SITE-SPECIFIC SSSI ANALYSIS FOR DEEPLY EMBEDDED SMR USING FLEXIBLE VOLUME REDUCED-ORDER MODELING WITH IMPEDANCE INTERPOLATION (FVROM-INT)

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Abstract

The seismic responses of deeply embedded structures are significantly affected by the soil-structure-interaction (SSI) considerations. Site-specific SSI and structure-soil-structure interaction (SSSI) analyses are performed for a deeply embedded Small Modular Reactor (SMR) and its surrounding surface-founded power block structures. Because of the complexities of the model, evolution of design, and considerations of several sensitivity studies, where different bounding variation of the structural model are included, implementation of an effective and efficient approach for solving the SSI solution for the structure was necessary. To achieve this goal, the Flexible Volume Reduced-Order Modeling approach with Impedance Interpolation option (FVROM-INT) of ACS SASSI was employed.

Compared with the Enhanced Subtraction Method (ESM), the FVROM-INT approach significantly reduced the analysis time, especially when different variations of the structural model were considered without loss of accuracy of the solution – see Figure 1. The selection of an adequate set of "Condensation" frequencies was critical in obtaining the accurate solution and depended on the geometry and boundary conditions of the excavated volume and subgrade material properties. These SSI analysis runtime reductions can be tens of times when different variations of the structural model are considered.

The use of this approach is recommended when repetitions of the SSI analysis are required for design development, sensitivity analysis cases, or probabilistic studies, and results in significant savings in the required computational effort – see Table 1.

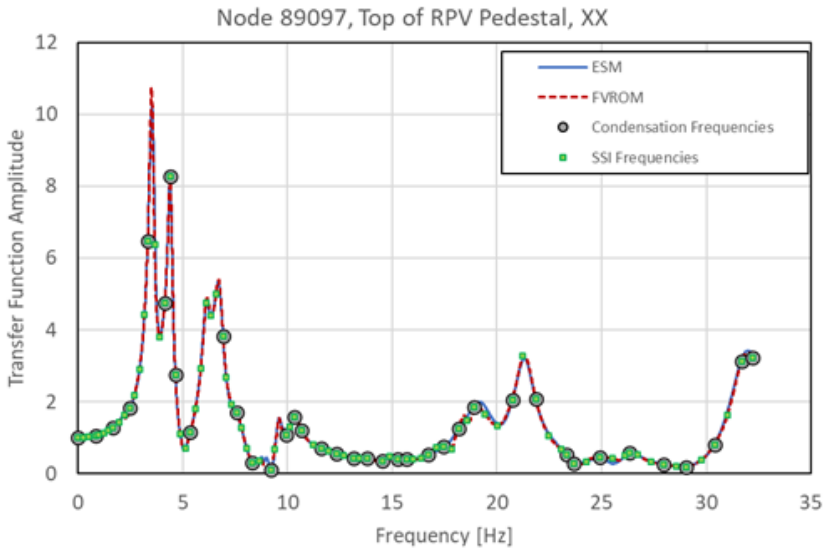

Figure 1. Acceleration Transfer Function Amplitudes at a Key Location – Horizontal (X) direction

Table 1: Analysis time for different SSI analysis approaches

Analysis Approach		Number of frequencies	Analysis time per frequency	Analysis time for full solution	Analysis time for a repeat analysis for a structural variation
ESM		87	4.75 hrs	17.2 days	17.2 days
FVROM-INT	Excavated soil solution and static condensation	38	3.75 hrs	7.6 days	0.6 days
	Frequency domain interpolation of the impedance matrix	49	0.5 hrs		
	SSI Analysis	87	0.17 hrs		