International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 4, Issue 8, August 2015)

Seismic Analysis of Irregular Building Resting on Sloping Ground

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***Abstract*— The construction of structures on sloping ground is a common practice due to the scarcity of level areas. However, buildings constructed on slopes differ from those on flat terrain, exhibiting irregularities and asymmetry in both horizontal and vertical planes. Consequently, these structures are more vulnerable to significant damage when subjected to earthquake-induced ground motion.**

There are two primary configurations for buildings on sloping ground: step back and step back setback. In this research, a reinforced concrete (RCC) building with ten stories (G+10) and varying ground slopes ranging from 0° to 30° is examined.There are two type of Plan taken for the analysis(C-type and L-type). A comparative analysis is conducted, comparing these scenarios with a building situated on level ground and with various seismic Zones. The modeling and analysis of the building are performed using the structural analysis tool ETABS 2020. The primary focus is on investigating the impact of different column heights in the bottom storey during an earthquake event. Seismic analysis is conducted through linear static Analysis, and Response spectrum Analysis are carried out in accordance with the IS:1893 (Part 1):2016.

The outcomes obtained cover a range of variables, including top-storey displacement, storey drift, base shear, time period, and storey acceleration. Notably, it has been found that shorter columns typically have more severe consequences during earthquake events.

Introduction

The rapid urbanization and population growth in various regions of the world have led to the construction of buildings in areas with complex geological conditions. As a consequence, buildings are increasingly being constructed on sloping ground, which introduces additional challenges to their structural performance, particularly during seismic events. Seismic analysis plays a crucial role in understanding the behavior of buildings under earthquake-induced forces and designing robust structures that can withstand such dynamic loads. In-Plane Discontinuity in vertical elements resisting lateral forceIn this present study it is proposed to consider the building frames that are irregular in plan with variation in slope of ground and analyze the response and behavior of the structures under earthquake.

To compare the various parameters like base shear , storey displacement , storey drift , time period , storey acceleration of irregular structure resting on sloping ground with structure on plain ground in different seismic zones with the help of ETABS

In-plane discontinuity in vertical elements are resisting lateral force shall be considered to exist, when in-plane offset of the lateral force resisting elements is greater than 20 percent of the plan length of those elements

❖ Step-Back Frame:

A step-back building on sloping ground is a design concept that involves constructing a building in such a way that each floor is positioned slightly behind or above the floor below it. This arrangement creates a cascading or terraced effect that follows the natural slope of the site. The primary goal of implementing step-backs is to seamlessly integrate the building with the existing landscape, thereby reducing the necessity for extensive excavation, retaining walls, or other earthmoving measures.

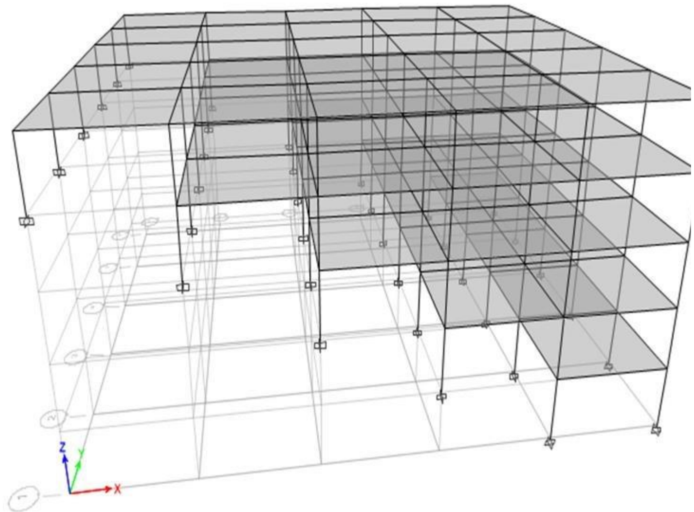

Figure 1.1: Step-back Frame

Step-back and Set-back Frame:It is the combination of Step-back frame and Set-back frame.

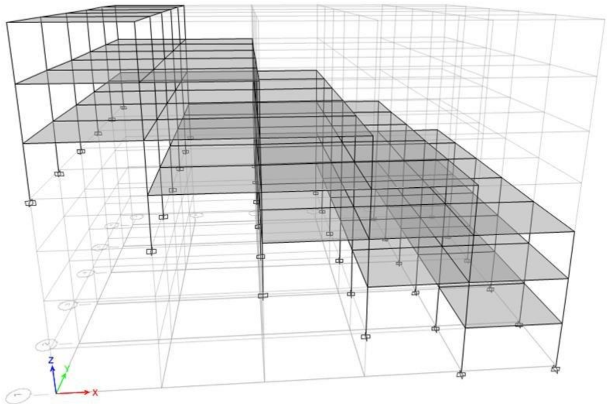

Figure 1.2: Step-back and Set-back Frame

The Plan dimension for the building is 24 m X 24 m. G+10 buildings with variation in slope(0°,10°,20°,30°) are discussed in the following sections and analysed in ETABS.

