



## ANALYSIS AND DESIGN OF G+10 STOREY BUILDING UNDER DIFFERENT SLOPING CONDITION

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### ABSTRACT

Structures are typically built on level ground; however, due to a lack of level ground, construction operations have begun on sloping terrain. The 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 a ground slope of 20 and 44 degrees was investigated. The building has been compared to one that is standing on flat ground. The structure analysis programme ETAB 2018 was used for modelling and analysis of the building. To use the time history and response spectrum approach to assess a structure on sloping terrain with or without a shear wall. On the basis of the results from both analyses, a comparison of different response parameters is made. Designing and optimizing various structural elements under the current conditions by comparing the analysis of the identical structure on level ground with the structure on sloping land. The seismic study was carried out using response spectrum analyses and time history in accordance with IS:1893 (part 1) 2016. Top storey displacement, storey shear, and storey drift were used to get the results.

### INTRODUCTION

#### 1.1 General

Seismic analysis is a branch of structural analysis that involves calculating a structure's response to dynamic excitation. It is a subset of the structural design, earthquake engineering, or structural assessment and retrofit process in earthquake-prone areas. During seismic excitation, a structure can "wave" back and forth. During a strong windstorm, this behaviour is also observable. The 'basic mode,' as the name implies, corresponds to the lowest frequency of building response. The structure takes the least amount of energy to vibrate at this frequency. The majority of structures, on the other hand, have greater reaction modes that are only triggered 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 inputs are necessary. Methods used for seismic response analysis of structures can be classified as (i) time history analysis, (ii) response spectrum method of analysis, and (iii) 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 on sloping ground with or without shear wall using time history method.
2. To analyze the structure on sloping ground with or without shear wall using response spectrum method.
3. Comparison of different response parameters, based on results obtained in both the analysis.
4. Comparing the analysis of same structure on flat ground with the structure on sloping ground
5. Designing and optimizing various structural elements in the prevailing conditions.

### LITERATURE REVIEW

**Sylviya.B et al. (2018)** did a comparative study on the effective arrangement of shear walls at different sites in different seismic zones for an RCC multi-story structure. Four models were developed for the investigation, and storey drift, displacement, and storey shear were observed in all zones, i.e. (Zone II, III, IV and V). Shear walls are most effective when placed at the building's extremities, and storey drift and displacement are highest at zone.

**M V Naresh et al. (2019)** conducted a research on the static and dynamic analysis of multi-story buildings, concluding that static analysis is insufficient for high-rise structures and emphasising the importance of dynamic analysis to counteract the lateral stresses created during earthquakes.

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

## METHODOLOGY

### 3.1 Geometric parameters

One building layout is investigated in this study, which includes structures that are positioned on flat land. The number of stories taken into account for each type of setup is ten. All variants of the building frame have the same plan arrangement. To prevent complications like 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 do a response spectrum analysis and a time history study on a normal building, as illustrated in fig. The response spectrum of the El Centro earthquake was matched using the time domain approach. For each level, the storey displacement, storey drift, storey shear forces, spectral acceleration, and spectral displacement were computed, and the graph was shown.

3.3 Model description Number of stories	G+10
Grade of concrete	M30 and M25
Grade of Steel	Fe415
Beam size	450mm*300mm
Column size	600mm*300mm
Slab thickness	100mm
Zone factor (Z)	0.36
Damping ratio	5%
Floor to floor height	3.1m
Ground floor height	3.5m
Importance factor	1
Response reduction factor (R)	5
Soil type	I (Rock, Hard soil)
Ecc. Ratio	0.05

## RESULTS

### Storey displacement

**Table 1 Displacement (mm) using response spectrum analysis in X and Y direction with shear wall.**

STOREY	RESPONSE SPECTRUM					
	MODEL 1		MODEL 2		MODEL 3	
	X	Y	X	Y	X	Y
10	21.083	48.131	19.446	53.154	20.131	52.521
9	19.957	44.094	18.44	48.517	18.828	47.609
8	18.441	39.545	17.127	43.476	17.299	43.224
7	16.59	34.564	15.475	37.997	15.524	37.963
6	14.473	29.275	13.556	32.215	13.519	32.372
5	12.165	23.822	11.431	26.264	11.334	26.564
4	9.728	18.351	9.158	20.288	9.022	20.674
3	7.217	13.02	6.785	14.444	6.636	14.847
2	4.678	8	4.357	8.902	4.237	9.25
1	2.181	3.523	1.923	3.857	1.899	4.082
BASE	0	0	0	0	0	0

**Table 2 Displacement (mm) using time history analysis in X and Y direction with shear wall.**

STOREY			TIME HISTORY			
MODEL 1			MODEL 2		MODEL 3	
	X	Y	X	Y	X	Y
10	20.425	27.791	27.9	33.119	31.034	34.336
9	18.243	24.573	25.647	29.321	28.092	30.531
8	15.899	21.255	23.141	25.429	24.941	26.795
7	13.455	17.888	20.4	21.487	21.719	22.893
6	10.993	14.528	17.452	17.57	18.391	18.98
5	8.597	11.255	14.356	13.765	15.01	15.121
4	6.34	8.166	11.188	10.168	11.638	11.399
3	4.424	5.371	8.039	6.88	8.35	7.914
2	2.692	2.991	5.011	4.01	5.237	4.773
1	1.176	1.173	2.214	1.673	2.398	2.091
BASE	0	0	0	0	0	0

## CONCLUSION

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

#### a) With shear wall

- I. The 3D model on 44o sloping ground was found to have maximum displacement in both the direction. Whereas model on flat ground has less displacement in both the direction.
- II. It is observed that maximum storey drift is seen on the 9th storey of 44o sloping ground model. It is also observed that on increasing sloping angle from 0o to 44o slope storey drift increases.
- III. Building model on 44o sloping ground was found to have maximum value of storey shear in both the direction, while on flat ground is least.

#### b) Without shear wall

- I. The 3D model on 20o sloping ground was found to have maximum displacement in Y direction. While model on flat ground have maximum displacement in X direction.
- II. It is observed that maximum storey drift is seen on the 2th storey of 20o sloping ground model.
- III. Building model on 44o sloping ground was found to have maximum value of storey shear in both the direction, while on flat ground is least.

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

#### a) With shear wall

- I. The 3D model on 20o sloping ground was found to have maximum displacement in Y direction. Whereas model on flat ground has maximum displacement in X direction.
- II. It is observed that maximum storey drift is seen on the 5th storey of 20o sloping ground model.
- III. Building model on flat ground was found to have maximum value of storey shear in X direction, while on 44o sloping ground has maximum values in Y direction.

#### b) Without shear wall

- I. The 3D model on 20o sloping ground was found to have maximum displacement in both the direction.
- II. It is observed that maximum storey drift is seen on the 2nd storey of 20o sloping ground model.
- III. Building model on 44o sloping ground was found to have maximum value of storey shear in both the direction.

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

- I. So on changing the location of shear wall building model made safe against the torsional irregularity.
- II. On increasing the depth of slab building model made safe against deflection.
- III. On increasing the dimensions of beam and column all member passed.

### 4) It has been observed that building is safe in soft storey check and in Check for percentage of reinforcement for beam and column.

5) It has been observed that spectral acceleration is maximum for building model on 44o sloping ground with shear wall. While building without shear wall gets maximum spectral acceleration on flat ground model.

6) It has been observed that spectral displacement is maximum for building model on 44o sloping ground, for both with and without shear wall.

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