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Study on Tall Structure for Hilly and Plane Surface under Seismic & Wind Load Conditions using STAAD ProV8i Software

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ABSTRACT

- There are various previous studies done for proper planning and good construction practices of multistoried buildings on sloping ground in particular, which lead to irregularities in plan and elevation of the buildings.
- Analysis and design of space building frame for seismic loading and wind pressure is very essential these days because of the construction of high rise buildings. It is also necessary to construct an economical and more durable structure.
- The current work examines the structural behavior of reinforced concrete columns, beam, and footing in sloping geometry. In this study a G+8 storey RCC building is analyzed on varying sloping angles i.e., 0^o or plane surface and Hilly Surface 15^o.
- The seismic forces and wind pressure are considered simultaneously as per IS: 1893-2002 and IS: 875 PART 3 respectively. The whole structure is analysis on software STAAD Pro v8i.
- The effect of Hilly ground on building performance during earthquake and wind pressure is observed. Seismic analysis has been done using Linear Static method.
- Analysis is done to evaluate the effect of sloping grounds on structural forces and displacement. In horizontal and vertical reaction, beam, shear force, and bending in lateral displacement in the column, axial force and columns, the moment of bending is critically analyzed to measure the effects of plane and hilly ground.
- It has been observed that the small height paving columns attract more forces, because their stiffness has increased significantly, which, in turn increases the bending moment and shear force. Thus, the section of these columns should be designed for modified forces due to the effect of hilly ground.

INTRODUCTION

- Earthquakes occur when energy stored in elastically strained rocks is suddenly released. This release of energy causes severe ground shaking in the areas near the source of the earthquake and sends wave of elastic energy called seismic waves throughout the earth.
- When an earthquake occurs, the elastic energy is released and it sends the vibration that travels throughout the earth. These vibrations are also called seismic waves.
- Multi-storey building frames on sloping ground will be coming up in large number in future times. Thus realistic analysis of these building frames on sloping ground is of paramount importance.
- Due to site conditions, buildings on hill-slopes have unequal column heights which results in variation of column stiffness.

Tall Structure

- Tall buildings throughout the world are becoming popular day by day. With the advent of modern day construction technology and computers, the basic aim has been to construct safer buildings keeping in view the overall economics of the project. A high-rise building, apartment tower, office tower, apartment block, or block of flats, is a tall buildingor structure used as a residential and or office use. In some areas they may be referred to as "Multi Dwelling Unit" or “Vertical cities”. They have the potential to decongest the urban sprawl on the ground level, and increase the urban density, housing higher number of families in lesser space
- Although there is no precise definition that is universally accepted, various bodies have tried to define what 'high-rise' means:
- The International Conference on Fire Safety in high-rise Buildings defined a high-rise as "any structure where the height can have a serious impact on evacuation"
- Massachusetts, United States General Laws define a high-rise as being higher than 70 feet (21 m).
- Most building engineers, inspectors, architects and similar professions define a high-rise as a building that is at least 75 feet (23 m) tall.

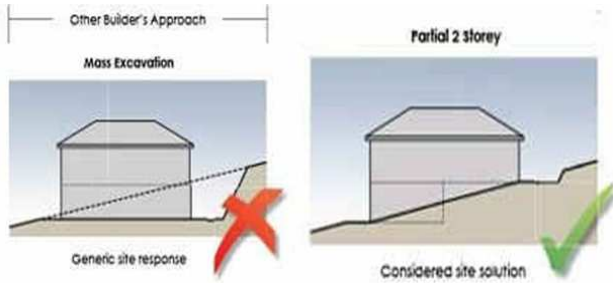

Figure Shows solution for res

Literature Survey

General

Zaid Mohammada (2016) Confined structures built on slope inclines indicate unexpected basic conduct in comparison to that on the plain ground. Since these structures are unsymmetrical in nature, subsequently draw in huge measure of shear powers and torsional minutes, and show unequal circulation because of changing segment lengths. In present investigation, two unique setups of slope structures have been displayed and broke down utilizing ETABS v 9.0 limited component codes. A parametric report has been completed, in which slope structures are geometrically differed in stature and length. Taking all things together.

