SEISMIC ANALYSIS AND DESIGN OF MULTI STOREY REGULAR AND IRREGULAR BUILDING ON SLOPING GROUND AND FLAT GROUND BY USING E-TABS

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ABSTRACT

In a developing country like India there is a scarcity of land due to urbanization and industrialization, which led the way for construction of high rise multi storey buildings on hilly regions. Buildings constructed on hilly areas are different from the buildings constructed on flat grounds because of their irregularity and unsymmetrical structure in vertical and horizontal plane. Also, these buildings on hilly areas are much more prone to earthquake forces. The main objective of the present work is to study the behavior of the buildings on sloping ground and flat ground.The buildings resting on hill areas have to be configured differently from flat ground. Hill buildings are different from those in plains; they are very irregular and unsymmetrical in horizontal and vertical planes, and torsionally coupled & hence susceptible to sever damage when affected by earthquake.

In this work an attempt has been made to study the behavior of the regular and irregular Multi story building with two different sloping angles and the comparison was made with the flat ground. by considering earth quake zone V. The comparison is made for flat ground building and sloped ground building. The models are prepared using ETABS structural analysis software. Analysis is done by using Response spectrum analysis. The results of the analysis i.e., displacement, moments, storey shear and storey drifts are tabulated and studied.

KEY WORDS: *irregularity, sloping ground, sloping angles, ETABS software, Response spectrum analysis.*

I. INTRODUCTION

Steel is a material which has top notch per unit mass. Along these lines it is used being developed of structures with enormous segment free space. Most of the Industrial Structures require this norm. An Industrial Warehouse is a limit creating and is commonly depicted as single story steel structures with or without mezzanine floors. The alcoves of these structures may be block workmanship, strong dividers or GI sheet covers. The dividers are all around non-bearing anyway enough adequately ready to withstand

As of late Sikkim (2011), Doda (2013) and Nepal seismic tremor (2015) caused gigantic obliteration. In this district there is a request of development of multistory RC confined structures because of the quick urbanization and increment in monetary development and subsequently increment in populace thickness. Because of the shortage of the plain territory in this district there is a commitment of the development of the structures on the slanting ground. In display work, atenstoried confined working with a tendency of 120°and 140° to the ground subjected to sinusoidal ground movement is demonstrated with a test by performing Response range investigation in basic examination and plan programming.

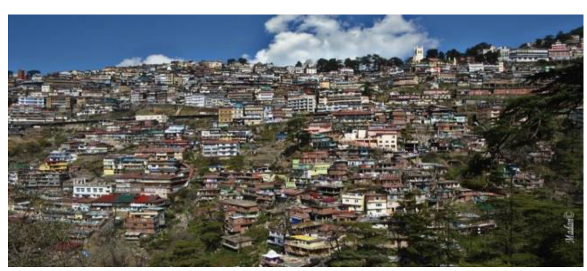


Figure 1: Buildings on sloping ground

1.2 IRREGLAR BUILDINGS

In order to design a structure to resist wind and earthquake loads, the forces on the structure must be specified. The exact forces that will occur during the life of the structure cannot be anticipated. Most National Building Codes identify some factors according to the boundary conditions of each building considered in the analysis to provide for life safety. A realistic estimate for these factors is important; however the cost of construction and therefore the economic viability of the project are essential. Owing to lack of earthquake and wind forecasting centers the Egyptian Codes 1993 and 2003 give more concentration on calculating these lateral loads and the corresponding additional stresses to be taken into account in the design of the structures.

During an earthquake, failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are termed as Irregular structures. Irregular structures contribute a large portion of urban infrastructure. Vertical irregularities are one of the major reasons of failures of structures during earthquakes. For example structures with soft storey were the most notable structures which collapsed. So, the effect of vertically irregularities in the seismic performance of structures becomes really important. Height-wise changes in stiffness and mass render the dynamic characteristics of these buildings different from the “regular‘ building. IS 1893 definition of Vertically Irregular structures:

The irregularity in the building structures may be due to irregular distributions in their mass, strength and stiffness along the height of building. When such buildings are constructed in high seismic zones, the analysis and design becomes more complicated.

