# Seismic Response of "Cut-and-Cover" Underground Nuclear Reactor Containments with Porous Backfill

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Abstract

Nonlinear structure-medium interaction is studied for the dynamic response of a "cut-and-cover" type of nuclear reactor containment to seismic excitation by the finite element method.

The concept chosen is a prestressed concrete horseshore-shaped containment in a porous medium, with and without a surrounding drain. A linear/elastoplastic stress-strain relationship for the soil and Darcy's law for the flow of pore fluid are assumed. The compressibility of the soil and pore fluid are taken into account. The Drucker-Prager yield condition is used for the plastic modelling of concrete (impermeable material) with the yield surface defined by the uniaxial strengths in tension and compression. The reinforcements in the concrete and soil are represented by an orthotropic model with the effect of the reinforcement smeared over the associated concrete/soil elements.

The study includes the effects of the water table level, presence of a drain around the containment, soil reinforcement, containment thickness, level of prestress, and parametric variation of soil properties with particular reference to containment stresses and pore water pressure.

The sensitivity of the structure-medium response to the type of excitation is investigated using a family of artificially generated response spectrum-compatible ground motions. The numerical simulation of ground motion is based on the representation of a periodic function as a series of sinusoidal waves with random phase angles. A deterministic envelope function is used to simulate the transient character of real earthquakes. The response spectrum of generated motion is matched with the smoothened target sprectrum by an iterative procedure.