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Analysis Of A Multi-storied Building In Different Soil Conditions With Different Seismic Zones Of India

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Abstract

Earthquakes are the natural phenomenon which can happen suddenly and can cause vast destruction. Most of the Indian land is insecure because of the vibrations caused by earthquakes. In the other sense, it is impossible to prevent the occurrence of earthquakes. But the damages can be controlled by means of effective seismic designs. The present investigation's main focus is to evaluate multi-storeyed building performance with and without infill walls under various seismic zones and soil conditions. The analysis is carried out by ETABS software. The present work provides a good source of information on the parameters shear force, bending moment, and base shear. The equivalent static force method is considered for the analysis, and comparative results are drawn.

Keywords — *RCC frame structure, base shear, shear force, bending moment, ETABS.*

I. INTRODUCTION

While the subject of earthquake engineering has its sophistication and a lot of new 3research is being conducted on this very important subject, it is also important to widely disseminate the basic concepts of earthquake-resistant constructions through simple language. With this objective, the Indian Institute of Technology Kanpur (IITK) and the Building Materials and Technology Promotion Council (BMTPC), a constituent of the Ministry of Urban Development & Poverty Alleviation, Government of India, launched the IITK-BMTPC Series on Earthquake Tips in early 2002. Professor C. V. R. Murty was requested to take up the daunting task of expressing difficult concepts in very simple language, which he has very ably done.

A special situation arises during earthquake shaking in sandy (cohesionless) soils that are loose and saturated with water. Horizontal shaking of the earth at the bedrock level is transmitted upwards to the soil's overlying layer(s). Saturated loose cohesionless soils have voids between soil particles filled with water. During strong ground shaking, loose sand tends to density; this tends to compress water, but because water is incompressible, it tends to escape. Water cannot drain out quickly from the soil, and therefore pore water pressure increases in soil. This reduces the effective stress between soil particles. At some stage, the effective stress may become almost zero.

II. LITERATURE REVIEW

R. Arun, K. Suhana, L. Saicharan Reddy (2019), "Seismic base shear variation between regular and irregular RCC structure in various zones by STAAD.PRO": The earthquake frequently causes multistorey structures by the scarcity of provision. Earthquake often occurs on zone 4 and zone 5 region due to lack of remedies building cannot be elevated beyond the certain height. This present study was done based on the sheer variation between regular and irregular configuration informs of the various zones such as zone II, zone III, zone IV, & V various soil conditions such as Medium, Soft, and Hard. So, such preliminary data were considered to improve buildings' performance, and two designs were done, such as manual design & software design by Staad. Pro. Eventually, the base shear performance was found between different zone regions and soils, respectively. This SLA was assumed out by considering different seismic zones & soils. As per data, ACP was done for Regular & Irregular structures to view the plan.

Arun Babu M, Ajisha R (2018), "Analysis of Multistoried Building in Different Seismic Zones with Different Soil Conditions": The foundation of a building is the substructure through which loads of the whole structure are transmitted to the soil. There are various types of soil present in India. The types of soil play a major role while designing a structure. Here the analysis and design of the building are done by varying the type of soil. The difference in the analysis of structure is studied. After that, the seismic analysis for various zones is carried out for the same soil conditions, and also by changing the model of the building, the same is done. And the difference is studied.

Anujdomale, L.G. Kalurkar (2018), "Seismic Analysis of RCC And Steel Frame Structure by Using ETABS": The residential housing sector (G+3, G+6, etc.) use of steel has increased, but RCC construction still predominates the Indian construction business. In the present study, an attempt has been made to analyze RCC and steel frames' seismic behavior using Etabs2015. The high self-weight and brittleness of concrete are not favorable to seismic prone structures, whereas steel structures are 60% lesser in weight through they can withstand earthquakes more effectively than concrete structures. The study aims to compare the seismic performance of G+6 and G+9 frames for `both steel and RCC. For the current study, all frames are analyzed under the equivalent static method. This comparative study concludes that steel frames are most effective than the concrete as it has the highest strength to weight ratio.

Salahuddin Shakeeb. S.M, Prof. Brii Bhushan, Prof. Maneeth.P. D, Prof. Shaik Abdulla (2015), "Comparative Study on Percentage Variation of steel in Different Seismic Zones of India": Earthquakes are a natural phenomenon which can happen suddenly and can cause vast destruction. Most of the Indian land is insecure because of the vibrations caused by the earthquakes. In the other sense, it is impossible to prevent earthquakes, but the damages can be controlled by means of effective seismic designs. The design can be done by considering various limit states specified by the codes and applying the economical ones. The structure can be designed as semi-elastic, and it is economical rather than elastic because designing of structure for total elastic in response is very uneconomical. The present study mainly focuses on determining the variation in reinforcement percentage for various seismic zones of India. The current IS code for seismic design, i.e., IS 1893-2002 part one, suggests that maximum reinforcement should be provided for higher seismic zones, but it doesn't provide clear information, how much percentage of reinforcement can be used for various seismic zones. For the study, the asymmetrical building plan is used with 13 storeys and analysed and designed using the structural analysis software tool ETABS-2013. The study also includes the determination of base shear, displacement, moment, and shear, and the results are compared between gravity loads and various seismic zones. These parameters have also considered the effect of masonry infills.

