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DESIGN OF EARTHQUAKE RESISTANT MULTISTORY BUILDING

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Abstract: ***Earthquake resistant structures are capable of resisting lateral and vertical forces acting on the structures. But no structures can entirely survive during earthquake without any damages. According to codes, earthquake resistant structures are designed to withstand expected earthquake at least to occur once during the design life of the structure. Reinforced concrete buildings are analyzed and designed to meet the requirements of relevant codes of practice. Such buildings designed as per codal provision will survive during earthquake with minor damages of structural elements. Many of the countries have their own codes of practice for Earthquake Resistant structures. The buildings are designed and detailed as per codes. This paper gives the review on performance of buildings towards seismic load for various designs. The review explains the need of improvement in codes, thus improve the performance of structures better during earthquake.***

The framework was also tested for P-analysis and adjustments required from time to time have been made after the IBC code .When the steel resistance frame was developed in accordance with IS-800: 2007 based on these analytical methods. In the process of naming this stage it has been repeated many times until all the standards specified in IS 800 have been met. The developed framework was then analyzed and the results were compared according to the categories used. The cost-effectiveness of both methods has been compared. Also the basic design that contains the base plate is made according to IS 800: 2007. Important statistics are calculated and statistics are created.

The software used for analyze and design is STAAD Pro. Both at the time of design and analysis the calculations performed were performed and compared.

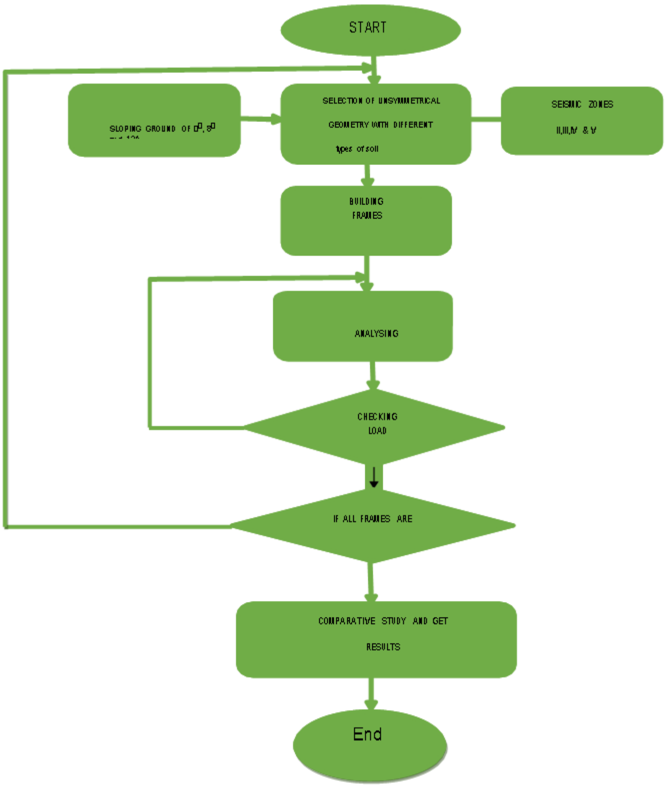
Keywords: Base shear, Displacement, Seismic analysis, Storey drift, stiffness.

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

2. FLOW CHART DIAGRAM



3. 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.

4. LOADING CONDITIONS

Following loading is adopted for analysis:-

(a) 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/m³	12.75	kN/m	
Parapet wall	–	0.23 m x (1.0) m x 20kN/m³	4.6	kN/m	
Floor Load					
Slab Load	=	0.15 m x 25kN/m³	3.75	kN/m²	slab thick. 150 mm assumed
Floor Finish	=		1.0	kN/m²	
Total Load	=		4.75	kN/m²	

(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	

5. ANALYSIS ANDRESULT

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.

6. 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° 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

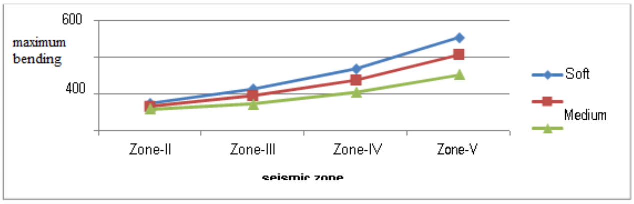


Fig 5.1: Maximum bending moment (kN-m) in 0 degree slope

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.

: Maximum Shear Force (kN) in 0o Slant.

Table 5.2: Maximum Shear force (kN) in 0o slope

Soil Type	Shear force (kN) in 0° slope			
	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Soft	120.92	170.92	237.77	338.05
Medium	105.17	146.10	200.54	282.20
Hard	87.85	117.47	157.31	217.35

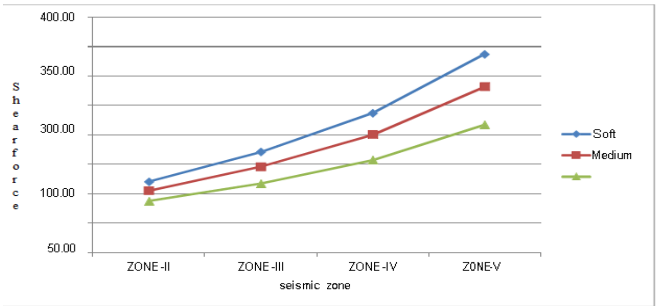


Fig 5.2: Maximum shear force (kN) in 0o slant

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

Maximum Axial Force

Table 5.3: Maximum axial force (kN) in 0o slope

Soil type	Axial force kN in 0 degree slope			
	Zone II	Zone III	Zone IV	Zone V
Soft	2990.928	2990.928	2990.928	3486.254
Medium	2990.928	2990.928	2990.928	3129.163
Hard	2990.928	2990.928	2990.928	2990.928