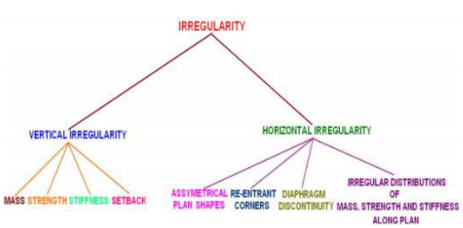


Figure 2: Irregularity in Building

Objectives of the study

The following are the main objectives of the project

1. To study the seismic behavior of multi story regular and irregular buildings by using IS 1893:2002
2. To compare the multi story slope buildings with flat ground.
3. To study the seismic behavior of multi story buildings in Zone V as per IS 1893:2002.
4. To compare the results of Story Drift, Shear force, Bending moment, Building torsion of regular and irregular buildings with 5 degree and 10 degree slope ground structures with flat ground models.
5. To study the buildings in ETABS Software

II LITERATURE REVIEWS

Singh et al. (2012) carried out an analytical study using linear and nonlinear time history analysis. They considered 9 story RC frame building (Step back) with 45 degrees to the horizontal located on steep slope. The number of storeys was 3 and 9 and 7 bays along the slope and 3 across the slope. They took 5 set of ground motions i.e., 1999 Chi-Chi, 1979 Imperial Valley, 1994 Northridge , 1971 San Fernando , 1995 Kobe from strong motion database of pacific Earthquake Engineering Research Centre (PEER).

Babu et al. (2012) They considered a 4 storey building in which one storey is above ground level and it is constructed at a slope of 30 degree. They observed that the short column subjected to worst level of severity and lie beyond collapse prevention (CP) from pushover analysis. They obtained displacement as 104 mm and base shear as 2.77*103 kN. Based on these results they developed pushover curves with X-axis as displacement and Y-axis as base shear and gave various comparisons for the cases they considered. They found that up to failure limit for maximum displacement by symmetric structure is 70% and by asymmetric building is 24% more than the structure on plain ground.

Patel et al. (2014) In the present study lateral load analysis as per seismic code was done to study the effect of seismic load and assess the seismic vulnerability by performing pushover analysis. It was observed that vulnerability of buildings on sloping ground increases due to formation of plastic hinges on columns in each base level and on beams at each storey level at performance point.

III METHODOLOGY

Response Spectrum Method

Response spectrum analysis is also known as linear dynamic statistical analysis method. This analysis generally done with the help of IS code for seismic analysis. The IS code used for this study is IS 1893:2002 (Part 1). The values of seismic zone factor, soil type are taken from the tables which are from this IS 1893:2002 (Part 1) code. The damping ratio is generally taken as 5% for this analysis. The response spectrum Graph for medium soil condition is shown in the below graph. The graph is plotted between the Time period and Spectral acceleration coefficient (Sa/g).

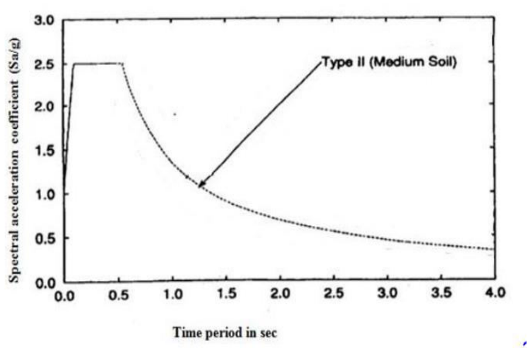


Figure 3: Response spectrum for medium soil type for 5% damping

In this we need to discover the size of powers finished for instance X, Y and Z and after that see the repercussions for the structure. Mix techniques combine the going with:

1. Absolute - crest esteems are included
2. Square foundation of the total of the squares (SRSS)
3. Complete quadratic blend (CQC) - a strategy that is a change on SRSS for firmly divided modes.