III. DESCRIPTION OF SAMPLE BUILDING

In the study, symmetric building models have been taken for all cases. The building model has divided into two categories.

- Models without infill.
- Models with infill (Base soft storey).

i) Models without infill:

Model 1: Building does not have masonry infill and seismic load applied by considering zone-2 and soil type-1.

Model 2: Building does not have masonry infill and seismic load applied by considering zone-3 and soil type-2.

ii) Models with infill:

Model 3: Building does have masonry infill and seismic load applied by considering zone-2 and soil type-1.

Model 4: Building does have masonry infill and seismic load applied by considering zone-3 and soil type-2.

IV. DESIGN DATA

TABLE 1: Material and Member Properties of Structure

Material Properties		
Young's modulus of (M30) concrete, E	=	$27.386X10^6$ KN/m^2
The density of reinforced concrete	=	25 KN/m^2
Modulus of elasticity of brick masonry	=	$3500X10^3$ KN/m^2
The density of brick masonry	=	20 KN/m^2
Assumed live load	=	4 KN/m^2
Assumed floor finish	=	1 KN/m^2
Member Properties		
Thickness of slab	=	0.15m
Column size (with infill)	=	0.45X0.45 m
Column size (without infill)	=	0.5X0.5 m
Beam size	=	0.3X0.3 m
Thickness of wall	=	0.230 m
Earthquake lives load on the slab as per clause 7.3.1 and 7.3.2 of IS 1893 (part-1) -2002 is calculated as:		
Roof (clause 7.3.2)	=	0
Floor (clause 7.3.1)	= =	0.5X4 2 KN/m^2
Type of structure	=	RCC framed structure
Floor to floor height	=	3m
Type of soil taken	=	hard rocky
Seismic zones considered	=	2,3
Type of wall	=	brick masonry