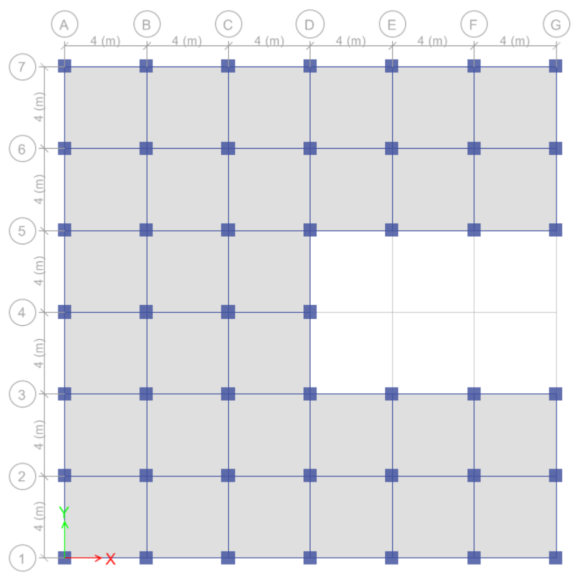

Figure 5.1: Typical floor Plan of C-type Building

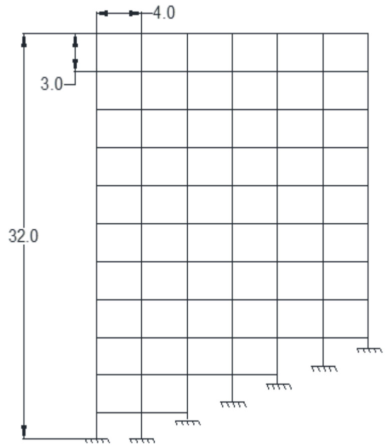

Figure 5.2: Elevation of building [C-type,20°Slope]

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- According to the above Results, for the C-type Plan, the building with slope of 0 Degree experiences the greatest storey drift of 0.003262, with a small variation from the building with slope of 10 Degree.

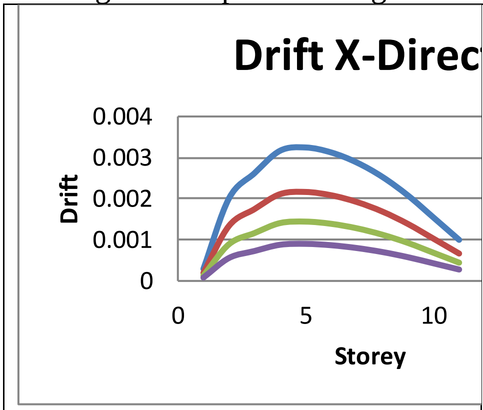


Figure 6.1: Storey drift for 0°Slope in X-direction

- analysis methods suggest that an increase in the slope of the building reduces storey drift.

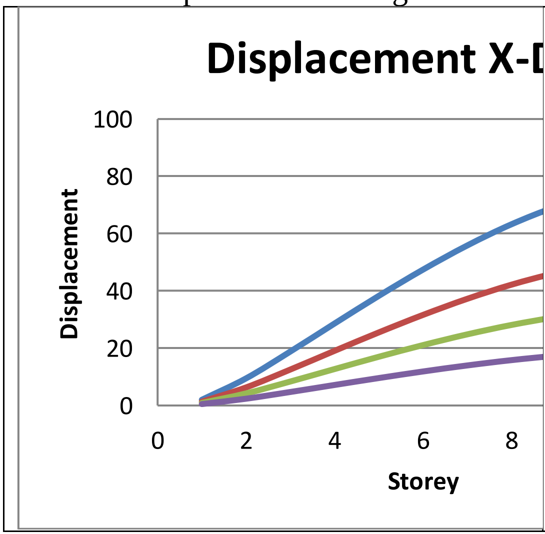
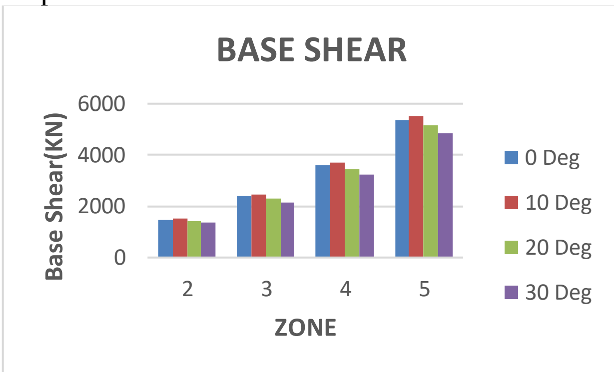


Figure 6.2: Storey Displacement for 0° Slope in X-direction.

- both analysis methods lead to the conclusion that with an increase in the seismic zone, there is a corresponding increase in storey displacement.



- Figure 6.3: Base Shear for C-type Building

Conclusions

the Building in Zone 5 experiences the largest storey drift.

for the C-type Plan, the building with slope of 0° experiences the greatest storey drift

the variation of storey drift for the buildings with different angle of ground slope is significant upto the 8th storey, but the difference of storey drift is negligible above that storey.

1. In the case of buildings resting on sloping ground, short column on the uphill side attracts maximum shear force in the range of 160-685% compared to adjcent long columns, which are the worst affected due to seismic excitation. Special attention should be given while designing this columns. So, we can provide higher size of column in the lower storey than the upper storey of building.

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