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Analysis of Setback Structure Considering Different Isolation Techniques: A Review

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Abstract: Structural analysis is Nowadays a primary requirement to identify whether the planned and modelled structure would be able to withstand any natural or man made calamities namely earthquake and wind effects. While this considerations there has been rise in development of irregular high rise structures which further leads the engineers to conduct set back analysis. In this paper we are presenting review of literatures related to utilization of different techniques to isolate setback structures.
Keywords: Analysis, setback, lateral loads, high rise structures, review, techniques.

I. INTRODUCTION

In the history of structures, maybe nothing is more dazzling than the human goal to make progressively tall structures. Different social and financial factors, for example, migration of people from to urban areas looking for better way of life and openings for work, the increment in land values in urban regions and higher population density, have prompted an incredible increase in the number of tall structures all over the world. As the tall structure is best to land use strategy in present time it can spare a ton of land, hence the horizons of the world's urban areas are ceaselessly being punctured by particular and recognizable tall structures as great as mountain ranges, and achieving more height keeps on being the challenge and goal. However, there are some incredible challenges which are to be looked by the designer every day to make these structures a reality. Out of many challenges, one is that of lateral loads i.e. seismic load and wind load. So there is a need to stabilize the tall buildings against these lateral loads and to provide comfort to the occupants.

In this study we are presenting review of publications, journals, citations and researches related to isolation of setback structures.

Sohani et. al. (2017) the research paper presented seismic analysis of a R.C. building with rectangular plan. 3D analytical model of 10,15 & 20 storied buildings was generated for symmetric and asymmetric building Models and analyzed using structural analysis tool 'STADD-PRO" to study the effect of varying height of columns in ground stored due to sloping ground and the effect of shear wall at different positions during earthquake. Building (G+10, 15 and 20) was analyzed using Response Spectrum method on 0°, 10°, 15°, 20° slope ground. The Response Spectra as per IS 1893 (Part 1):2002 for medium soil was used and comparative results for (G+10), (G+15), (G+20) building were generated for same slope and same soil condition.

Results stated that buildings resting on sloping ground have less base shear compared to buildings on Plain ground. Base shear increases as slope of ground increase. Buildings resting on sloping ground have more lateral displacement compared to buildings on Plain ground. Buildings with set back – step back showcased less displacement than step back model. The shear force and moment in columns was more on sloping ground than on plain ground. The shear force and bending moment value in beams is high in plain ground model than on sloping ground model. The performance of set- step back building during seismic excitation could prove more vulnerable than other configurations of buildings. The development of moments in set - step back buildings is higher than that in the set back building. Hence, Set back buildings are found to be less vulnerable building against seismic ground motion. Step back Set back buildings, overall economic cost involved in leveling the sloping ground and other related issues needs to be studied in detail.

Adani et. al. (2018) the research paper presented Seismic analysis of Step Back and Set Back Buildings using Response Spectrum Method in ETABS 2016. The maximum storey displacement, maximum storey drift and base reactions was observed for all the configurations of building model with and without shear wall. These buildings even with shear walls were subjected to get more affected by earthquake force.

The fundamental Time Period from the IS 1893:2016 given equation stated higher value than from RS. Conclusion derived from results stated that the maximum displacement in both the direction in Step Back Building for given storey was more than that of in Step Back and Set Back Building. In Step Back-Set Back Building when Shear wall was introduced in X and XY both direction max. displacement reduces by 60-80% in X-Dir. shear all cases. And for Y dir. when shear wall was introduced same results were seen. For Step Back Building Max. Displacement in X-Dir. reduces to 80-90% and in Y-Dir. it reduces to 50-80% for all cases. In all type of configuration without shear wall max. Base reaction was being taken by the top most support on Hill and when Shear wall was introduced in all type of configuration support connected to Shear Wall bears highest reaction.

Naveen Kumar et. al. (2017) the research paper considered a G+ 10 storeys RCC building for the analysis and comparative analysis was conducted with the building resting on level ground. The modeling and analysis of the building was done by using structure analysis tool ETAB 2015. The seismic analysis was performed by the response spectrum analyses as per IS: 1893 (part 1): 2002. The results were obtained in the form of top storey displacement, Storey drift, Base shear and over turning moment.

