**ANALYSIS AND DESIGN OF MULTI - STORAGE BUILDING G+10 UNDER DIFFERENT SLOPING CONDITION**

**Jhamman Lal1, Mr. Vagesh Kumbhakar2**

**M.Tech. Scholar1, Assistant professor2**

**Jhammanlal922@gmail.com1**

**ISBM University, Gariyaband, Chhattisgarh, India.**

**ABSTRACT**

Structures are usually built on level ground; However, due to lack of flat land, construction work has started on the sloping terrain. Step back and step back setback are two different types of construction configurations on sloping terrain. For the purposes of this study, a G+ 10 storey RCC structure with ground slopes of 20 and 44 degrees was investigated. This building has been compared to a building standing on level ground. The structural analysis program ETAB 2018 was used for modeling and analysis of the building. Using time history and response spectrum approaches to assess a structure on sloping terrain with or without a shear wall. Based on the results of both analyses, various reaction parameters are compared. To design and adapt various structural elements to the present conditions by comparing the analysis of the same structure on level ground with the structure on sloping land. The seismic study was conducted as per IS:1893 (Part 1) 2016 using response spectrum analysis and time history. Top floor displacement, floor shear and floor drift were used to obtain the results.

**Key word:** - Structures, spectrum, sloping terrain, Seismic analysis, structural assessment, windstorm etc.

**INTRODUCTION**

**1.1 General**

Seismic analysis is a branch of structural analysis that involves calculating the response of a structure to dynamic excitation. It is a subset of structural design, earthquake engineering, or the structural assessment and retrofit process in earthquake-prone areas. During seismic excitation, a structure may "wave" back and forth. During strong thunderstorms, this behavior can also be observed. As the name suggests, 'Basic Mode' corresponds to the lowest frequency of the building response. The structure requires the least amount of energy to vibrate at this frequency. On the other hand, most structures have more response modes that are triggered only during earthquakes. Nonetheless, in most cases, the first and second modes cause the most damage. For seismic response analysis of structures, various forms of ground motion input are necessary. The methods used for seismic response analysis of structures can be classified as

1. Time history analysis,
2. Response spectrum method of analysis, and
3. Frequency domain spectral analysis, depending on the available input information.

**Objective of present study**

Objective of present study are as follows:-

1. To analyze the structure with or without shear wall on sloping ground using time history method.

2. To analyze the structure with or without shear wall on sloping ground using response spectrum method.

3. Comparison of various reaction parameters based on the results obtained in both the analyses.

4. Comparing the analysis of the same structure on level ground with that on sloping ground

5. To design and adapt various structural elements to existing conditions.

**LITERATURE REVIEW**

**Silvia.B et al. (2018)** conducted a comparative study on the effective arrangement of shear walls at different sites in different seismic zones for RCC multi-storey structure. Four models were developed for the investigation, and floor drift, displacement and floor shear were observed in all zones, i.e. (Zone II, III, IV and V). Shear walls are most effective when placed at the ends of the building, and floor drift and displacement are greatest in that area.

**M V Naresh et al. (2019)** conducted a research on static and dynamic analysis of multi-storey buildings, which concluded that static analysis is inadequate for high-rise buildings and emphasized the importance of dynamic analysis to counteract the lateral stresses generated during earthquakes.

When **Kusuma.S (2020)** used Etabs to evaluate response spectrum analysis and time history analysis for a multi-story structure, he observed that the response spectrum technique produced more accurate findings and higher base shear values.

**METHODOLOGY**

**3.1 Geometric parameters**

This study examines a building layout consisting of structures located on flat ground. The number of stories taken into account for each type of setup is ten. All types of building frames have similar planning arrangements. To prevent complications such as orientation, the columns are assumed to be square.

**Software used**

ETABS - Extended Three-Dimensional Analysis of Building System

ETABS is a cutting-edge, multi-purpose research and design programme designed specifically for building systems. With its best-integrated systems and skills, even the largest and most complicated building models may be readily sketched.

Etabs-2018 software was used to conduct response spectrum analysis and time history study on a typical building, as shown in the figure. The response spectrum of the El Centro earthquake was matched using a time domain approach. For each level, floor displacement, floor drift, floor shear force, spectral acceleration, and spectral displacement were calculated, and graphs shown.

**RESULTS & CONCLUSION**

**1) On analysis by time history method of 3D mathematical model following conclusions have been made:-**

**a) With shear wall**

i) Maximum displacement in both directions was found in the 3D model on 44o sloping ground. Whereas on flat ground the model has less displacement in both directions.

ii) It is observed that the maximum floor drift is observed at the 9th floor of the ground model having a slope of 44o. It is also observed that the slope floor flow increases as the slope angle is increased from 0° to 44°.

iii) The value of floor shear in both directions in the building model was found to be maximum on ground with a slope of 44o, while it was lowest on flat ground.

**b) Without shear wall**

i) Maximum displacement was found in Y direction in the 3D model on 20° slope ground. Whereas on flat ground the displacement of the model is maximum in the X direction.

ii) It is observed that maximum floor flow is observed on the second floor of the ground model with 20° slope.

iii) The value of floor shear in both directions in the building model was found to be maximum on ground with a slope of 44o, while it was lowest on flat ground.

**2) On analysis by response spectrum method of 3D mathematical model following conclusions have been made:-**

**a) With shear wall**

i) Maximum displacement was found in Y direction in the 3D model on 20° slope ground. Whereas on flat ground the displacement of the model is maximum in the X direction.

ii) It is observed that maximum floor drift is observed at the 5th floor of the ground model with 20° slope.

iii) The maximum value of floor shear in the building model on level ground was found to be in the.

**b) Without shear wall**

i) Maximum displacement was found in both directions in the 3D model on 20o sloping ground.

ii) It is observed that maximum floor flow is observed on the second floor of the ground model with 20° slope.

iii) Maximum value of floor shear was found in both directions in the building model on 44o sloping ground.

**3) On performing some checks building model was found to have fail in torsional irregularity check , deflection and in member passed.**

A) Hence, the shear wall construction model was made safe against torsional irregularities when changing location.

b) Made safe against deflection when depth of slab building model is increased.

c) All members passed when dimensions of beam and column were increased.

**4) It is observed that the building is safe in checking the soft floor and checking the percentage of reinforcement for beams and columns.**

**5) It is observed that the spectral acceleration is maximum for modeled ground with 44o slope along the shear wall. Whereas maximum spectral acceleration is obtained on flat land model without shear wall construction.**

**6) It is observed that the spectral displacement is maximum for the model constructed on 44° slope ground, both with and without shear wall.**

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