Investigation of the Soil Structure Interaction Effect on the Dynamic Behavior of Multistory RC Buildings

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ABSTRACT

Nonlinear dynamic analysis of full-scale reinforced concrete structures through the use of 3D detailed modeling that considers the soil-structure-interaction (SSI) phenomenon is a significant study field for both researchers and engineers. The numerical instabilities that immerse when the opening and closing of cracks initiates during the nonlinear dynamic analysis of SSI models and the excessive computational demand that rises even when dealing with small numerical models are the main numerical problems when performing this type of analysis. For these reasons, researchers adopt numerical models like the beam-column element to discretize the superstructure and the piles of a foundation system when analyzing SSI models. The limitations of this approach are well documented especially when modeling shear walls and joints through the use of 1D models. Furthermore, the interaction between the 3D soil domain and the pile foundation is also affected when the beam-column element is adopted.

In this research work, a computationally efficient and robust 3D modeling approach is used for the simulation of RC structures, where the concrete domain is discretized by 8-noded hexahedral elements and the steel reinforcement is modeled with beam elements, which are considered embedded inside the hexahedral concrete mesh. Additionally, the hybrid modeling (HYMOD) method is implemented in order to decrease the computational demand that derives from the modeling of the superstructure. The HYMOD approach combines hexahedral and Natural Beam-Column Flexibility-Based fiber elements for shear and bending dominated structural members, respectively. This numerical strategy manages to decrease the computational demand and at the same time maintain a sufficient level of accuracy.

Based on the numerical investigation that was performed for the needs of this research work, the results that derived from the modal analysis of different multistorey RC buildings, with and without soil, are presented herein. Based on the numerical investigation findings, the developed modeling approach provides a robust numerical tool for performing modal analysis of large-scale numerical models. Finally, the development of this numerical tool provides the ability to further investigate the SSI effect under dynamic analysis, which is this research project's main objective.

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