Rupali Kavilkar and Shweta Patil (2016) High-rise structures are also called "vertical cities", having the potential to decongest urban sprawl. Indian cities are witnessing immense demographic expansion due to migration from surrounding villages, leading to urban sprawl, housing demand, rise in cost of land. Housing has developed into an economy generating industry. Given this demand, while high-rise residential structures have become a solution in the metropolitan cities, they remain eluded in tier II cities in India. Low-rise or mid-rise high-density dwelling types have developed in these cities. A study of Pune city's housing needs, demands, market, and type of structures being built, reveal that tall buildings of 11 floors are being developed on the city's urban fringe. Most of the high-rise projects remain as proposals. An investigation in this case study reveal that high rise structures are not preferred due to user perception of insecurity in case of fire and high cost of the building. The paper aims at studying the availability and use of fly ash in various proportions, which can be used in Indian high-rise residential buildings. The research paper indicates that fly ash concrete can be used to reduce the cost of construction and has the potential to minimize the damage caused due to high temperature.

Roser J. Robert and Ranjana M. Ghate (2016) made a comparison between the behaviour of G+4 storey building rested on sloped surface and on flat surface with same intensity of seismic load on both the buildings. They are mainly focused on storey displacement and base shear of buildings have been evaluated in +X and –X direction as well as in +Z and –Z direction. They conclude that i). The story displacement is 10% more in Flat surface in X direction and 30% more in sloped surface in Z direction. ii). Base shear is 7.45% more in Flat surface than sloped surface. iii). number of storey increases storey displacement decreases in both buildings iv) building rested on sloped surface is more vulnerable than building rested on flat surface during seismic effect.

A Joshua Daniel and S Sivakamasundari (2016) made a comparative study of three setback buildings of Type A building is stepping back at every floor level on the slope, up to 4 storeys and has two storeys above road level. The Type B building is stepping and setting back at every floor level. The Type C buildings is stepping back at fourth floor level only and has two storeys above road level having weight and plan same as with the regular building resting on flat ground. He concluded that, i). From the cumulative modal mass participation ratio, the energy dissipation of regular building on flat ground is higher than the respective hill building. ii). Flexibility of regular building endures larger displacement than building resting on hill.

Akhil R (2017) made a comparative study to better understand of regular and irregular structure response to incoherent ground motion. The modeling of regular and irregular building for zone V of G+10 is analyzed .The main aim of his work is comparative study about the stiffness of the regular and irregular configuration. A geometric irregularity introduces discontinuities in distribution of mass, stiffness and strength along vertical direction needs to work in these regarding area. Author made an attempt to reach on more accurate conclusion to reduce their effect on structure. Among these regular and irregular, he identifies the best configuration from his analysis. It was concluded that response spectrum analysis allows clear understanding of contributions of different modes of vibration. Comparing the results, it was concluded that base shear and displacement are maximum in regular building.

Esther (2018) generated different types of analytical models using STTAD. He made an attempt on vertical geometrical irregularities of 6 storeys, 8 storeys and 10 storeys with a range of 0 to 75 % irregularities with interval of 25%. For each case he studied member forces such as bending moment, shear force, displacement, and drift. From his study he concluded that i). Shear force and bending moment is maximum in 75% irregularity i.e., irregularity increases **Sharon** bending moment and shear force increases. ii). Drift also increases with irregularity of building increased if it exceeds 0.10 it leads to collapse. iii). The maximum displacement of 75 % increased by 75% irregularity and 65% with plus shape without irregularity.

In this thesis, seismic analysis of building is done at two different grounds plane and hilly (i.e., 0^o, and 15^0). Comparison of footings in terms of horizontal reaction, vertical reaction and bending moment is carried out at above mentioned sloping ground. Also axial force and bending moment in columns, shear force and bending moment in beams is compared, Lateral displacement and drift is also compared.

Objectives

The objectives of the research are outlined below:

- To analyses problems of Tall RCC building considering earthquake Zone III in different geometries using Staad Pro V8i software.

METHODOLOGY

- This thesis deals with relative study of behavior of sloping ground building frames considering different inclination (15^o) under earthquake forces. The comparison of sloping ground and plane ground building under seismic forces is done. Here G+ 8 storey is taken

and same live load is applied in three the buildings for its behavior and comparison.

