STUDY ON THE BEHAVIOUR OF RC FRAMED STRUCTURE WITH SHEAR WALL AND BRACING SYSTEM FOR REGULAR AND IRREGULAR IN PLAN WITH CONSIDERING SSI

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Abstract: Earthquake has a high potential to cause a wide spread damages in densely populated areas which causes heavy loss of life and high economic losses. Convectional analysis of structures is generally carried out by assuming the base of structure to be fixed. The soil below foundation alters the earthquake loading and varies the lateral forces action on the structure. Therefore, it is unrealistic to analysis the structure by considering it to be fixed at base. In present study, the effect of SSI with shear wall and bracing system is carried out for regular and irregular in plan reinforced concrete framed structure. Analysis will be carried out for G+9 storey structures with C and T shapes in plan with shear wall and X-bracing in seismic zone IV. Analysis will be compare with bare frame model by using ETABS to study SSI. Seismic parameters i.e. Maximum Storey Displacement, Maximum Storey Drift, Time period and Base shear will be considered for the comparison.

Index Terms **–Irregular building, Shear wall, X-bracing, Soil Structure Interaction, Winkler's approach, Response Spectrum Analysis.**

I. INTRODUCTION

Over the last few years, considerable progress has been made in understanding the nature of the earthquake and seismic behavior of the structure. During past and recent earthquakes it is seen that the seismic response of the super-structure and sub-structure affected by Soil Structure Interaction (SSI) effect and also soil greatly influence the overall structural response. Due to seismic waves, damages of the structure it not only depending on the behavior of super-structure but also on the soil below and surrounding the foundation. The earthquake caused socio-economic damaged is depends on a great extent on the characteristics of the strong ground motion.

Traditional seismic analysis and design of superstructure is carried out by assuming fixed base condition. In other words, seismic response of the structure is only influence by structure itself and neglecting flexibility of the soil. Conventionally design of the superstructure and substructure are carried our as independent systems. But, the actual behavior of the structure during an earthquake significantly depends on the structure, the foundation and the soil underlying also surrounding foundation. Overall response of structure is linkage between soil and structure. Secondly, the frequently and amplitude of the ground motion is change by the stiffness of the soil deposit. Building with an asymmetric distribution of stiffness and strength in plan undergo coupled lateral and torsional motions during earthquake

The free field motion is defined as it is a ground motion that are generated by the absence of the structure. If the light weight structure is resting on the rock, input motion of the structure is almost same as free field motion. If the structure is heavy weight and resting on the medium or soft soil than input motion of the structure is varies from the free field motion. The SSI problem has become most significant for heavy weight structure like bridges, underground structures, nuclear plants, tall building etc. its foundation is resting on the flexible soil condition.

II. OBJECTIVES

- To evaluate the SSI effect on regular and irregular in plan R.C.C. frame structure having shear wall.
- To evaluate the SSI effect on regular and irregular in plan R.C.C. frame stricture having X-bracing system.
- To comparative study the structural response of structure having regular and irregular in plan with and without considering soil structure interaction effect for various types of soil condition.

III. LITERATURE REVIEW

[6]Nirav M. Katarmal, Hemal J. Shah, investigated that displacement is increases up to 69% for irregular plan with SSI and also conclude that % of displacement is more for FEM compared to spring model and fixed base condition.

[7]Pallavi Badry, Dr. Neelima Satyam, investigated that C-shaped building is more critical as it experience the 38% and 29% more displacement than T-shaped and L-shaped building respectively.

[8]Purva M. Kulkarni, investigated that story displacement increases up to 28% while considering soil structure interaction effect and for clayey soil condition SSI effect is more.

IV. METHODOLOGY

In present work the analysis of following structures having 10 storey structure with and without Soil Structure Interaction (SSI) effect are to be carried out for various types of structure:

i) Bare Frame

ii) R.C.C. frame with Shear Wall
iii) R.C.C. frame with X-bracing system

The plan areas of the all structures are same for the analysis; also, the beam and column dimensions are same. The material properties such as Poisson ratio, Density of RCC, Density of Masonry, Young's modulus, compressive strength of steel and concrete etc. are kept constant in all buildings. George Gazetas equations are used for soil spring.