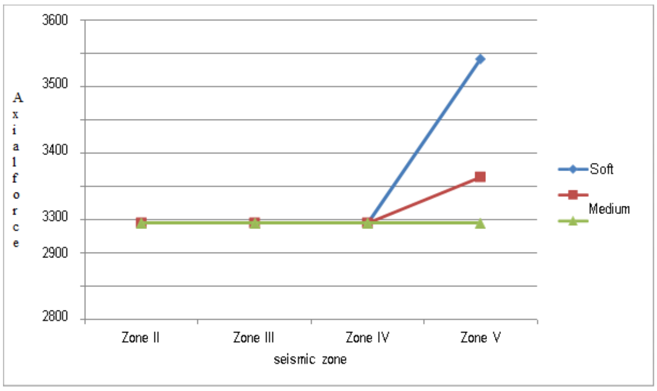


Fig 5.3: Maximum axial force (kN) in 0o slope

Informality in axial forces is observed in zones except zone IV and V. which shows gradual increase in axial forces at higher zones With respect to soil type.

Maximum displacement (mm) in X direction in 0o slant..

Table 5.4: Maximum displacement in X direction 0o slope

Soil Type	Maximum Displacement (mm) in 0^0 Sloping Ground in X dir.			
	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Soft	67.456	106.455	158.455	236.454
Medium	55.39	87.15	129.497	193.017
Hard	41.378	64.731	95.869	142.575

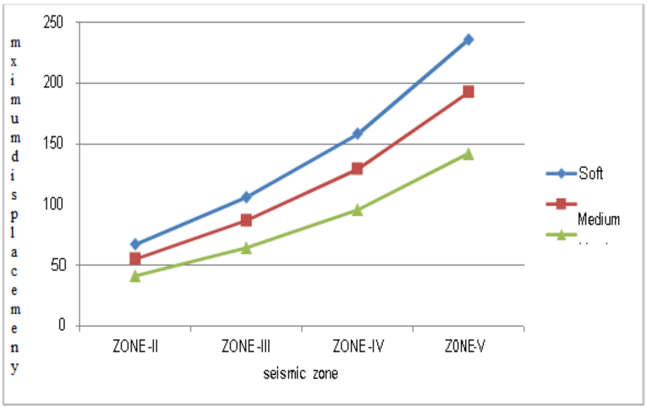


Fig 5.4: Maximum displacement in X direction 0o slant

It is observed that maximum displacement occurs in soft soil whereas minimum in hard soil type, thus hard soil is more stable.

Maximum displacement (mm) in Z direction in 0o slant.

Table 5.5: Maximum displacement in Z direction 0o slope

Soil Type	Maximum Displacement (mm) in 0^0 Sloping Ground in z dir.			
	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Soft	67.456	106.455	158.455	236.454
Medium	55.39	87.15	129.497	193.017
Hard	41.378	64.731	95.869	142.575

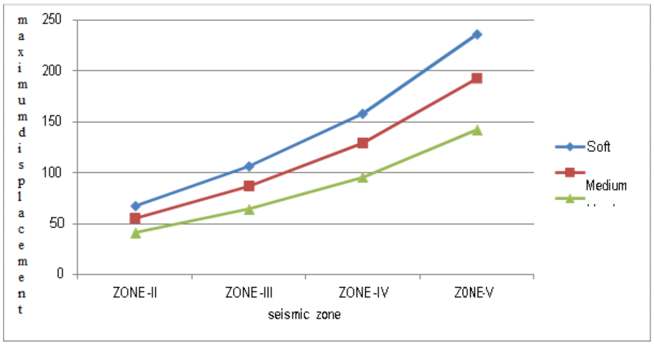


Fig 5.5: Maximum displacement in X direction 0o slant

It is observed that maximum displacement occurs in soft soil whereas minimum in hard soil type, thus hard soil is more stable.

7. CONCLUSIONS

Frame with shear wall performs better and the base shear increased by 9.82% when compared to the frame without shear wall. Shear wall performs better to lateral displacement and it reduces by 26.7% when compared to the frame without shear wall. The ductility of SMRF buildings is more than the OMRF buildings, the reason being the heavy confinement of concrete due to splicing and usage of more number of stirrups as ductile reinforcement. The base shear capacity of OMRF buildings is 7 to 28% more than that of SMRF buildings. So it is necessary to increase strength and stiffness of building to withstand seismic loads. Finally, it is concluded that the floating column building, will lead to the increase in dimensions of the members in the structure to increase the stiffness and for the earthquake resistant design of the building with various recommendations considered which are more in cost comparing with a normal building cost of construction. But following sustainable measures and recommendations can even give a earthquake resistant design of the building with floating column building built even at the higher seismic zone.

8. 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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