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Brief study on Soil-Structure interaction on the Seismic response of base isolated in High- Rise buildings

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Abstract: In this paper, the interaction between the super-structure and sub-structure is investigated by modelling the soil as simple as possible to capture the overall response of the system. As new analytical hysteresis rules and more advanced tools of analysis have been developed in recentyears, first the nonlinear response of a single-degree-of freedom system which can be representative of a broad range of newly designed structures, is investigated while allowing for flexibility of the soil-foundation system and SSI effects.

Keywords- Soil structure interaction (SSI), R.C.frame, Seismic load, High rise buildings

I. INTRODUCTION

During the last quarter of the 20th century, the importance of dynamic soil-structure interaction for several structures founded on soft soils was well recognized. If not accounted for in analysis, the accuracy in assessing structural safety in the face of earthquakes cannot be accounted for adequately. For this reason, seismic soil-structure interaction analysis has become a major topic in earthquake engineering. In Earthquake Engineering when the soil medium is relatively soft, the dynamic interaction between the superstructure, its foundation, and the soil medium may become important. During the shaking of an Earthquake, seismic waves are transmitted through the soil from fault rupture to a structure of interest. The wave motion of the soil excites the structure which in turn modifies the input motion by its movement relative to the ground. These interaction phenomena will be called "so il fo undatio n -sup er structure interactio n" or simp ly "so il structure interaction". Depending upon the material properties of the soil medium, the source of dynamic excitation and the particular type of foundation considered, the response of the structural system can be quite different from the case where the supporting system is rigid. This interaction effect may be especially significant in the frequency band near the resonant frequencies of the super structure because the soft foundation can provide the means for energy absorption. Because of this, the interaction is generally considered to be favorable in earthquake engineering design.

II. RELATED WORKS

Several investigations by Skinner have been done to develop new methods of seismic resistant design in New Zealand which resulted in presenting the new isolation concept of the laminated rubber bearing [1]. Robinson's experiments demonstrate that displacements of isolation systems should be reduced by adding more damping mechanisms to the structure besides the LRB damping [2].

The main use of the lead core of the LRB is to damp additional strain of the entire structure. Kelly, Buckle and Mayes made an extensive report on the history, applications and performances of several damping mechanisms which had been developed till 1990 [3], [4]. Tsai and Kelly's study represent that for a base-isolated shear building, damping within the lead core of the LRB causes an increase in the accelerations of lumped masses [5]. Also, the rubber bearing increases the global flexibility and restoring force which leads to lowering accelerations and inertial forces in the structure [6].

An experimental and analytical research was conducted on the base isolated structure assuming to be a SDOF system [7]. Iemura and Pradono observed that damping plays an important role in the bearing stiffness for various bridge retrofit strategies [8]. Abe et al. proposed two kinds of mathematical models for laminated rubber bearings under multi-axial loading. Then they conducted tri-axial hybrid experiment in which two-directional displacement paths are given to the bearings under a constant vertical load to see whether the models accurately predict responses or not [9]. The effects of SSI and isolation on the bridges with elastomeric bearings have been reported by Tongaonkar and Jangid in 2003 [10]. They show that considering SSI could lead to more precise results of displacements at abutments.

Dicleri et al. determined that SSI should be considered in isolated bridges, regardless to the soil stiffness. It is acquired by assuming a non-deteriorating force-deformation relation which entirely explains the natural nonlinear behavior of investigated isolators [11]. Base isolators which indicate a hardening behavior to resist an increasing load have been developed for buildings with utmost four stories subjected to moderate earthquakes by Pocanschi and Phocas [12].

In a noteworthy practice, Spyrakos implemented an equivalent two-degree-of-freedom system for a base isolated multistory building, which showed that dynamic characteristics of this type of structures, including frequencies, damping and mode shapes can be modified significantly by considering SSI effects [13]. Using nonlinear dynamic analysis which includes soil-structure interaction and footing base uplift, Anastasopoulos et al. and Abdel Raheem have shown that Hysteric damping of the base soil can cause isolating effects especially on shallow foundations [14], [15].

III. THE PROPOSED APPROACH

Overview of SSI: The dynamic interplay between superstructure and substructure may be divided into components: inertial interplay and kinematic interaction. Early SSI development was motivated by the seismic layout of nuclear energy plants. Kinematic interplay has cited the deviation of floor motion because of the presence of a stiff basis with/without mass and inertial interaction is a consequent deformation of foundation soil because of precipitated base shear and moments from the superstructure. The relative importance of these additives relies upon on the foundation characteristics and nature of incoming wave subject. Since typically mass of the soil excavated to construct the inspiration is just like the structure mass, the kinematic interaction can be neglected until the replaced foundation is very stiff. Therefore, the kinematic component of SSI analyses is generally of difficulty in designing nuclear energy vegetation or off-shore structures and oil industries. In addition, for motions that aren't rich in excessive frequencies, the input motion can approximately be taken into consideration equal with that of the goose field. Kinematic interaction outcomes are generally some distance extra tough to evaluate fastidiously than inertial interaction effects.