The output from the Response spectrum analysis is purely different from the linear dynamic analysis using the ground motions, in case of structure or building is irregular or high rise building this analysis of response is not accurate as we compared with other analysis and other method of analysis is needed, which is non linear static analysis or dynamic analysis.

In the present study I was considered a medium rise building and regular structure for the seismic loading condition for the response analysis case.

IV STRUCTURE MODELING

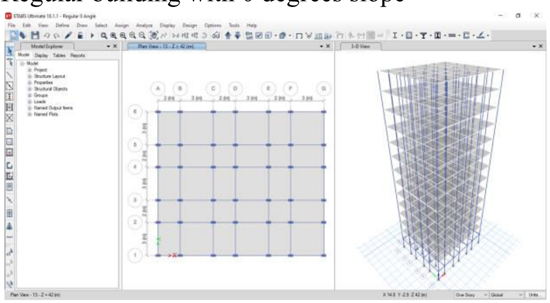
The following are the basic data considered for analysis

1. Height of typical Storey = 3 m
2. Height of ground Storey = 3 m
3. Length of the building = 15 m
4. Width of the building = 13 m
5. Height of the building = 39 m
6. Number of stores = 13 (G+12)
7. Wall thickness = 230 mm
8. Slab Thickness = 150 mm
9. Grade of concrete = M30
10. Grade of the steel = Fe500
11. Support = Fixed
12. Column size = 460mmX230mm
13. Beam size = 350mmX230mm
14. Location of Building = India
15. Live load = 3 KN/m^2
16. Dead load = 2 KN/m^2
17. Density of concrete = 25 KN/m^3
18. Seismic Zones = Zone 5
19. Site type = II
20. Importance factor = 1.5
21. Response reduction factor = 5
22. Damping Ratio = 5%
23. Structure class = C
24. Basic wind speed = 44m/s
25. Risk coefficient (K1) = 1.08
26. Terrain size coefficient (K2) =1.14
27. Topography factor (K3) = 1.36

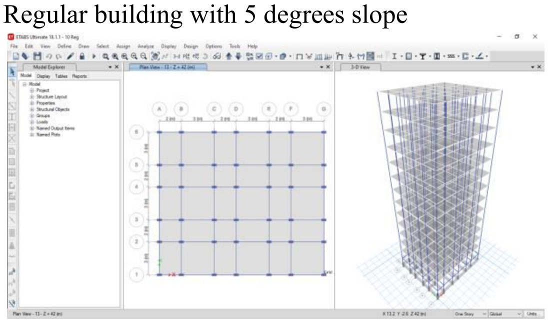
28. Wind design code = IS 875: 2015 (Part 3)
29. RCC design code = IS 456:2000
30. Steel design code = IS 800: 2007
31. Earth quake design code = IS 1893: 2016 (Part 1).

