ANALYSING THE EFFECTS OF SEISMIC FORCES ON HIGH RISE STRUCTURES IN SLOPING AREA

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Abstract: - Structural Engineers are aiming at the behavior of a structure when subjected to seismic load and adequate stiffness is required for the buildings which are high rise to confront lateral forces aroused by winds and earthquakes. The behavior and stability of a building in a sloped region depend on structural configuration. With the rapid growth of urbanization occurring across the entire world, irregular buildings are quite frequently built in almost every country, including India. Due to this, population density in the hilly region has increased enormously. Therefore, there is a popular and most pressing demand for the construction of multi-storey buildings on a slope and around the cities. Situated on a sloping ground for which in this dissertation slopes of 0 degree, 8 degree and 12 degree is considered with different soil conditions to find out the effect of different soils too. Comparative study have been made on unsymmetrical plan of G+9 floors considering all the four seismic zones as per I.S. 1893 part 1 2002. For analyzing and modeling purpose STAAD. Pro programming is utilized and study is done on the premise of maximum storey displacement, axial forces, shear forces, maximum bending and displacement in X and Z direction.

Keywords: - structural analysis, staad. Pro, Axial force, soil, seismic zone, sloping ground

1. OBJECTIVES

Many irregular configured buildings with different foundation levels are constructed with locally available traditional material in hilly slopes due to lack of flat land in hilly regions. Because of population density, demand of such type of building in hilly slopes is increased. The study of earthquake resistant building on slopes with different type of soils is required to prevent the loss of life, property during earthquake ground motion
Main objectives of this study are:

- To determine the effect of seismic zones on sloping ground.
- To determine the effect of different type of soils on the structure.
- To determine the variation due to sloping angels.

MODELLING AND PROBLEM FORMULATION

GEOMERICAL PROPERTIES
Following geometrical properties has been considered with materials in modeling: - Density of RCC: 25 kN/m3
Density of Masonry: 20 kN/m3

The unsymmetrical structural plan in X direction is 3.0x4.0x5.0 meters (12.0 m) respectively and in Z direction is 3.0x4.0x5.0 meter (12.0 m) respectively, the storey height of each floor is 3 m. The sections of columns are considered of 450 mm x 450 mm and the section of beam size is 400 mm x 300 mm.

LOADING CONDITIONS
Following loading is adopted for analysis:- Dead Loads: as per IS: 875 (part-1) -1987

Table 4.1: Details of dead load

Brick masonry wall load					Remark
For floor height 3 m	=	0.245 m x (3.0 - 0.40) m x 20kN/m^3	12.75	kN/m	
Parapet wall	=	0.23 m x (1.0) m x 20kN/m^3	4.6	kN/m	
Floor Load					
Slab Load	=	0.15 m x 25kN/m^3	3.75	kN/m^2	slab thick. 150 mm assumed
Floor Finish	=		1.0	kN/m^2	
Total Load	=		4.75	kN/m^2	

(b) Live Loads: as per IS: 875 (part-2) 1987.
Live Load on typical floors = 4.75kN/m2
Live Load seismic calculation = 0.70kN/m2
(c) Earth Quake Loads: All frames are analyzed for all the 4 earthquake zones
The seismic load calculation are as per IS: 1893 (part-1)-2002.

Table 4.2: Seismic force parameters for proposed issue

S.No.	Parameter	Value	As per code	As per thesis
1	Zone factor (II, III, IV and V)	0.10, 0.16, 0.24 and 0.36 .	Table -2	Table -1
2	Importance factor	1.5	Table -6	Table -2
3	Response reduction	3	Table -7	Fig-1.2
4	Soil site factor	Soft, medium and hard	Fig- 2	Fig-1.3
5	Damp ratio		Table -3	

ANALYSIS AND RESULT

There are following cases for analysis of different zones, type of soils and sloping degrees:
12.0 x12.0 meters considering soft, medium and hard soil and sloping angel of 0 degree G+9 unsymmetrical Structure

12.0 x12.0 meters considering soft, medium and hard soil and sloping angel of8 degree G+9 unsymmetrical Structure. X12.0 meter considering soft, medium and hard soil and sloping angel of 12 degree G+9 unsymmetrical Structure.

RESULTS OF ANALYSIS IN 00 SLOPING GROUND
Maximum bending moment (kN-m) in 0o slant.

