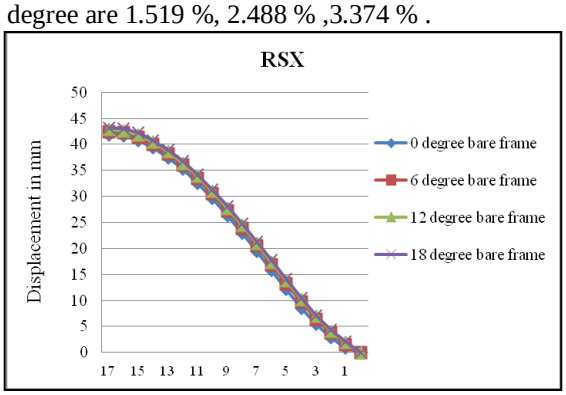
10) Storey Displacement Vs storey for different degree of gmt soft storey & L type sw: The % ↑ of maximum displacement w.r.t 0 degree are 4.012 % , 15.291 % ,8.230 % .



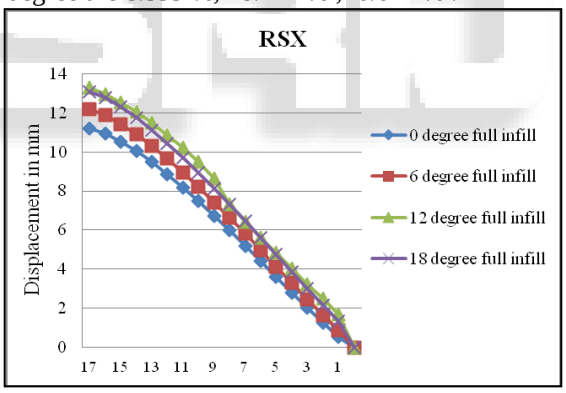
11) Storey Displacement Vs storey for different degree of gmt soft storey & C type sw: The % ↑ of maximum displacement w.r.t 0 degree are 4.671 %, 10.424 % 8.633 % .



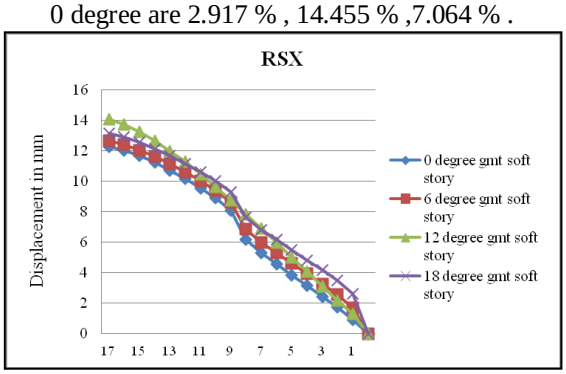
12) Storey Displacement Vs storey for different degree of bare frame: The % ↑ of maximum displacement w.r.t 0 degree are 1.519 %, 2.488 % ,3.374 % .



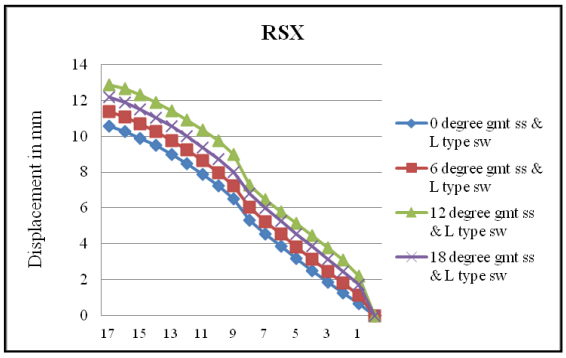
13) Storey Displacement Vs storey for different degree of full infill: The % ↑ of maximum displacement w.r.t 0 degree are 8.399 %, 18.421 % ,16.611 % .



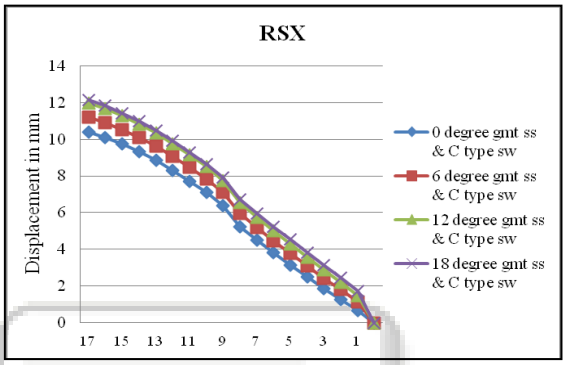
14) Storey Displacement Vs storey for different degree of gmt soft storey: The % ↑ of maximum displacement w.r.t 0 degree are 2.917 % , 14.455 % ,7.064 % .



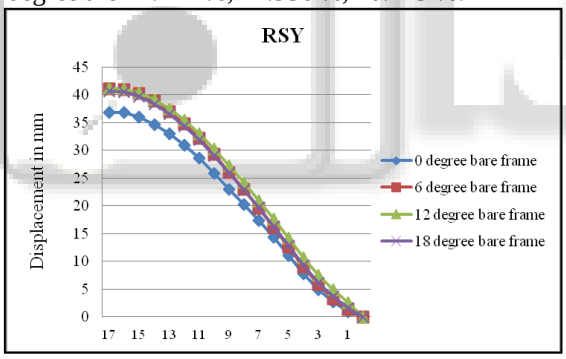
15) Storey Displacement Vs storey for different degree of gmt soft storey & L type sw: The % ↑ of maximum displacement w.r.t 0 degree are 7.806%, 22.158%, 15.537 % .