- The Response Spectrum Analysis for Zone IV is considered.
- The result parameter includes the Base Shear and Displacement.

❖ **Structure and Section details:**

Storey	10 storey
Plan Dimension	42m X 30m
Bay Width in X-Direction	6m
Bay Width in Y-Direction	5m
Floor Height	3m
Shear wall Thickness	230mm
Bracing	300mm x 300mm
Slab Thickness	150mm
Beam Dimension	300mm X 500mm
Column Dimension	600mm X 600mm
Live Load	4 KN/m^2
Floor Finish	1.5 KN/m^2
External Wall Load	13.8 KN/m^2
Internal Wall Load	6.9 KN/m^2
Concrete Grade	M30
Steel Grade	Fe500

❖ **Soil properties of soil used in the study (Mehta and Gandhi, 2008):**

Sr. no.	*Soil type*	*Modulus's modulus (KN/m²)*	*Poisson's ratio*	*Shear modules (KN/m²)*
1.	*Rock*	*30.42×10^7*	*0.30*	*3758900*
2.	*Dense Soil*	*50.53×10^7*	*0.35*	*822000*
3.	*Medium Soil*	*25.84×10^5*	*0.45*	*183500*
4.	*Soft Soil*	*14.95×10^4*	*0.49*	*36700*

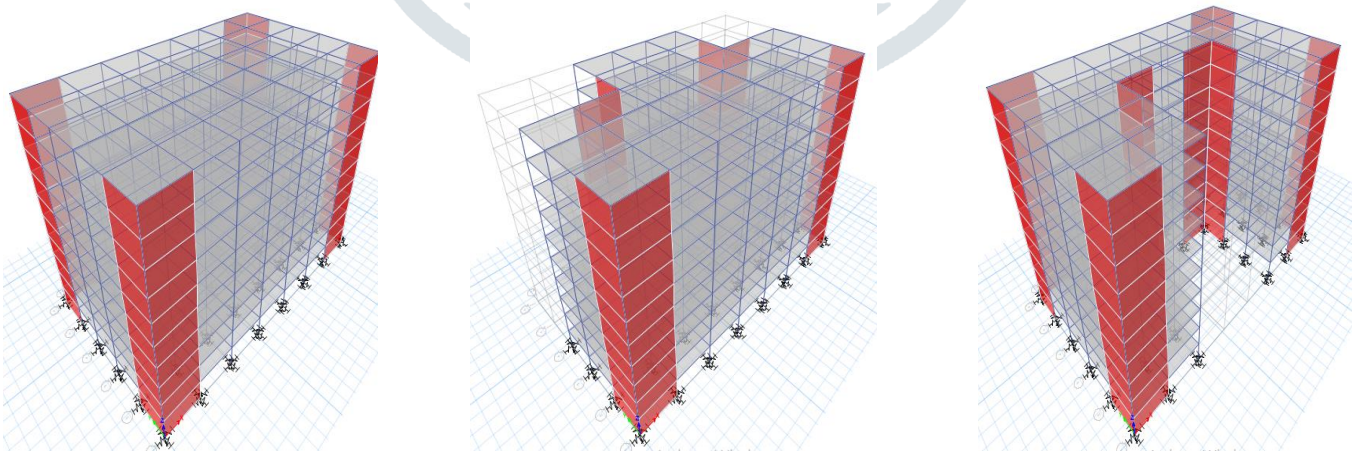


Fig 1. Elevation view of 10 storey having shear wall (a) Rectangle (b) T-shaped (c) C-shaped