Table 5.1: Maximum bending moment (kN-m) in 0o slope.

Soil Type	Maximum Bending Moment (kN-m) in 0^0 sloping ground			
	Zone-II	Zone-III	Zone-IV	Zone-V
Soft	150.307	227.571	337.745	507.936
Medium	131.377	189.154	274.561	413.159
Hard	115.192	145.209	206.503	303.096

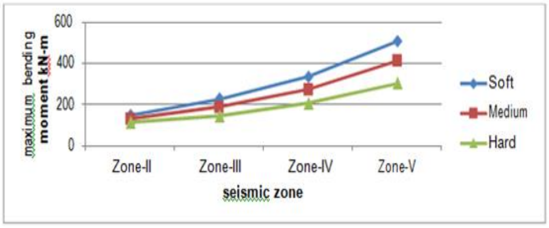

Fig 5.1: Maximum bending moment (kN-m) in 0 degree slope

Maximum bending moment It is observed that maximum bending moment is in Soft soil and minimum in hard soil, therefore hard soil is comparatively more stable and decreases reinforcement requirement.

RESULTS OF ANALYSIS IN 8O SLOPING GROUND
Maximum bending moment (kN-m) in 8o slant.

Table 5.12: Maximum bending moment (kN-m) in 8o slope.

Soil Type	MaxBending Moment (kNm) in 8^0 sloping ground			
	Zone-II	Zone-III	Zone-IV	Zone-V
Soft	285.717	457.302	686.082	1029.251
Medium	232.632	372.365	558.677	838.145
Hard	170.984	273.73	410.724	616.215

Maximum Shear Force (kN) in 8o Slant.

Table 5.13: Maximum Shear force (kN) in 8o slope

Soil Type	Shear force (kN) in 8^0 slope			
	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Soft	231.42	360.13	531.76	789.19
Medium	191.59	296.42	436.18	696.76
Hard	145.35	222.43	325.19	479.34

It is observed that maximum shear force is seen in soft soil whereas minimum in hard soil, therefore hard soil is considered better.

RESULTS OF ANALYSIS IN 120 SLOPING GROUND.
Maximum bending moment (kN-m) in 12o slant.

Table 5.23: Maximum bending moment (kN-m) in 12o slope.

Soil Type	MaxBending Moment (kNm) in 12^0 sloping ground			
	Zone-II	Zone-III	Zone-IV	Zone-V
Soft	171.675	287.806	442.648	674.91
Medium	135.746	230.32	356.419	545.566
Hard	114.142	163.562	256.282	395.361

: Maximum Shear Force (kN) in 12o Slant

Table 5.24: Maximum Shear force (kN) in 12o slope

Soil Type	Shear force (kN) in 12^0 slope			
	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Soft	261.56	410.04	608.02	904.99
Medium	215.62	336.54	497.77	739.61
Hard	162.27	251.18	369.73	548.51

CONCLUSIONS

Following are the conclusions as per study-

- As the angle of slope increase then every Model frames of Mode period, Base shear, Storey displacement, and storey drift values increases in both directions, but in the case of storey shear, its values decrease in both direction of each Model frames as the angle of slope increases
- In seismic zones, maximum displacement is measured in zone-V and minimum in zone-II hence zone-V is critical
- Since the mass is not varying with the increased ground slope, it can be concluded that the stiffness of the building is getting reduced where length of the columns is higher, relative to the other extreme end. In this comparative study zone-II, hard soil, 0 degree sloping is best because it is stable.
- Maximum bending moment is observed in soft soil and minimal in hard soil therefore hard soil is stable.
- In earthquake zones, bending moment maximum is observed in zone-V and minimal in zone-II means zone-II provide better strength.
- As contrasting slopes, maximum bending moment is observed in 12 degree sloping ground and minimal in 0 degree sloping ground, means as slope is rising bending moment is also rising.
- In this comparative study seismic zone-II hard soil, 0 degree slope is cost effective as it shows lesser moment means lesser reinforcement.

FUTURE SCOPE OF THE STUDY

(a) In this study sloping ground of 0 degree, 8 degree and 12 degree have been provided. The study can be stretched out to further more level of slope
(b) In this study G + 9 unsymmetrical structures has been considered. The study can be extended to more tall structures.
(c) This study performs seismic load analysis and in further study wind load analysis can be included.

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