

THE EFFECT OF SOIL CONDITIONS ON THE SEISMIC FORCE IN RC BUILDING BY USING ETABS

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Abstract- The rapid development of urban population and the pressure on limited liberty considerably influence the residential/commercial development of the city. The price of the land is high, the aspiration to keep away from uneven and uncontrolled developing of urban area and tolerate on the land for wants of important agricultural production activity have all lead to route building upwards. An attempt is through in this project to study the effect of Soil-structure interaction on multi storied buildings by means of various groundwork systems. Also to study the response of multi storied buildings subjected to seismic forces through Rigid and Flexible basics subjected to seismic forces are analyzed under dissimilar soil conditions like hard, medium and soft. A multi-storied RC frame structure rests on different soils is chosen for the analytical model part. The influence of soil-structure interaction is compared to the results obtained when the society is supposed to be fixed at the base.

Keywords- Local site conditions, RC buildings, Standard codes, Seismic analysis, Parametric study.

1. INTRODUCTION

Most of the civil structures are attached to ground. When the external forces, such as earthquakes act on these systems, neither the structural displacements nor the ground displacements, are independent of each other. The process in which the response of the soil influences the motion of the structure and the motion of the structure influences the response of the soil is termed as soil-structure interaction (SSI).

Conventional structural design methods neglect the SSI effects. Neglecting SSI is reasonable

for light structures in relatively stiff soil such as low rise buildings and simple rigid retaining walls. The effect of SSI, however, becomes prominent for heavy structures resting on relatively soft soils for example nuclear power plants, high-rise buildings and elevated-highways on soft soil.

A seismic soil-structure interaction analysis evaluates the collective response of the structure, the foundation, and the geologic media underlying and surrounding the foundation, to a specified free-field ground motion.

The term free-field refers to motions that are not affected by structural vibrations or the scattering of waves at, and around, the foundation. SSI effects are absent for the theoretical condition of a rigid foundation supported on rigid soil. Accordingly, SSI accounts for the difference between the actual response of the structure and the response of the theoretical, rigid base condition.

2. NEED FOR PROJECT

India having dissimilar earth environment and different seismic activity intensity places with more than 60% area is prone to earthquakes, should expand earthquake anti structures in reflection to IS: 1893(part: I):2002. India classified into four seismic zones specifically zone II, III, IV, V, having different types of soils which increases the importance of understanding of consequence of base shear in reflection to various types of soils in same zone also. Response of structures to earth's exterior vibrations is a purpose of type of soil available at site conditions. Response increase of velocity coefficient (S_a/g) for 5% damping is considered for rock, medium, soft soils. Zone factor value indicates accepted strength of earthquake in diverse seismic zones.

3. STRUCTURAL MODELING

A four storey and basement building is considered for this project which will be used for offices. ETABS V9.7.2 software is used for modeling. This software is based on finite element method which is used widely for the analysis of structures. ETABS can perform static and dynamic analysis for both linear and non-linear behaviour of structures. The model elements include reinforced concrete beam, column, walls and slabs. The concrete walls and slabs are modeled as shell elements. The modelings of structure with three supports are shown in Figure 1, Figure 2, and Figure 3.