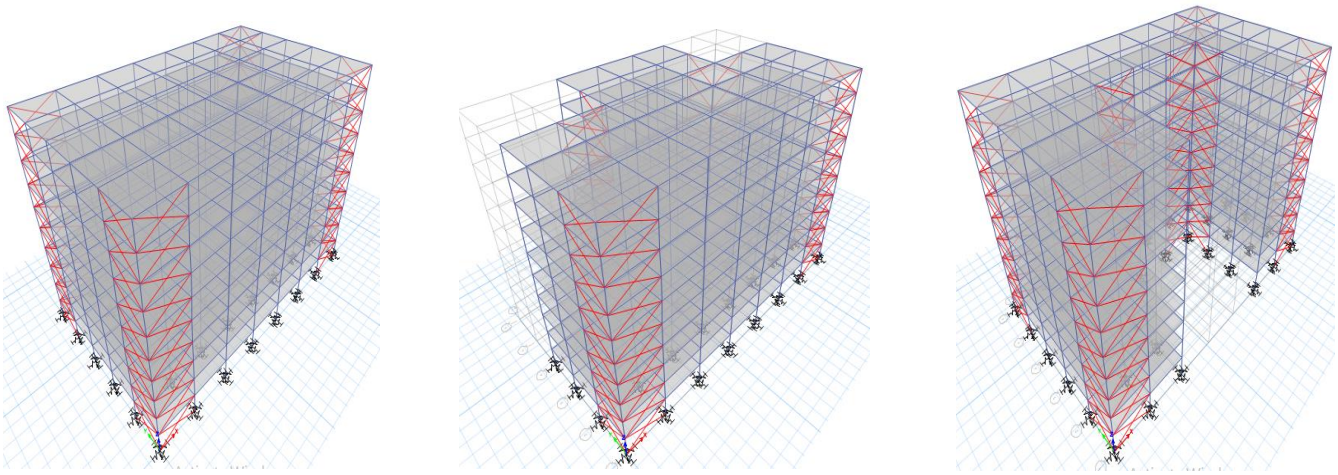
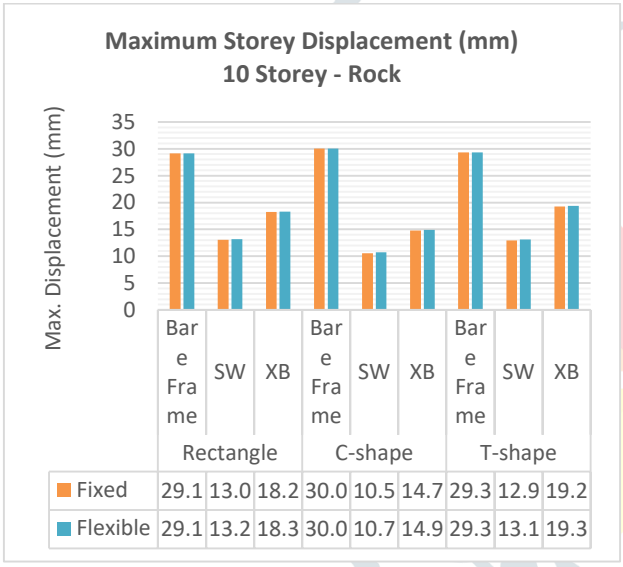
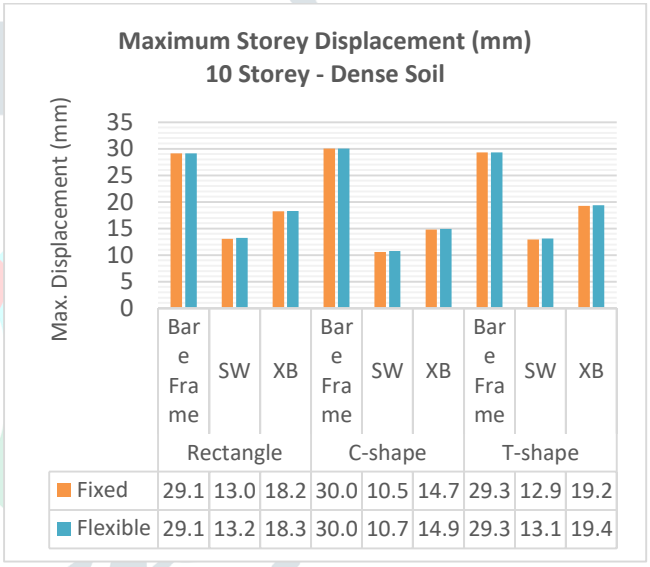


