3D vs 1D vs 3x1D Ground Motions and the Earthquake Soil Structure Interaction

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Abstract

A large number of seismic ground motion recordings that have been collected over last many years, show that all three components of motions (East-West (EW), North-South (NS), and Up-Down (UD)) are always present. Sometimes one of the components is not too prominent, however all three are always present. Vertical motions are of particular interest as they appear as a results of either primary (compressional) waves (initially, first to appear, hence name Primary, P) or as as result of surface (Rayleigh) waves. Modelling of Earthquake Soil Structure Interactio n (ESSI) should ideally take all three components into account. In fact, in addition to the three translations (EW, NS, UD) there are also rotations that arise from surface waves (Rayleigh, Love, etc...) that need to be taken into account for accurate modelling of ESSI effects.

Presented here is a comparative study of ESSI effects on a model Nuclear Power Plant (NPP) when different ground motions are used for modelling. A full 3D wave field (with three translations and three rotations) is developed using regional scale finite difference modelling, using SW4 code. Developed 3D motions are then used to develop 1D and 3x1D motions. The ESSI analysis of a model NPP is then performed using 1D, 3x1D and full 3D motions. Presented results are used to emphasize differences in using 1D and 3x1D approximations versus ESSI effects that stem from realistic 3D motions.