Models in ETABS Software

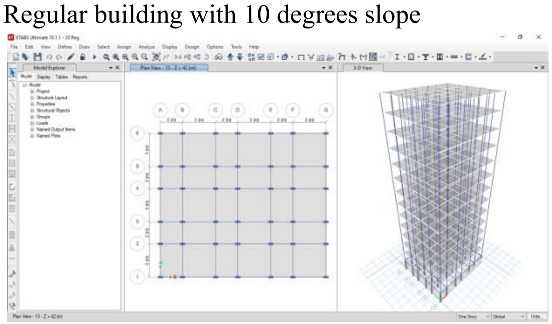
Regular building with 0 degrees slope



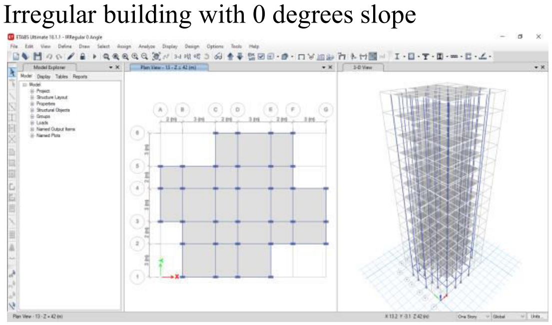
Regular building with 5 degrees slope



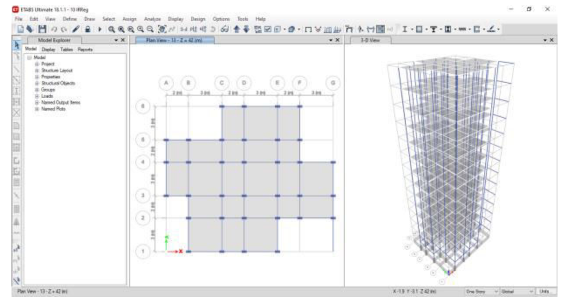
Regular building with 10 degrees slope



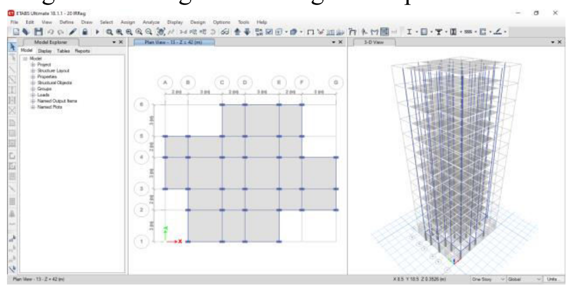
Irregular building with 0 degrees slope



Irregular building with 5 degrees slope



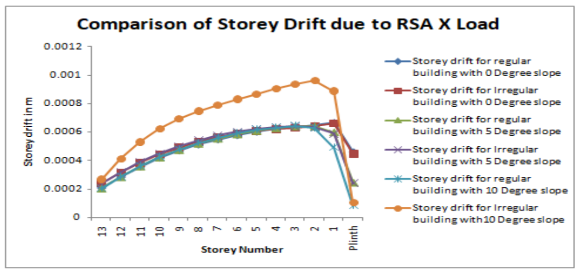
Irregular building with 10 degrees slope