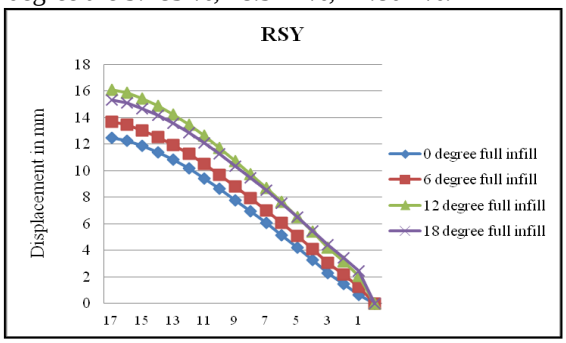
16) Storey Displacement Vs storey for different degree of gmt soft storey & C type sw: The % ↑ of maximum displacement w.r.t 0 degree are 7.876 %, 15.175 %, 16.639 %.



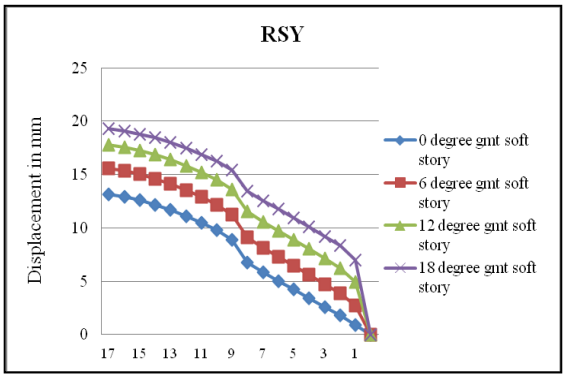
17) Storey Displacement Vs storey for different degree of bare frame: The % ↑ of maximum displacement w.r.t 0 degree are 11.444 %, 11.956 %, 10.149 %.



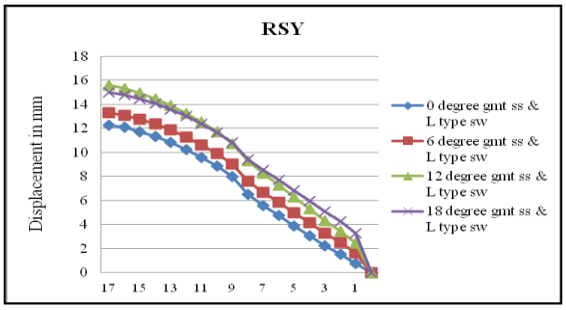
18) Storey Displacement Vs storey for different degree of full infill: The % ↑ of maximum displacement w.r.t 0 degree are 9.483 %, 28.977 %, 22.807 %.



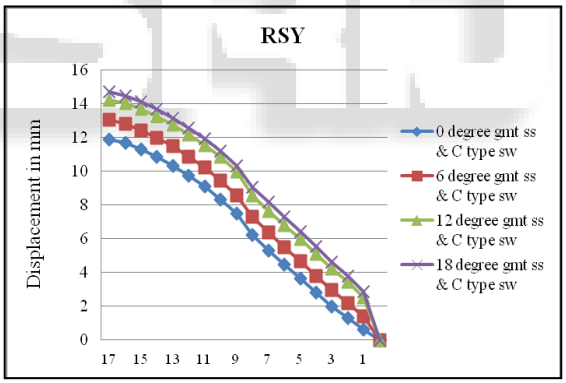
19) Storey Displacement Vs storey for different degree of gmt soft storey: The % ↑ of maximum displacement w.r.t 0 degree are 18.467 % , 35.176 % ,46.805 %



20) Storey Displacement Vs storey for different degree of gmt soft storey & L type sw: The % ↑ of maximum displacement w.r.t 0 degree are 8.426 %, 27.004 %, 22.266 %.



21) Storey Displacement Vs storey for different degree of gmt soft storey & C type sw: The % ↑ of maximum displacement w.r.t 0 degree are 9.653 %, 19.567 %, 23.775 %.



VI. SUMMARY AND CONCLUSIONS

A. *Summary:*

The present work attempts to study the seismic response of RC building on sloped ground located in zone V. In this study all important components that influence the mass, strength and stiffness of the structure are included in the analytical model. The fundamental time period, deflections at each storey levels and storey drifts, seismic base shear, are compared by performing Equivalent static method and Response spectrum method.

B. *Conclusions:*

1. IS Code give empirical formulae for bare frame and fully infill frame but it do not give empirical formulae to determine the time period for soft storey building .Therefore the software like ETABS & SAP2000 is used to determine the fundamental time period.

2. Bare frame model has got highest time period compared to other models and C type shear wall model with gmt soft storey has got least time period.
3. Period increases for soft storey building due to insufficient stiffness as seen in models. 4. Fundamental time period decreases when the effect of masonry infill wall and concrete shear wall is considered
4. As the angle of slope is increased the time period also increased.
5. It is observed that displacement values are higher for bare frame model when compared to other models.
6. When the effect of masonry infill and shear wall are taken into consideration storey drift and storey displacement considerably reduces for bare frame as well as soft storey building.
7. Maximum storey displacement was found to be decreasing for higher angle of ground slope.
8. Storey drifts are found within permissible limit as specified by IS 1893 (Part -1): 2002.
9. When effect of masonry infill wall and shear wall is considered , the seismic base shear drastically increase as compare with that of bare frame , the base shear was found to be least for bare frame model . Base shear was increased in X direction and decreased in Y direction.

VII. SCOPE FOR FURTHER STUDY:

Further studies can be carried out on same models by providing floating columns. Further study can also be done on unsymmetrical building with successive soft storey. Shear wall with openings can be studied on the same building configuration. Seismic analysis of the building using nonlinear analysis procedure can be done.

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