World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:18, No:10, 2024

A Research on the Effect of Soil-Structure Interaction on the Dynamic Response of Symmetrical Reinforced Concrete Buildings

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Abstract : The effect of soil-structure interaction on the dynamic response of reinforced concrete buildings of regular and symmetrical geometry are considered in this study. The structures are presumed to be generally embedded in a homogenous soil formation underlain by very stiff material or bedrock. The structure-foundation–soil system is excited at the base by an earthquake ground motion. The superstructure is idealized as a system with lumped masses concentrated at the floor levels, and coupled with the substructure. The substructure system, which comprises of the foundation and soil, is represented, and replaced by springs and dashpots. Frequency-dependent impedances of the foundation system are incorporated in the discrete model in terms of the springs and dashpots coefficients. The excitation applied to the model is field ground motions of actual earthquake records. Modal superposition principle is employed to transform the equations of motion in geometrical coordinates to modal coordinates. However, the modal equations remain coupled with respect to damping terms due to the difference in damping mechanisms of the superstructure and the soil. Hence, proportional damping for the coupled structural system may not be assumed. An iterative approach is adopted and programmed to solve the system of coupled equations of motion in modal coordinates to obtain the displacement responses of the system. Parametric studies for responses of building structures with regular and symmetric plans of different structural properties and heights are made for fixed and flexible base conditions, for different soil conditions encountered in Addis Ababa. The displacement, base shear and base overturning moments are used in the comparison of different types of structures for various foundation embedment depths, site conditions and height of structures. These values are compared against those of fixed base structure. The study shows that the flexible base structures, generally exhibit different responses from those structures with fixed base. Basically, the natural circular frequencies, the base shears and the inter-story displacements for the flexible base are less than those of the fixed base structures. This trend is particularly evident when the flexible soil has large thickness. In contrast, the trend becomes less predictable, when the thickness of the flexible soil decreases. Moreover, in the latter case, the iteration undulates significantly making the prediction difficult. This is attributed to the highly jagged nature of the impedance functions of frequencies for such formations. In this case, it is difficult to conclude whether the conventional fixed-base approach yields conservative design forces, as is the case for soil formations of large thickness.

Keywords : effect of soil structure, dynamic response corroborated, the modal superposition principle, parametric studies
Conference Title : ICACE 2024 : International Conference on Advances in Civil Engineering
Conference Location : Athens, Greece
Conference Dates : October 17-18, 2024