Results stated that displacement was very less for sloping ground compare to plane ground. Story drift was less for step back configuration on flat ground compare to step back configuration on Sloping ground and again it goes to negative. Base shear is very less for step back configuration on flat ground compare to step back configuration on Sloping ground. Overturning moment was same till story 4 because column height was same, but after story 4 it overturns due to column variation and also overturning moment gradually decreases compare to step back on Sloping ground.

Arathi S et. al. (2016) the research paper investigated behaviour of G+3 storied sloped frame building having step back set back configuration was 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 carried out as per IS:1893 (part 1): 2002. The grounds were analyzed on the basis of variation of base shear, displacement with respect to variation in various hill slopes and determination of the angle that subjected to less displacement and which was safe in increasing the height of building.

It was found that the 16.7 degree sloped frame experiences maximum storey displacement due to low value of stiffness of column. The top storey displacement decreases with the increase in slope angles and the base shear value increases with the increase in slope angles. The base shear of all the buildings was nearly the same with slight variations but their distribution on columns of ground storey was such that the short column attracts the majority (75% approx.) of the shear force which leads to plastic hinge formation on the short column and are vulnerable to damage. The base shear acts more in longitudinal direction than in transverse direction. It was further observed that for 21.8 and 26.57 degrees was safe to increase the height of the building due to the less displacement values.

Sekhar and Das (2017) the research paper considered seismic behavior of three 8-Storied buildings with and without setbacks for seismic loads (DL, LL & EL). The structure was analyzed using Time History Analysis and Response Spectrum Method. The effect of Setback was investigated considering the parameters such as Time Period, storey drifts, Displacements, Storey Shears, Bending Moments and Shear Forces and correlated with the building without a setback.

The conclusion stated that Generation of all forces due to unequal distribution of mass will be identified by critical setback ratio along the section of the plan and also in the vertical height of the building. The ideal appraisals of basic difficulty proportions are RA and RH. The above evaluation conforms to the criteria given in gauges for sporadic structures was considered. Unpredictable structures were treated with appropriate plan and ought to be trailed by all IS code procurements given the guidelines. It was likewise be reasoned that alteration of quake codes geometric horizontal anomalies appear to be important to determine more preventive ordinates or apply more precise explanatory strategy to distinguish the seismic execution of difficulty building. Especially for structures with basic difficulty proportions assumes a critical part.

Perumal et. al. (2018) the research paper projected seismic resistance to the seismic vibrations considering two building models G+4 and G+15 on different sloping ground angles like 0, 20, 27 and 40 degrees. The top storey displacement, base shear was calculated using ETABS and conclusions were drawn for step back buildings. Response spectrum analysis as per IS:1893- 2002 part 2 was computed base shear and top storey displacement. Analysis was done in both X & Y directions considering shell and membrane concepts. The seismic zone considered in research was zone V in India and medium soil was considered for the investigation.

Results stated that as the slope of the ground increases top storey displacement increases, towards the increasing slope direction, maximum being at 400 sloping angle with horizontal. Compared to buildings with bare frame, the top storey displacement in the case of buildings with core wall is uniformly less. This reduction becomes much less in the case of G+15 storey compared to G+4 storey building. As the number of storeys increases the effect of core wall in reducing the top storey displacement becomes less. Here, uniform size of core wall has been adopted for both types of buildings. The effect will be better if the size of the core wall increases. The top storey displacements obtained using shell elements gives less displacement compared to the displacements obtained using membrane elements. In the case of G+15 storey building the reduction in the displacement on the use of core wall is around 17% in the case of 00 slope. This reduction reduces to around 11% in a case of 400 slope. In the case of G+4 building the reduction in the displacement on the use of core wall is 52-57% in the case of 00 slope. This reduction reduces to 23-25% in a case of 400 slope. Hence the core wall is found to be much effective when the number of storeys is less. Hence, as the number of storeys increases the percentage reduction in the top storey displacement decreases. This is in the case of same size of core wall for both buildings. As the slope of the ground increases the percentage increment in base shear reduces in both X and Y directions, maximum reduction being at 400 slope with Horizontal. Compared to buildings with bare fame the base shear in the case of building with core wall uniformly increases.