Kinematic interaction results are negligible for shallow foundations in a seismic environment consisting completely of vertically propagating shear waves or dilatational waves. Kinematic interplay or base averaging outcomes typically filters out high frequencies. In-situ soil residences are notoriously variable and hard to decide on any diploma of accuracy. Therefore, a soil model that is straightforward to put into effect and computationally efficient is suited as it allows the person to behavior sensitivity studies and determines the impact of a variety of subsurface conditions on the seismic response of the shape this is being modeled. Introducing springs (impedance problem) and dashpots in the base of the shape is the best manner to do not forget the flexible boundary condition for evaluating seismic demands. The outcomes for a uniform half of space are quite amenable. Modelling the foundation soil and base mat with finite elements offers greater practical results however it's miles too complicated for normal engineering applications. Seismic codes advise instances in which SSI have to be considered. NEHRP Commentary Studies of the interplay outcomes in structure-soil systems have proven that inside the commonplace stages of parameters for systems subjected to earthquakes, the effects are insensitive to the length and that it is sufficiently correct for practical purposes to apply the static stiffness. Stiffness properties of soil are much less large than the stiffness and mass properties of extremely good –structure on reaction. Soil-structure interaction (SSI) can be enormous for stiff structures based on smooth soils. The rocking thing of SSI outcomes in trendy, tend to be most significant for the laterally stiff shape which includes buildings with shear walls mainly those positioned on smooth soils. In this situation, the consequences of frequency dependence aren't normally large due to the fact the frequency of this mode of vibration is usually low,

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and not in the range where the consequences are important.

Interactions outcomes for higher vibration modes are small. Inertial interaction is maximum important for the essential model because it has excessive participation in base shear and base second. Fundamental period of the bendy-base structures is longer than constant-base systems in addition to powerful damping which is higher for the soil-structure gadget than for the structure on my own. Total displacements of the shape are large in flexibly based shape and may be quite vital for pounding of buildings; on the hand, drifts, and damage to structural additives are smaller than those of fixed base systems. The reaction of soil-structure gadget could be very touchy to the intensity of the enter motion.

A sturdy earthquake can deliver the soil foundation into the inelastic variety decreasing the stiffness and growing the damping while during a small earthquake the soil remains relatively stiff and damping is low. Under some site condition and ground motion properties, SSI can induce detrimental effect on some moderately flexible structures. Similar to the response of structures to far-field earthquakes, the effect of SSI on the seismic performance of structures subjected to near-field earthquake is more pronounced in soft soil types, and has less and negligible effects in stiff and rock soil types, respectively.

1. Geometry: The system geometry consists of G+42 Storeys located in Mumbai with plan dimension of 42.2m X 16m. The building will be used for residence. The lateral and vertical load resisting systems are reinforced concrete frames. The frames are composed of columns, shear walls, primary beams and secondary beams.

2. Geological Site Condition: The site condition consists of Yellowish stiff Clay for 3m and Greyish Moderately Weathered Rock beneath.

3. Material and Geometric Properties

Table 1: Material and Geometric Properties of Beams, Shear walls, Raft and Piles.

SR. NO	STRUCTURE	COMPONENT	DETAIL
1.	Frame	a.Storey Height b.Beam Size c.Shear Wall Thickness	Varying (3-3.5m) Varying Varying(0.23-0.45m)
2.	Pile	a.Diameter b.Length	1m 12m
3.	Concrete	a.For shear wall b.For Beamsand Slabs c.For pile andraft	M40 M30 M20
4.	Clay	a.Young'sModulus b.Unit weight	50000kN/sq.m 20kN/cu.m
5.	Sand	a.Young'sModulus b.Unit weight	500000kN/sq.m 20kN/cu.m

4. Seismic conditions and parameters:

Table 2: List of Seismic parameters

CATEGORY	PARAMETER
Zone	3
Zone Factor	0.16
Importance Factor	1
Response Reduction Factor	5
Vertical irregularity ingeometry	Yes
Soil Type	Soft
Time history	Elcentro City

5. Wind/Gust Category and Parameters

Table 3:List of wind/gust parameters

CATEGORY	PARAMETER
Wind Speed	44m/s
Terrain	3
Structure Class	B
Risk Coefficient(k1)	1
Topography(k3)	1
Windward Co-efficient	0.72
Leeward Co-efficient	0.48
Gust Factor in X-direction	2.28
Gust Factor in Y-direction	2.47