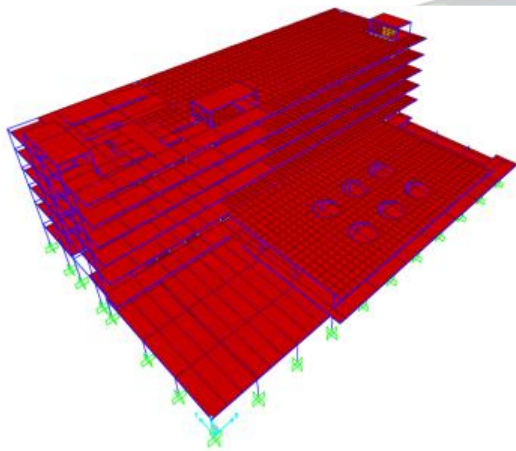


Figure 1. 3D model of structure with fixed support in ETABS

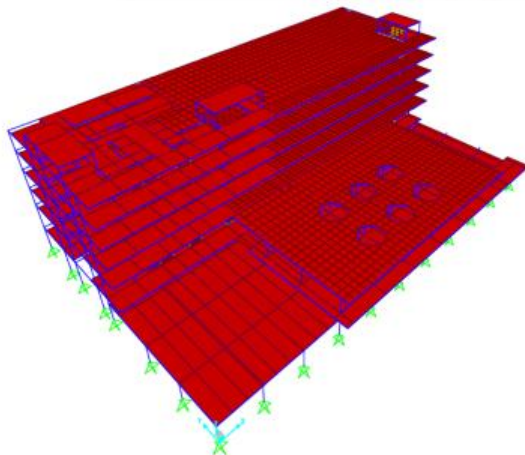


Figure 2. 3D model of structure with Hinged support in ETABS

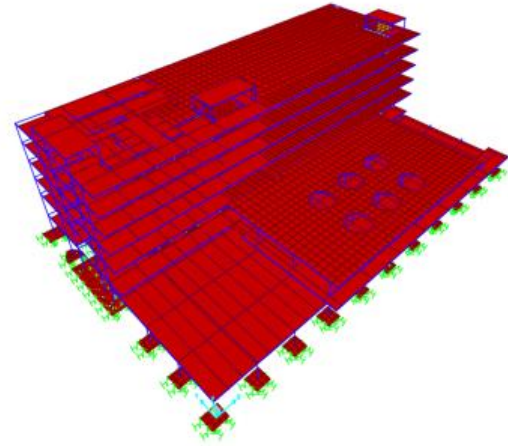


Figure 3. 3D model of structure with Soil spring support in ETABS

Material	Reinforced concrete
Grade of concrete	M50 & M30
Youngs modulus	$5000\sqrt{f_{ck}}$
Poisson's ratio	0.20
Grade of steel	Fe 500

Table 1. Material parameters for the structure

4. STRUCTURAL ANALYSIS

The three models stimulating various conditions have to be used for dynamic analysis. The main aim of this seismic analysis is to obtain the response of the structures. The responses includes in the terms of time period, inter storey drift and base shear, moment. The loadings are assigned to the model as per the reference of IS 875 part I for Dead load and IS 875 part II for Live load. The criteria for calculating seismic loads is given in table 2.

Category	Parameter
Seismic zone	III
Zone factor(Z)	0.16
Importance factor(I)	1
Response reduction factor(R)	3

Table 2. Criteria for seismic loads

Seismic analysis is carried out in ETABS using Response-spectrum analysis (RSA) which is a linear-dynamic statistical analysis method. Response-spectrum analysis is useful for design decision-making because it relates structural type-selection to dynamic performance. Average Response acceleration coefficient is calculated for hard soil, medium soil and soft soil as per IS 1893 Part 1. These values are used for calculating spectral acceleration.

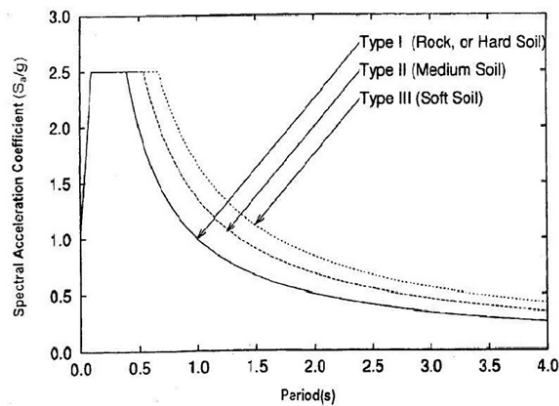


Figure 4. Response Spectrum Curve as per IS Code

Stiffness value of spring kN/m		
Pile dia mm	600	750
Horizontal	55357.1	43750
Vertical	5208.3	3802.8

Table 3. Stiffness value of spring

5. RESULTS& DISCUSSIONS

Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. The base shear obtained for three models is shown in table 4 and table 5 depicts the base shear value as per the IS 1893 Part 1

Cases	BASE SHEAR			
	Values in kN		\$ - Value in %	
	ELX	ELY	ELX	ELY
Fixed Base Model	7695.18	8627.56	100	100
Hinged Base Model	9541.62	10783.23	123.99	124.99

