Effect Of Soil Structure Interaction On Base Isolated Building Structure

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Abstract— In this paper, a real 10-story base isolated structure, designed is selected .This study investigates the effect of soil– structure interaction (SSI) on the response of base-isolated buildings. The equations of motion are formulated in the frequency domain, assuming frequency independent soil stiffness and damping constants. An equivalent fixed-base system is developed that accounts for soil compliance and damping characteristics of the base-isolated building. For preliminary design, the methodology can serve as a means to assess effective use of base isolation on building structures accounting for SSI. This study concludes that the effects of SSI are more pronounced on the modal properties of the system. The comparison of natural period, base shear and total relative displacements of the structure has been realized based on analytical models. such type of buildings Strategies proposed in this study are (i) increasing superstructure stiffness, (ii) increasing superstructure damping and (iii) increasing flexibility of isolation system.

Keywords: *Displacement, Base isolation,SSI*

I. Introduction

The response of a structure to earthquake shaking is affected by interactions betweenthree linked systems: the structure, the foundation, and the soil underlying andsurrounding the foundation. Soil-structure interaction analysis valuates the collective response of these systems to a specified ground motion.thefoundation is considered part of the structure, and the term SSI has been adopted.This report presents a synthesis of the body of knowledge contained in SSI literature, which has been distilled into a concise narrative and harmonized under a consistentset of variables and units. Specific techniques are described by which SSIphenomena can be simulated in engineering practice, and recommendations formodeling seismic soil-structure interaction effects on building structures areprovided. Foundation stiffness and damping.- Inertia developed in a vibrating structure gives rise to base shear, moment, and torsion. These forces generate displacements and rotations at the soil-foundation interface. These displacements and rotations are only possible because of flexibility in the soil-foundation system, which significantly contributes to overall structural flexibility (and increases the building period). Moreover, these displacements give rise to energy dissipation via radiation damping and hysteretic soil damping, which can significantly affect overall system damping. Proper consideration of SSI effects in a substructure approach requires:

(i) An evaluation of free-field soil motions and corresponding soil material properties;

(ii) An evaluation of transfer functions to convert free-field motions to foundation input motions;

(iii) Incorporation of springs and dashpots (or more complex nonlinear elements) to represent the stiffness and damping at the soil foundation interface; and

(iv) A response analysis of the combined structure spring/dashpot system with the foundation input motion applied.

The superstructure is modeled above the foundation and the system is excited through the foundation by displacing the ends of the springs and dashpots using the rocking and translational components of the FIM. It should be noted that FIM varies with depth. In the case of the distributed spring and dashpot model, differential ground displacements should be applied over the depth of embedment. This application of spatially variable displacements introduces a rotational component to the FIM.

II. Materials & Methods

Base Isolation

Base isolation intends to uncouple the structure from seismicground motion, minimizing, simultaneously, the interstory deformation sand the floor accelerations by interposing elements of high axial and low horizontal stiffness between the structure and the foundation. Use of base isolation is increasingly applied to seismically upgrade existing buildings as well as to effectively reduce the seismic vulnerability of new buildings. It is also well recognized that soil–structure interaction (SSI) could play a significant role on structural response. However, common practice usually does not account for the effects of SSI on the seismic behavior of base isolated structures. The present study attempts to quantify the effects of SSI on base-isolated building structures.

Base Isolated Structures

Sometimes the level of the ground motions is considerably high causing severe Structural damage. Many a seismic designs and technologies have been developed over The years to control the effects of earthquakes on structures. Seismic isolation is relatively recent and evolving technology compared to conventional seismic methods.
(i)Increasing superstructure stiffness,
(ii) Increasing superstructure damping and

(iii) increasing flexibility of isolation system.

Effect of isolation on buildings

There a number of types of isolation system which provide the essential elements of (1) flexibility (2) damping and (3) rigidity under service loads. Other systems provide some of these characteristics and can be used in parallel with other components to provide a complete system. To provide some guidance in selecting systems for a particular project, three prototype buildings have been used to examine the response under seismic loads of five types of system, each with variations in characteristics. An example is then provided of parametric studies that are performed to refine the system properties for a particular building.

Application of base isolation for flexible buildings

Seismic isolation enables the reduction in earthquake forces by lengthening the period of vibration of the structure. The conventional period of isolated structures is generally kept as 2 sec. Therefore; the significant benefits obtained from isolation are in structures for which the fundamental period of vibration without base isolation is short, less than 1.0 sec. This paper consists of analytical study of base-isolation for buildings with higher natural period ranging from 1.0 to 3.0 second. Different possibilities are explored to increase the feasibility of base isolation for such type of buildings. Strategies proposed in this study.

Suitability of base isolation

1. The structure is fairly jointed with sufficiently high column load.
2. The site permits horizontal displacement at the base.
3. Lateral load due to wind are less than approximately the weight of structure.

Need of base isolation

1) Protection of Life.
2) Protection of Building Frame.
3) Protection of Non-Structural Components and Contents.
4) Protection of Processes and Function.
5) Provide for an operational facility after the earthquake.

Effect of base isolation system:

1) Improvement for safety of building.
2) Keep for function of building.
3) Preservation for property.

III. Results

1) A simple frame structure with spring and dashpots is considered in this study.
2) Investigate the behavior of multi-storey frame-shear wall building structure under earthquake loads with damping devices strategically located within the wall.
3) Evaluate the influence of damping and isolation systems on the overall seismic response of the structure.
4) A damping and isolation mechanisms of different size, configuration and placed at various locations were treated.
5) The damping mechanisms were modeled as a contact pair with friction parameter for a friction damper linear spring and dash-pot in parallel damper.

IV. Conclusion

An attempt is made to investigate the strategies that may result base isolation effective for the buildings having 10 storeys.

Three approaches are explored viz. increase in
(i) superstructure stiffness,
(ii)superstructure damping and,
(iii) flexibility of isolation system.

The conclusions based on this analytical study are as follows:

1. Stiffening of superstructure affects the response of the base-isolated buildings. Base isolation results insignificant reduction in structural response of stiffened buildings as compared to unstiffened one.
2. There is no significant difference between the response of the base isolated buildings with and without superstructure stiffening though the influence of superstructure stiffening is more in case of taller buildings.
3.Stiffening of superstructure of base-isolated buildings results in reduction of the maximum roof acceleration and the maximum storey drift while it increases the maximum storey shear and the maximum base slab displacement.
4.Increase in the damping of superstructure reduces the seismic response of base-isolated buildings though the reduction is not appreciable. Response reduction due to increase in superstructure damping is more for high frequency base motions. Also the reduction is generally more for taller buildings.
5.Superstructure damping has negligible effect on maximum base displacement of base-isolated buildings. Increase in the flexibility of isolation system is very effective in reducing the response of the buildings. However, there is a small increase in the maximum base displacement.

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