Fig 2. Elevation view of 10 storey having X-bracing (a) Rectangle (b) T-shaped (c) C-shaped

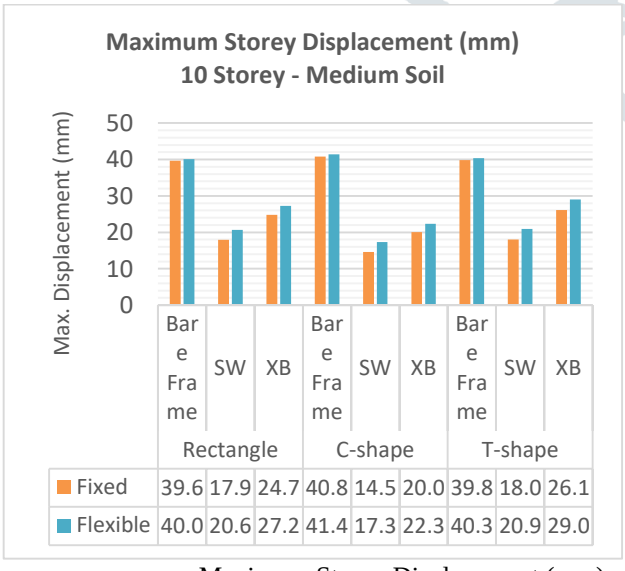
V. RESULTS

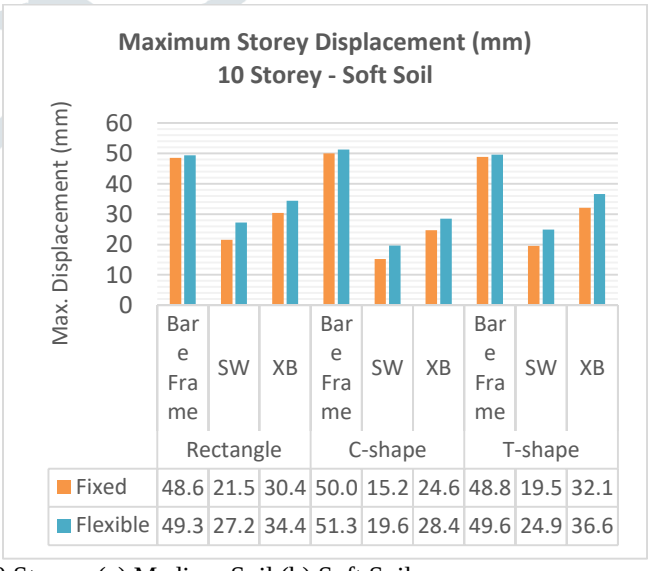
- **Maximum Storey Displacement:**





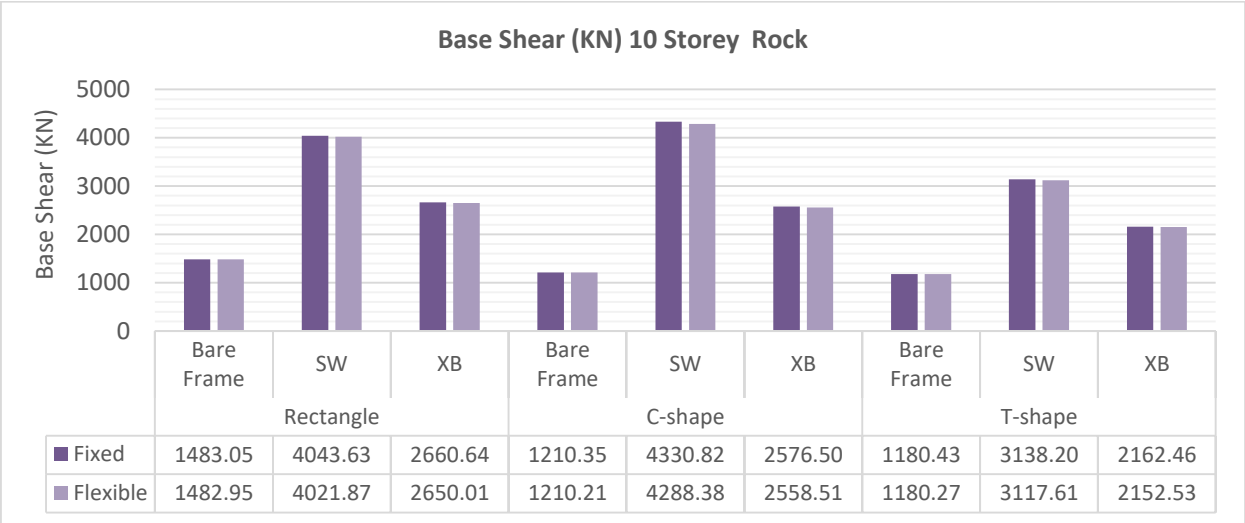
Maximum Storey Displacement (mm) of 10 Storey: (a) Rock (b) Dense Soil