Soil Spring Model	7414.18	8334.9	96.35	96.61
\$ - Base Value Considered as Fixed Base Model				

Table 4. Base Shear obtained from analysis

Cases	BASE SHEAR From IS Code	
	Values in kN	
	ELX	ELY
Fixed Base Model	9606	9606
Hinged Base Model	13064	13064
Soil Spring Model	16054	16054

Table 5. Base Shear as per IS code

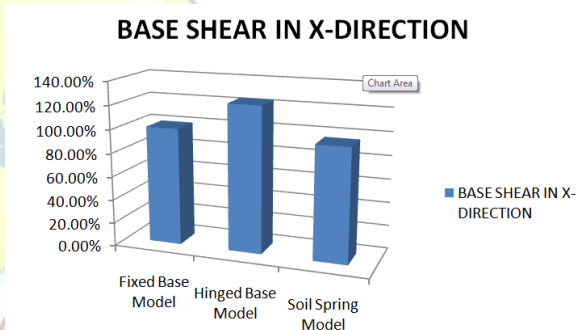


Figure 5. Graph of Base shear in X Direction

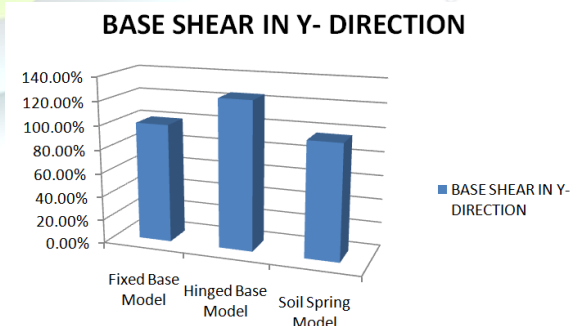


Figure 6. Graph of Base shear in Y Direction

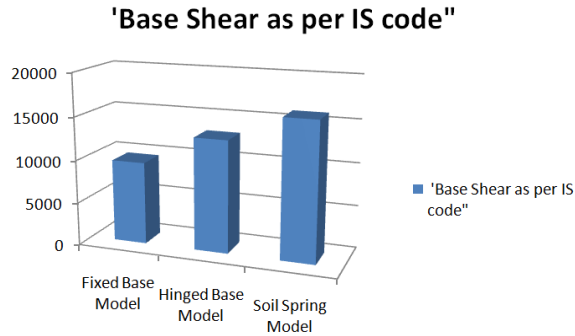


Figure 7. Graph of Base shear as per IS code

Cases	NATURAL TIME PERIOD in seconds	
	As Per IS 1893 Code	As Per ETABS Analysis
Fixed Base Model	0.866	1.4582
Hinged Base Model	0.866	1.4582
Soil Spring Model	0.866	2.993

Table 6. Natural Time Period

Storey drift is the total lateral displacement that occurs in a single storey of a multistorey building. This value is obtained from analysis and shown in Table 7 and 8

Storey	FIXED	HINGED	SPRING
HR	0.968	1.049	1.578
TF	0.542	0.688	1.419
4F	0.558	0.721	1.535
3F	0.56	0.73	1.591
2F	0.532	0.699	1.602
1F	2.837	3.755	3.273
GF	0.357	0.493	5.396
EX. BASEMENT	0.267	0.411	5.924

Table 7. Storey Drift in X direction

Storey	FIXED	HINGED	SPRING
HR	0.733	0.84	1.561
TF	2.334	2.891	2.766
4F	2.225	2.787	2.872
3F	7.527	9.64	4.197
2F	0.525	0.666	1.594
1F	0.419	0.528	1.6
GF	0.324	0.431	2.198
EX. BASEMENT	0.205	0.321	2.658