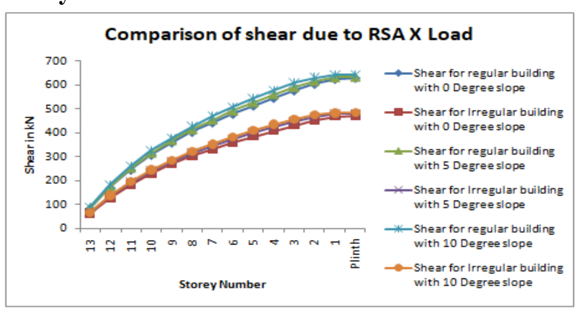
V RESULTS AND ANALYSIS

RSA X Results

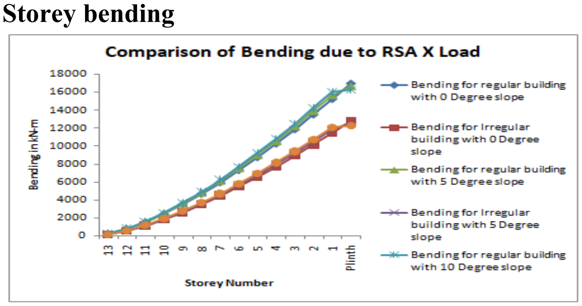
Storey drift



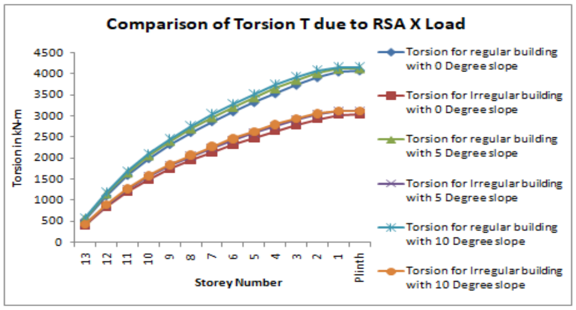
Storey shear



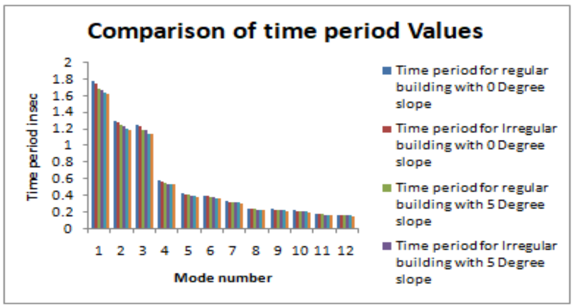
Storey bending



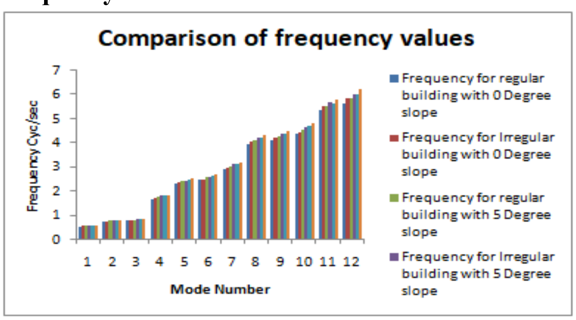
Storey torsion



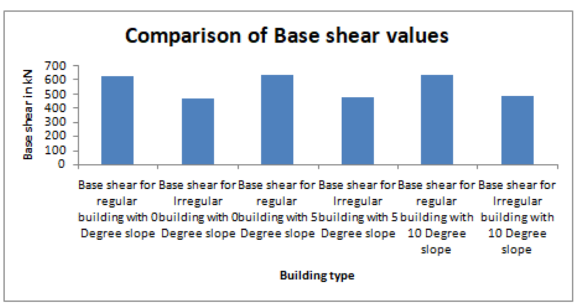
Time period



Frequency

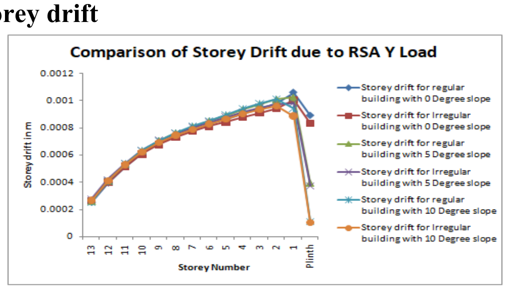


Base shear

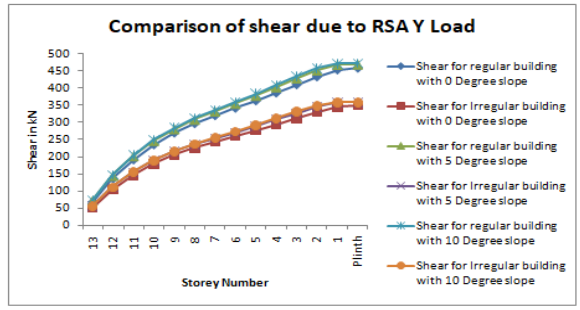


RSA Y Results

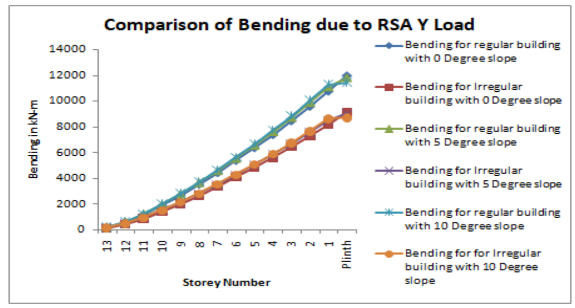
Storey drift



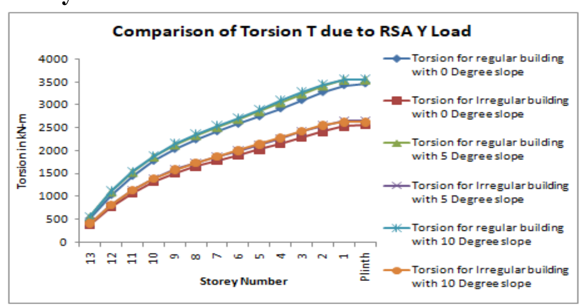
Storey shear



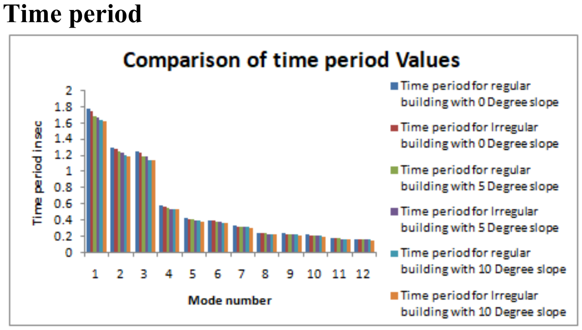
Storey bending



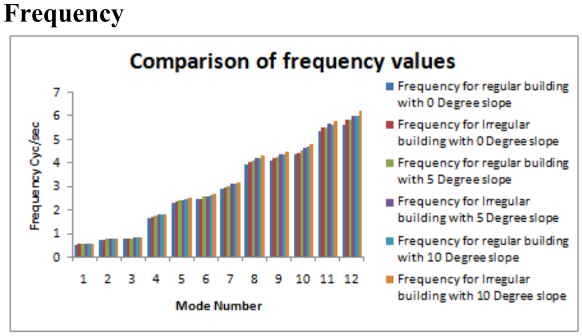
Storey torsion



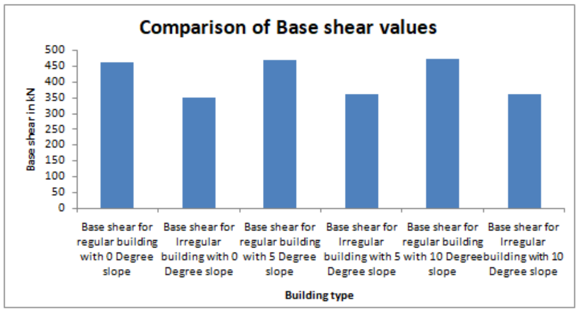
Time period



Frequency



Base shear



VI CONCLUSIONS

From the above study the following conclusions were made

1. By including irregularities in the building structure, the lateral load intensity for irregular models is reduced, which lowers the base shear values. The building is not significantly impacted by the slope to the ground.
2. Compared to alternative layouts on sloping terrain, irregular buildings on plan ground attract fewer action forces, making them more stable and less susceptible to damage from lateral load action.
3. Irregular buildings on sloping ground attract fewer action forces than step-back buildings, but they might be chosen provided the expense of cutting sloping ground is within reasonable bounds.
4. By including irregularities in the building structure, the lateral load intensity for irregular models is reduced, which lowers the base shear values. The building is not significantly impacted by the slope to the ground.
5. Compared to alternative layouts on sloping terrain, Irregular buildings on plan ground attract fewer action forces, making them more stable and less susceptible to damage from lateral load action.
6. Irregular buildings on sloping ground attract fewer action forces than step-back buildings, but they might be favored provided the expense of sloping ground cutting is within reasonable bounds.
7. In the case of the RSA X load instance, the storey drift values for the remaining 5 models are about comparable intensities, while the drift values were found to be high for irregular buildings with a 10 degree slope. For all irregularly shaped buildings, with or without slopes, the values of storey drifts were found to be lower in the RSAY case using the same procedure.
8. Compared to traditional building models, irregular buildings in zone V have lower shear, bending, and torsion values. Furthermore, as the slope increases from 0 to 10 degrees, the intensities increase as well. Higher values are obtained with a slope of 10 degrees, whereas lower numbers are obtained with a slope of 0 degrees.
9. By giving both the ground slope and the building imperfections, the time period is getting shorter.
10. The ground slope and construction imperfections both contribute to the lengthening of the time period.
11. We may also infer from the graphs that, in comparison to flat ground buildings, the impact of earthquakes is minimal for sloped ground buildings.

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