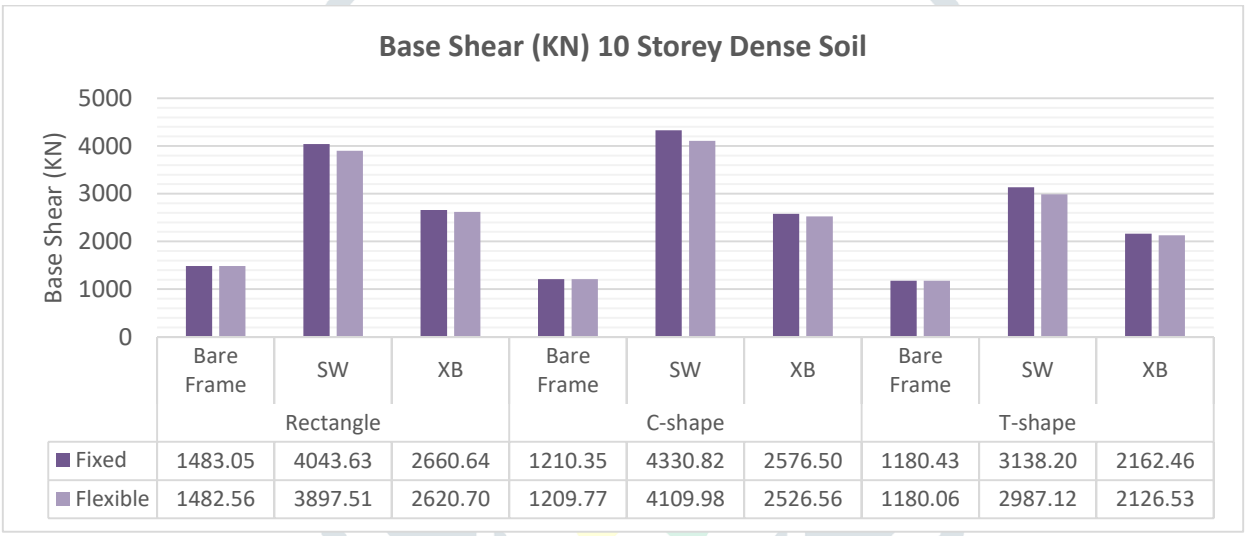
Maximum Storey Displacement (mm) of 10 Storey: (a) Medium Soil (b) Soft Soil