This increment become much less in the case of G+4 storey compared to G+15 storey building. As, the number of storeys increases the effect of core wall in increasing the base shear becomes more. The base shear obtained using shell elements gives lesser values compared to values obtained using membrane elements. In case of G+15 storey building the increase in base shear on the use of core wall is around 47% in the case of 00 slope. The increment reduced to around 33% in the case of 400 slope. In the case of G+4 building the increment in the base shear on the use of core wall is 20% in the case of 00 slope. This increment increases to 23% in the case of 400 slope.

Karthik Kumar et. al. (2016) the research paper considered three groups of building (i.e. configurations), out of which two are resting on sloping ground and third one is on plain ground. The first one is set back buildings and next two are step back and step back-set back buildings. The slope of ground is 10 degree with horizontal, which is neither too steep nor too flat. The height and length of building in a particular pattern are in multiple of blocks (in vertical and horizontal direction), the size of block is being maintained at 5m x 5 m x 4m. The depth of footing below ground level is taken as 2 m where, the hard stratum is available. Earthquake analysis has been carried out by Equivalent lateral force method (static method) or Dynamic analysis.' The static method is the simplest method with less computational effort. Dynamic analysis should be performed for regular buildings greater than 40 m in height in zones IV and V, and those greater than 90 m in height in zones II and III. For irregular buildings higher than 12 m in zones IV and V, and those greater than 40m in height in zones II and III, dynamic analysis is to be performed. The results were evaluated on grounds of the Storey displacements, base shear, bending moment and torsion, being developed for the building on plane ground and sloping ground.

It was concluded that the stiffness of the building was getting reduced where length of the columns is higher, relative to the other extreme end. There is a considerable variation in the distribution of storey shears. The maximum variation in storey shear is about 55%. Hence it is advisable to adopt response spectrum method for building with sloping ground The variation in bending moment between long column and short column is about 22%.This is due to presence of ground-slope is making one side of the building stiffer than the other side, which leads to variation in bending moment due to short column effect. The variation of torsion moments in Step back buildings is 2% higher compared to Step back set back buildings. Hence, Step back Set back buildings are found to be less vulnerable than Step back building against seismic ground motion. In Step back buildings and Step back-Set back buildings, it is observed that extreme left column at ground level, which are short, are the worst affected. Special attention should be given to these columns in design and detailing.

Krishna Kumar et. al. (2018) the research paper analyzed behavior of step back building. The structural models was analyzed for dynamic analysis on flat ground on different parameters namely lateral displacement, story drift, base shear, time period, bending moment, shear force and results were compared using ETABS software considering IS 456 and IS 1893: 2002.

The conclusion derived from the research stated that the building Share due to the response spectrum method in y direction was much more than in the x direction and the drift in the y direction was higher than the x direction but the stiffness in both are almost same. As per the maximum Story Drift it keep on increasing till the story 3 which has maximum story drift and then it reduces to zero on the base but the difference between the Response Spectrum in X direction n y direction much high the drift due RS in Y is much higher than RS in X.

Jagdish Chand et. al. (2020) the research paper analyzed the seismic and wind behaviour of high-rise G+30 structure, three building models namely Building having symmetric plan (SB), Irregular Plan Building (IPB) and Vertical Irregular Building (VIB). Three G+30 storied buildings were considered which were situated in seismic Zone-V and analysis were carried out using response spectrum method as per IS 1893- 2016 on ETABS software. Each building was subjected to wind load at different terrain categories to examine its effects at different slopes as per IS 875 Part 3 2015.Various parameters like Auto lateral load, maximum storey displacement, maximum storey drift, over-turning moment, storey shear and time period were considered in the research.

Results stated that the displacement of plan irregular building increases with increase of slope angle. In Terrain with slope of ground 20 degrees the displacements of SB, IPB and VIB are increased 20%, 11% and 48%. Conclusion stated vertical irregular building in terrain with ground slope less than 3 degrees provides greater resistance against both seismic and wind loading among all buildings.

Bairagi and Sujit Kumar (2018) the research focused on the comparison between two setback buildings. Pressure, force, and torsional moment coefficients were highlighted in the research. The suction at the roof top of single-side setback was 95.84% higher than the both-side setback model. Torsional moment of both-side setback model was 259.02% higher than the single-side setback model. The research stated that the both-side setback model were more susceptible than the single-side setback model.