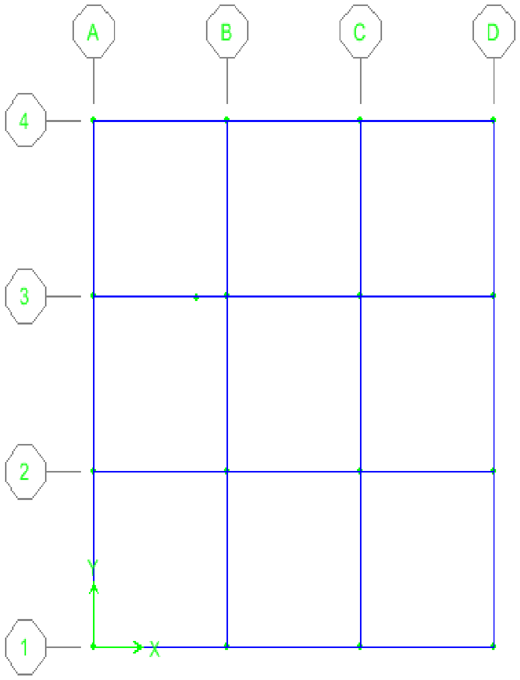

FIG.1: Building Plan for G+5 Building

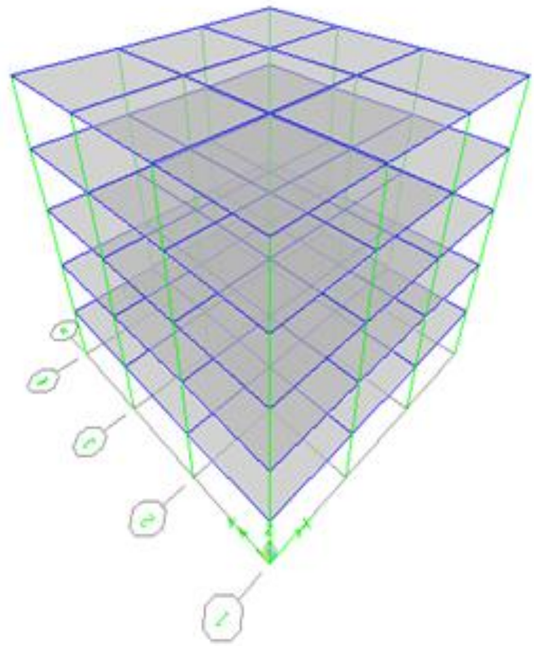

FIG.3: 3D Model of G+5 Storeyed Building without Walls

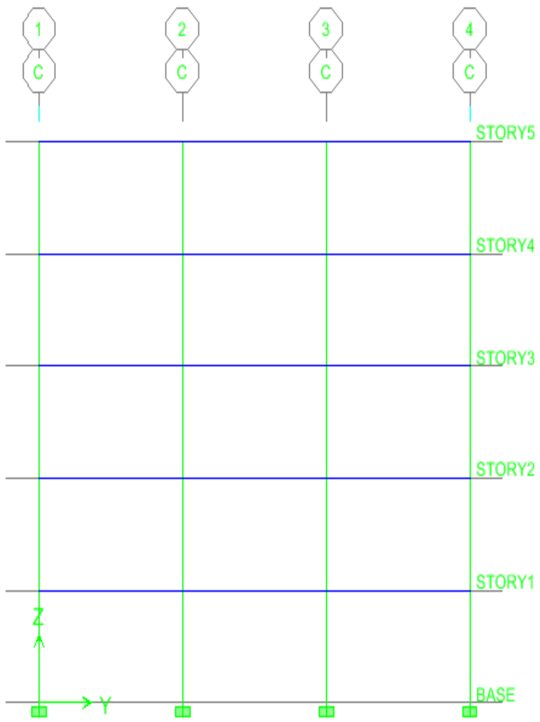

FIG.2: Model Elevation of G+5 Storeyed Building without Walls

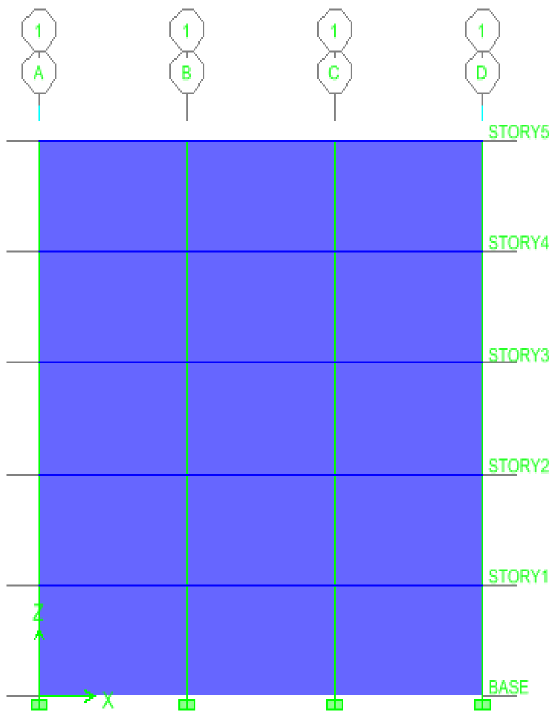

FIG.4: Model Elevation of G+5 Storeyed Building with Walls

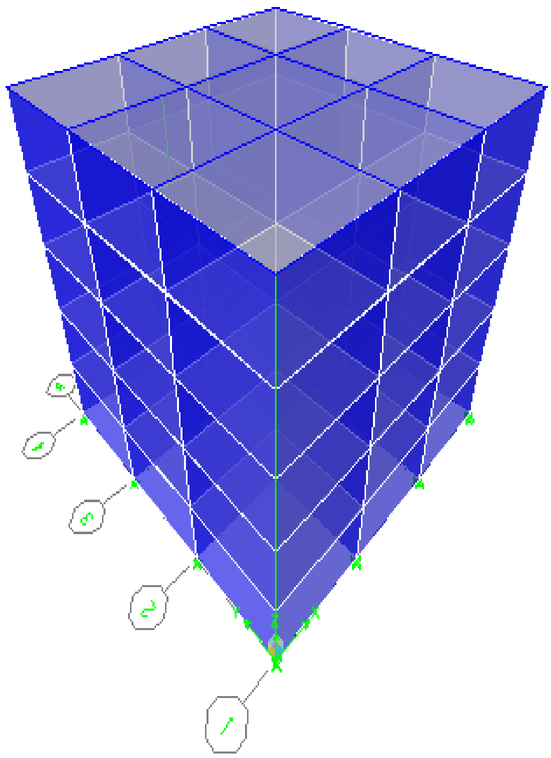

FIG.5: 3D Model of G+5 Storeyed Building with Walls

V. RESULTS AND DISCUSSIONS

A. BASE SHEAR

The base shear is the total lateral force design at the base of the building. The base shear is calculated depending on the vibration period of the building. The base shears calculated for the 5 storey building models with and without walls are shown below.