- **Base Shear:**



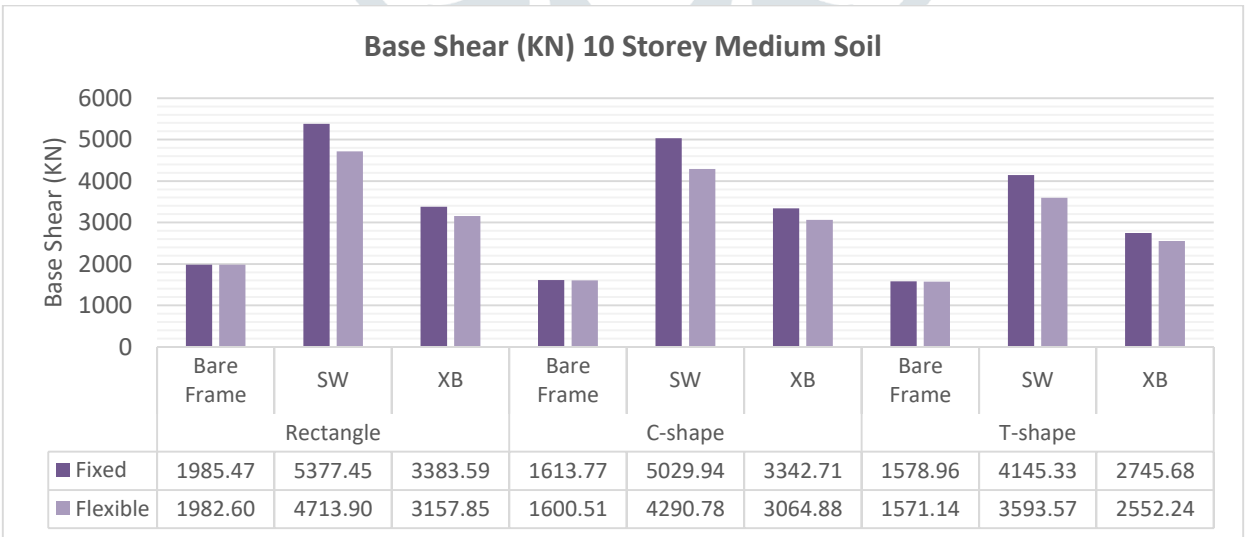
	Rectangle			C-shape			T-shape		
	Bare Frame	SW	XB	Bare Frame	SW	XB	Bare Frame	SW	XB
Fixed	1483.05	4043.63	2660.64	1210.35	4330.82	2576.50	1180.43	3138.20	2162.46
Flexible	1482.95	4021.87	2650.01	1210.21	4288.38	2558.51	1180.27	3117.61	2152.53

Base Shear (KN) for 10 Storey at Rock



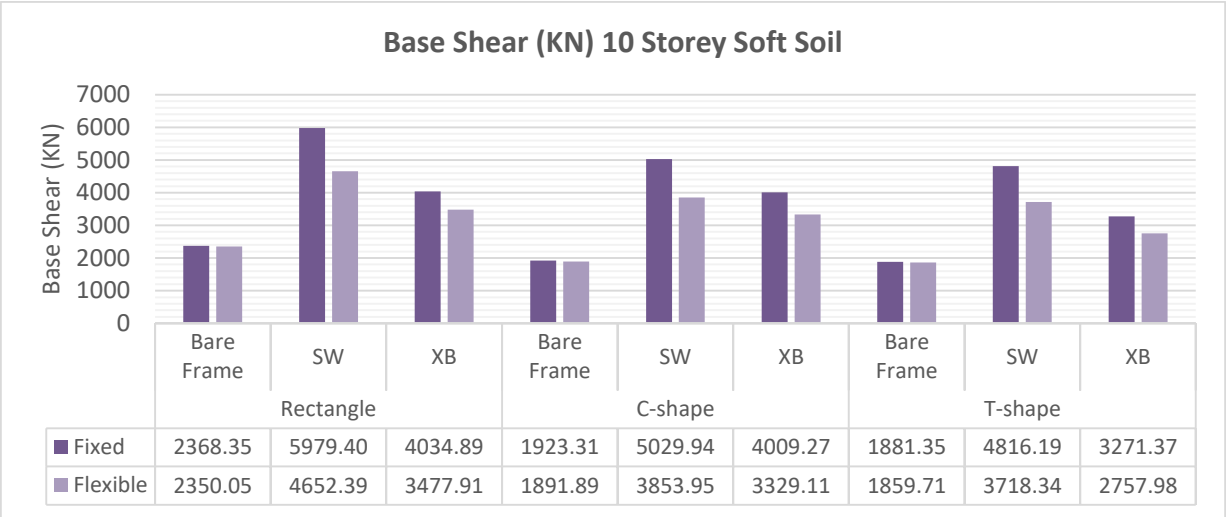
	Rectangle			C-shape			T-shape		
	Bare Frame	SW	XB	Bare Frame	SW	XB	Bare Frame	SW	XB
Fixed	1483.05	4043.63	2660.64	1210.35	4330.82	2576.50	1180.43	3138.20	2162.46
Flexible	1482.56	3897.51	2620.70	1209.77	4109.98	2526.56	1180.06	2987.12	2126.53