Table 8 Storey Drift in Y direction

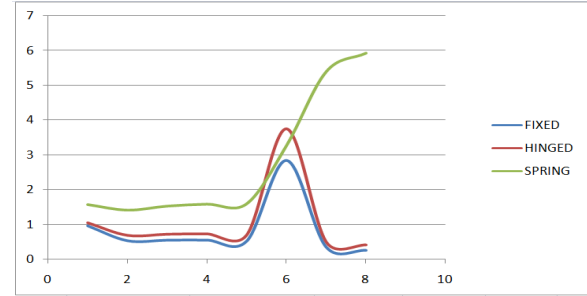


Figure 8. Graph of Storey drift in X direction

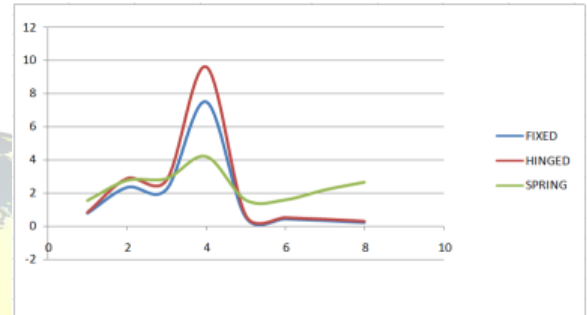


Figure 9. Graph of Storey drift in Y direction

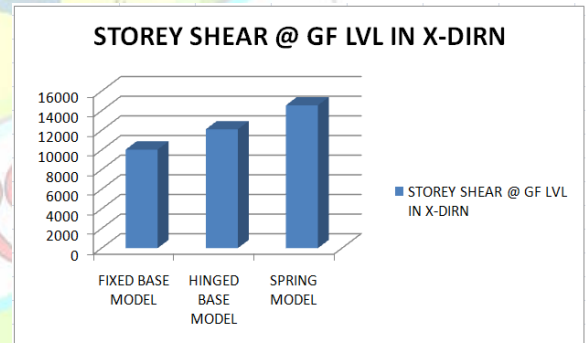


Figure 10. Storey shear in X direction

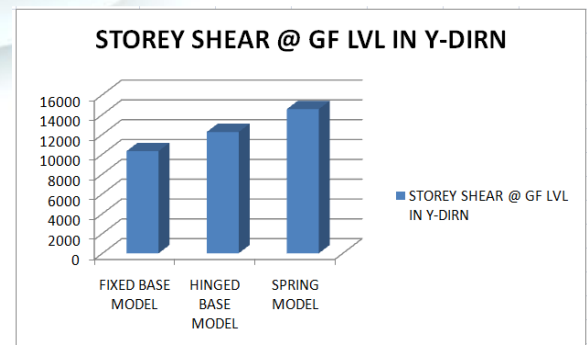


Figure 11. Storey shear in Y direction

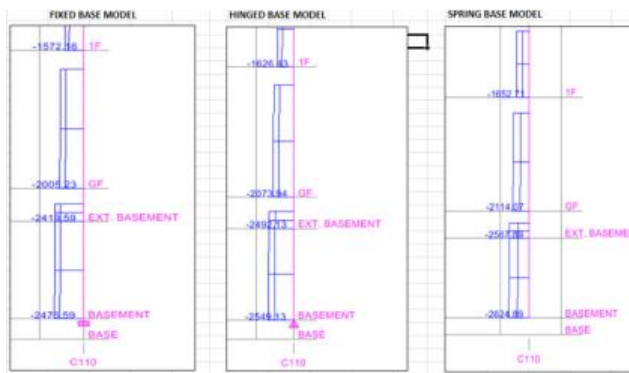


Figure 12. Column Axial Force Diagram (C110)

6. CONCLUSION

The study helps that the effects of soil-structure interaction significantly alter the lateral natural periods as well as foundation shear of any structural organization. Thus evaluation of these parameters without considering soil-structure interaction may cause seismic errors in seismic design.

Base shear value is decreased in soil spring (Soft Soil Condition) model considerably when compared to other two conditions such as fixed and hinged. This proves to be favorable factor which allows the reduction of base shear. This shear reduction is arrived from the anticipated increase of damping.

Comparing the result of time period, storey drift and storey shear for Soil II and Soil III it is clearly evident that their values are much greater than the fixed base of Soil type I.

Column axial force, bending force and lateral displacement increase as the soil type changes, soil structure interaction must be suitably well thought-out while designing frames for seismic forces.

Therefore conventional design procedure which excludes SSI in the analysis is not an adequate method to obtain safety for the structure. Design Engineers should take the effects of SSI predominantly in soft soils.

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