TABLE 2: Base Shear Values with and without walls

DESCRIPTION	WITHOUT WALL		WITH WALL	
MODELS	1	2	3	4
ZONE	II	III	II	III
SOIL TYPE	I	II	I	II
BASE SHEAR	0.38	0.84	1.61	2.57

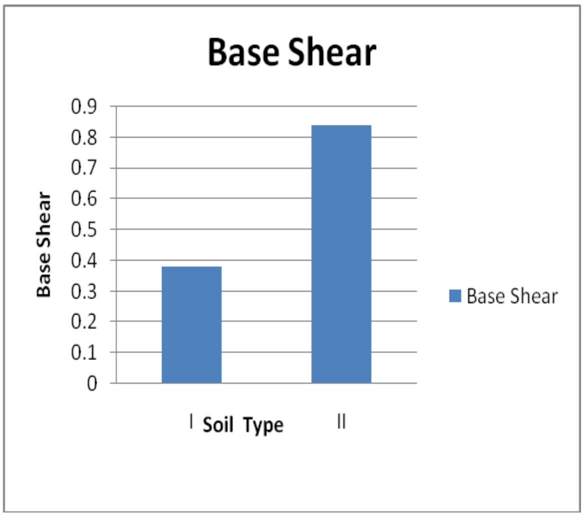

FIG.6: Base Shear of Models without Infill

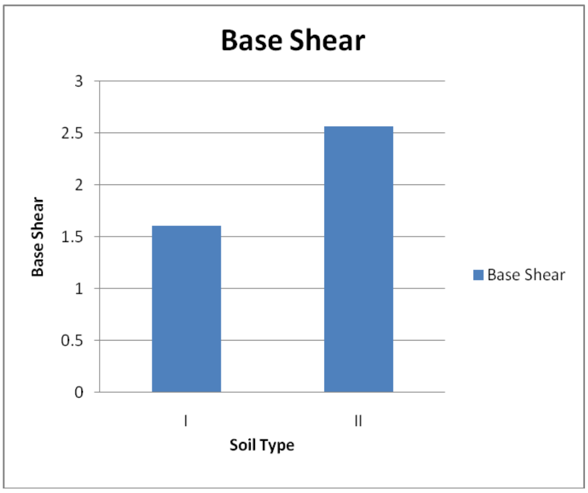

FIG.7: Base Shear of Models with Infill

B. BENDING MOMENT & SHEAR FORCE

The shear force and bending moment results for 13 storey building have been taken from the analysis results and tabulated below. The bending moment and shear force are calculated for each load combination and seismic zone. The results also include masonry infill and noninfill case. From the outcomes, it can easily be seen that as the seismic zone factor increases, the shear force and bending moment also increases.

5.2.1 THE RESULT VALUES OF SF & BM

TABLE 3: SF & BM of Model under Zone-2 with Soil Type-1

Moments and Shear Without Infill	ZONE		Zone 2	
			Moment	Shear
	Load Combination	Story-1	625750	0.58
		Story-2	500600	0.57
		Story-3	375450	0.52
		Story-4	250300	0.43
		Story-5	125150	0.26

TABLE 4: SF & BM of Model under Zone-3 With Soil Type-2

Moments and Shear Without Infill	ZONE		Zone 3	
			Moment	Shear
	Load Combination	Story-1	805391	1.25
		Story-2	644312.8	1.23
		Story-3	483234.6	1.14
		Story-4	322156.4	0.93
		Story-5	161078.2	0.57

TABLE 5: SF & BM of Model under Zone-2 with Soil Type-1

Moments and Shear with Infill	ZONE		Zone 2	
			Moment	Shear
	Load Combination	Story-1	1299059	2.41
		Story-2	1039247	2.36
		Story-3	779435.4	2.15
		Story-4	519623.6	1.68
		Story-5	259811.8	0.67

TABLE 6: SF & BM of Model under Zone-3 with Soil Type-2

Moments and Shear with Infill	ZONE		Zone 3	
			Moment	Shear
	Load Combination	Story-1	1466134	3.85
		Story-2	1172907	3.77
		Story-3	879680.3	3.44
		Story-4	586453.5	2.68
		Story-5	293226.8	1.35

VI. CONCLUSIONS

1. In both cases, the base shear, i.e., with infill and without infill, increases as the seismic zone increases.
2. The base shear is maximum in soil type II with infill wall compared to soil type I.
3. The base shear is maximum in soil type II without infill wall compared to the soil type I.
4. The moments in a building increases gradually according to seismic zones.
5. In both cases, the sheer force, i.e., with infill and without infill, increases as the seismic zone increases.

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