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Effects of Soil Nonlinearity on the Floor Response Spectra of the Buried Structures

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Abstract

This study investigates the seismic response of a buried structure that is typically located in a nuclear island. These buried structures may contain critical equipment and piping and, therefore, their seismic response can be critical for the safe shut down process of the nuclear power plant. Among the response parameters, the floor response spectra is typically used to perform seismic design calculations of the equipment and piping in these structures.

In the current practice, the floor response spectra for such embedded structures are computed using programs that performs solution in the frequency domain where elastic or equivalent elastic soil properties are used. The effect of non-linearity in the soil layers and also at the soil and structure interface can considerably affect the calculated floor response spectra.

This paper presents a comparative study where a buried reinforced concrete tunnel structure and its interaction with the surrounding soil medium is analysed using two different solution methods 1) equivalent elastic soil properties using the computer program ACS-SASSI and 2) non-linear soil properties with de-bonding capability of soil at the tunnel interface using the computer program PLAXIS. For both solution methods, the tunnel and the surrounding soil medium are represented using a two-dimensional finite element model. All models are subjected to acceleration time histories representing vertically propagating shear waves. The calculated floor response spectra are compared and the effect of non-linearity in the soil and at the soil-structure interface is discussed.