- The framed buildings are subjected to vibrations because of earthquake and therefore seismic analysis is essential for these building frames. The fixed base system is analyzed by employing in three building frames in seismic zone III by means of STAAD Pro. Software. The response of three the building frames is studied for useful interpretation of results.

STAAD Pro SOFTWARE

- The seismic analysis on buildings frame is done by STAAD Pro. V8i software. It is one of the most popular structural engineering software products for 3D model generation, analysis and multi-material design. It has a sensitive, user-friendly GUI, visualization tools, powerful analysis and design facilities and seamless integration to several other modeling and design software products.

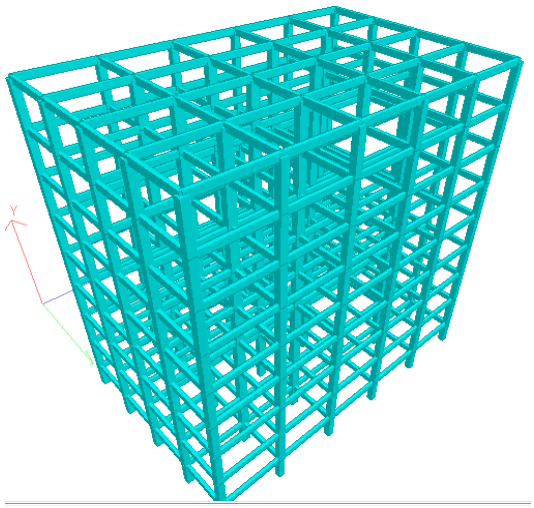

Figure 3D Rendered View of building frame

Results

The behavior of all the framing system is taken as a basic study on the modeled structure. The following parameters were considered to present a comparison between the different frames:

- **Maximum Deflection**
- **Maximum Shear Force**
- **Maximum Bending Moments**

Table - Effect of sloping ground on critical forces in footing

Sr. No.	Footing forces	Load case	Ground slope (in degree)		Comparison of various analyses	
			0	15		
			1	3	2/1	3/1
1	Horizontal Fx(kN)	EQX	-49.17	-147.4	1.69	3.00
2	Vertical Fy(kN)	EQX	171.37	192.40	0.93	1.12
3	Vertical Fy(kN)	EQZ	601.37	447.50	0.85	0.74
4	Vertical Fy(kN)	1.5(DL+ LL)	1953.4	2871.0	1.26	1.47
5	B.M Mz(kN-m)	EQZ	3.03	31.78	9.08	10.49
6	Torsion My(kN-m)	EQZ	10.37	56.16	3.20	5.42
7	B.M Mz (kN-m)	EQX	192.82	482.88	1.82	2.50
8	B.M Mz (kN-m)	1.5(DL+ LL)	194.09	324.94	1.47	1.67
9	Horizontal Fx(kN)	1.5(DL+ EQX)	68.47	285.29	3.00	4.17
10	Vertical Fy(kN)	1.5(DL+ LL)	1863.2	3873.7	1.32	2.08
11	B.M Mz (kN-m)	1.5(DL- EQX)	1039.7	3075.9	2.05	2.96

CONCLUSION

- Analysis and design of space building frame for seismic loading and wind pressure is very essential these days because of construction of high rise buildings. It is also necessary to construct an economic and more durable structure. It is possible by availability of various software and specialized programs. By using these softwares we can design a light weight reinforced structure which makes life very good. These structures are more economical and safe by different types of forces acting on the building structure such as seismic load, snow load , wind pressure etc.
- Reinforced concrete (RC) frame buildings are most common type of constructions resting on plane and hilly ground (hilly area) in India. There buildings are subjected to several types of forces during their lifetime, such as static forces due to dead and live loads and dynamic forces due to the wind and earthquake.
- Results from seismic analyses performed on three RC buildings with three different ground slopes
- (0^o & 15^o) has been carried out by using static method. The top storey displacement and the footing reaction, axial force, shear and moment action induced in columns and beams have been studied to investigate the influence of sloping ground on structural performance of building frame.
- The static analysis has been done on computer with the help of Staad Pro V8i software using the seismic parameters as per the IS: 1893- 2002 for the zone (III) and wind pressure as per IS: 875 PART 3, the post processing result obtained has summarized in tables.

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