Base Shear (KN) for 10 Storey at Dense Soil



	Rectangle			C-shape			T-shape		
	Bare Frame	SW	XB	Bare Frame	SW	XB	Bare Frame	SW	XB
Fixed	1985.47	5377.45	3383.59	1613.77	5029.94	3342.71	1578.96	4145.33	2745.68
Flexible	1982.60	4713.90	3157.85	1600.51	4290.78	3064.88	1571.14	3593.57	2552.24

Base Shear (KN) for 10 Storey at Medium Soil



	Rectangle			C-shape			T-shape		
Fixed	2368.35	5979.40	4034.89	1923.31	5029.94	4009.27	1881.35	4816.19	3271.37
Flexible	2350.05	4652.39	3477.91	1891.89	3853.95	3329.11	1859.71	3718.34	2757.98

Base Shear (KN) for 10 Storey at Soft Soil

VI. Conclusion

- Lateral displacement is increases for flexible base with fixed base.
- Consideration of Soil Structure Interaction effect, base shear of the structure is decreases as compare to fixed base.
- As the stiffness of the soil is decreases, the effect of SSI is become more predominant to the seismic behavior of the structure.
- Shear walled structure having more SSI effect as compare to bare frame and X-bracing structure.
- Result variation is more in C-shaped plan compared to Rectangle plan and T-shaped plan.

VII. References

1. Chinmayi H.K., Jayalekshmi B.R. (2013), "Soil Structure Interaction effects on seismic responses of a 16 storey RC framed building with shear wall", Volume 2, American Journal of Engineering Research (AJER).
2. CSI Analysis Reference Manual for ETABS, Structural and Earthquake Engineering Software, Computer and Structures, Inc.
3. Doris Mehta and Nishant Gandhi (2008), "Time response study of tall chimneys, under the effect of soil structure interaction and long period earthquake impulse", The 14th World Conference on Earthquake Engineering, China.
4. George Gazetas (1991), "Formulas and charts for impedances of surface and embedded foundations", Volume: 117, No.09, Journal of Geotechnical Engineering.
5. George Mylonakos, George Gazetas (2000), "Seismic Soil-Structure Interaction: Beneficial or Detrimental? ", Volume: 4, No.3, Journal of Earthquake Engineering.
6. Nirav M. Katarmal, Hemal J. Shah (2016), "Seismic response of RC Irregular frame with Soil Structure Interaction", Issue no. 4, Volume: 1, International Journal of Scientific Development of Research.
7. Pallavi Badry, Dr. Neelima Satyam (2016), "Seismic soil structure interaction analysis for asymmetrical buildings supported on piled raft for the 2015 Nepal earthquake", Journal of Asian Earth Sciences.
8. Purva M. Kulkarni, Dr. Y. M. Ghugal (2019), "Dynamic analysis of RCC building considering Soil Structure Interaction", Volume: 06 Issue: 08, International Journal of Research in Engineering and Technology.
9. Romeo Tomeo, Antonio Bilotta, Dimitris Pitilakis, Emidio Nigro (2017), "Soil Structure interaction effects on the seismic performance of reinforced concrete moment resisting frames", X Interactional Conference on Structural Dynamics EURODYN (Elsevier).
10. Sachin Hosamani, R.J.Fernades (2015), "Soil Structure Interaction of RC framed irregular building with shear wall", Volume: 2, Issue: 4, International Research Journal of Engineering and Technology.