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Correction Factors for Soil-Structure Interaction Predicted by Simplified Models: Axisymmetric 3D Model versus Fully 3D Model

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Abstract : The effects of soil-structure interaction (SSI) are often studied using axial-symmetric three-dimensional (3D) models to avoid the high computational cost of the more realistic, fully 3D models, which require 2-3 orders of magnitude more computer time and storage. This paper analyzes the error and presents correction factors for system frequency, system damping, and peak amplitude of structural response computed by axisymmetric models, embedded in uniform or layered half-space. The results are compared with those for fully 3D rectangular foundations of different aspect ratios. Correction factors are presented for a range of the model parameters, such as fixed-base frequency, structure mass, height and length-to-width ratio, foundation embedment, soil-layer stiffness and thickness. It is shown that the errors are larger for stiffer, taller and heavier structures, deeper foundations and deeper soil layer. For example, for a stiff structure like Millikan Library (NS response; length-to-width ratio 1), the error is 6.5% in system frequency, 49% in system damping and 180% in peak amplitude. Analysis of a case study shows that the NEHRP-2015 provisions for reduction of base shear force due to SSI effects may be unsafe for some structures and need revision. The presented correction factor diagrams can be used in practical design and other applications.

Keywords : 3D soil-structure interaction, correction factors for axisymmetric models, length-to-width ratio, NEHRP-2015 provisions for reduction of base shear force, rectangular embedded foundations, SSI system frequency, SSI system damping
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