6. Loading Considered

Table 4: Loading considered for slab (kN/sq.m)\

USE	SDL	LL
Parking	1.5	5
Residency Floors	1	2
Staircases	3	3
Lobby	1	3
Balcony	3	2

6. Load combinations

As per IS: 456-2000, following load combinations are applied to the modal:-

1. 1.5(DL + LL)
2. 1.5(DL +/- W x/Wy)
3. 1.2(DL + LL +/- W x/Wy)
4. 0.9DL +/- 1.5(W x/Wy)
5. 1.5(DL +/- Spec1/Spec2)
6. 1.2(DL + LL +/- Spec1/Spec2)
7. 0.9DL +/- 1.5(Spec1/Spec2)

V. CONCLUSION

1. At the very beginning, one has to estimate the significance of SSI and decide whether it must be considered in any respect. The solution relies upon at the soil information (wave velocities inside the soil, initially), base mat size/embedment and inertia of the structure. For civil systems most customarily SSI can be left out.

2. If SSI is to be considered, one needs to observe whether or not a few easy assumptions can be carried out. Main assumptions: homogeneous half-space or a layer underlain by using inflexible rock as a soil model, floor base mat, rigid base mat. The general advice is as follows. One ought, to begin with, the simplest model allowed by user requirements. Only if the consequences seem over conservative, one needs to try to visit extra sophisticated models, accounting for numerous specific SSI results.

3. SSI consequences are frequency-established. Most of the consequences are legitimate in a certain frequency variety. Out of this range they'll cause the other changes

REFERENCES

[1] R. I. Skinner, J. L. Beck, and G. N. Bycroft, "A practical system for isolating structures from earthquake attack," Earthquake Engineering & Structural Dynamics, vol. 3, no. 3, pp. 297–309, 1974.

[2] W. H. Robinson and A. G. Tucker, "lead-rubber shear damper," Bulletin of the New Zealand Society for Earthquake Engineering, vol. 10, pp. 151-153, 1975.

[3] J. M. Kelly, "Aseismic base isolation: Review and bibliography," Soil Dynamics and Earthquake Engineering, vol. 5, no. 4, pp. 202–216, 1986.

[4] I. G. Buckle and R. L. Mayes, "Seismic isolation: History, application, and performance a world view," Earthquake Spectra, vol. 6, no. 2, pp. 161-201, 1990.

[5] B. Kang, G. Kang, and B. Moon, , "Hole and lead plug effect on fiber reinforced elastomeric isolator for seismic isolation," Journal of Material Processing Technology, vol. 140, no. 1-3, pp. 592-597, 2003.

[6] J. M. Kelly and H. Tsai, "Seismic response of heavily damped base isolation sy stems," Earthquake Engineering & Structural Dynamics, vol. 22, no. 7, pp. 633-645, 1993.

[7] P. B. Rao and R. S. Jangid, "Experimental study of base-isolated structures," ISET Journal of Earthquake Technology, vol. 38, no. 1, pp. 1-15, 2001.

[8] H. Lemura and M. H. Pardono, "Passive and semi-active seismic response control of a cable-stayed bridge," Structrul Control and Health Monitoring, vol. 9, no. 3, pp. 189-204, 2002.

[9] M. Abe, J. Yoshida, and Y. Fujino, "Multiaxial behaviors of laminated rubber bearings and their modeling. I: Experimental study," Journal of Structural Engineering, vol. 130, no. 8, pp. 1119-1132, 2004.

[10] N. P. Tongonkor and R. S. Jangid, "Seismic response of isolated bridges with soil-structure interaction," Soil Dynamics and Earthquake Engineering, vol. 23, no. 4, pp. 287-302, 2003.

[11] M. Dicleli, S. Albhaisi, and M. Y. Mansour, "Static soil-structure interaction effects inseismic-isolated bridges," Practice Periodical on Structural Design and Construction, vol. 10, no. 1, pp. 22-33, 2005.

[12] A. Pocanschi and M. C. Phocas, "Earthquake isolator with progressive nonlinear deformability," Engineering Strucures, vol. 29, no. 10, pp. 2586-2592, 2007.

[13] C. C. Spyrakos, I. A. Koutromanos, and Ch. A. Maniatakis, "Seismic response of base-isolated buildings including soil–structure interaction," Soil Dynamics and Earthquake Engineering, vol. 29, no. 4, pp. 658–668, 2009.

[14] I. Anastasopoulos, G. Gazetas, M. Loli, M. Apostolou, and N. Gerolymos, "Soil failure can be used for seismic protection of structures," Bulletin of Earthquake Engineering, vol. 8, no. 2, pp. 309-326, 2010.

[15] S. E. Abdel Raheem and T. Hayashikawa, "Soil-structure interaction modeling effects on seismic response of cable-stayed bridge tower," International Journal of Advanced Structural Engineering, vol. 5, no. 8, pp. 1-17, 2013.