II. CONCLUSION

In all of the previous work static analysis of buildings is considered but none of them defined the variation caused due to Lateral forces with orientation and dimensional objects of the building.

In previous studies no comparison was done on the effects of height of nearby structures.

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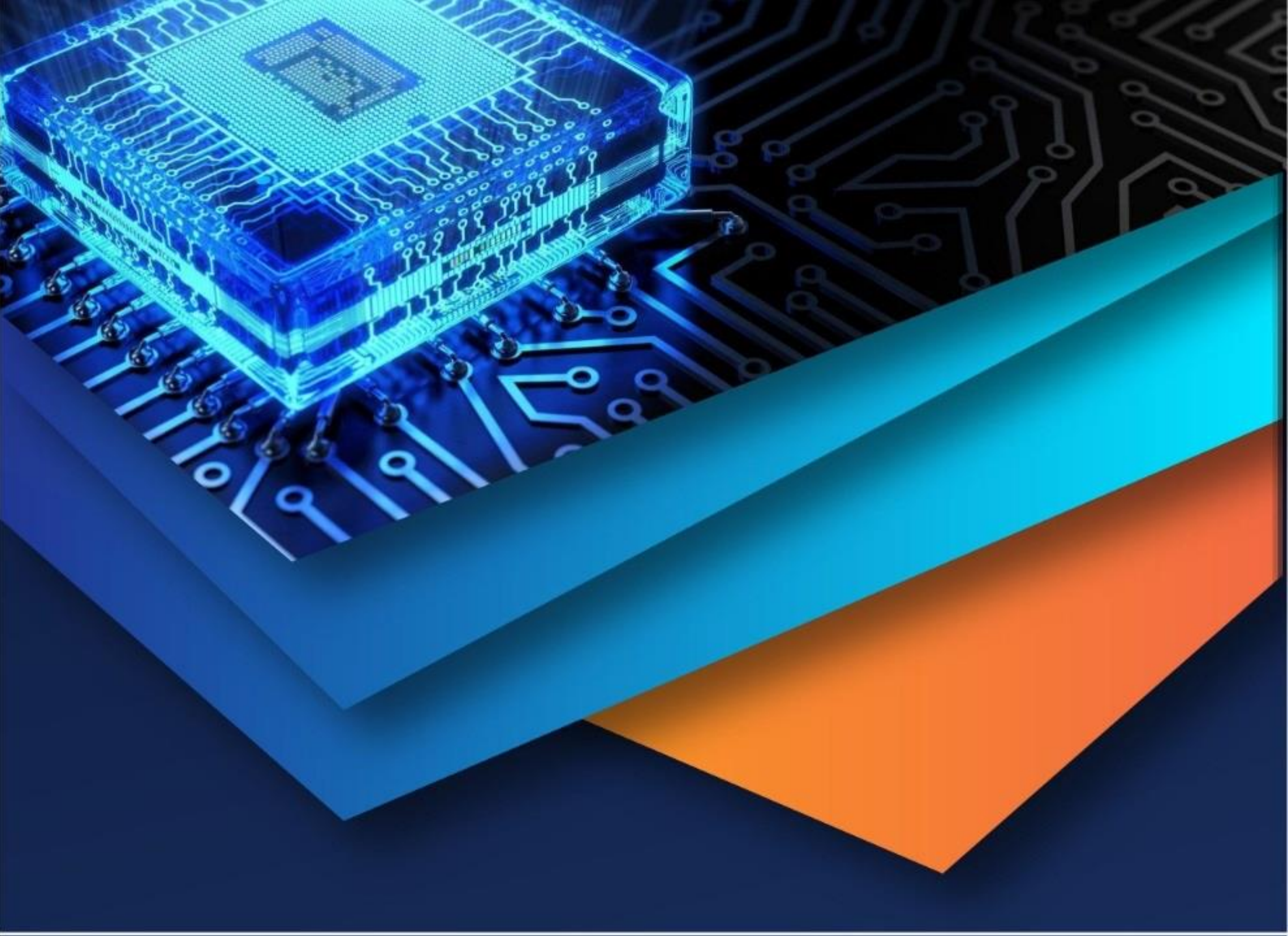

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