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(Hybrid Simulation to Assess Performance of Seismic Isolation in NPPs)

NUMERICAL SIMULATION OF THE IAEA & KEPCO SEISMIC ISOLATION BENCHMARK STRUCTURE

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ABSTRACT

This work deals with the numerical simulation of phase 1 of the IAEA-KEPCO benchmark on seismic isolation. To this end a matlab based code has been developed. The superstructure is represented by the first twenty modes of the model provided by KEPCO and six additional degrees of freedom for the lower face of the upper base mat assumed to have a rigid base motion. The effect of the deformation of the upper base mat was taken into account in a simplified fashion by means of a 12x12 mass super-element between the degrees of freedom of the lower face of the base mat and the base of the stick models represented the reactor and auxiliary buildings and the internal structures.

The 486 isolators were modelled using a model similar to that proposed by Kumar et al. and the effect of heating on the plug yield limit was considered. The explicit central difference method was used to integrate the equations of motion. The maximum shear strain is of about 140% and 330% respectively for the specified design and beyond design excitations. The computed floor spectra show, in general, the beneficial effect of seismic isolation in the horizontal response of equipment and components.

In parallel a finite element analysis was carried out with OPENSEES considering the original Kumar et al. model for the isolators and using an implicit integrator. The results given by the two codes are very close. Since the isolators' shear strain at the beyond design level is considerable the linear rubber behavior considered in the Kumar model is questionable. Therefore, supplemental analyses were carried out both with the in-house matlab code and OPENSEES using the model of Grant et al. for the horizontal behavior of the rubber taking into account hardening and generalized-like plasticity of the rubber. Due to lack of available data, Mullin's ad scragging effects were not addressed. With this model, slightly smaller horizontal strains are obtained due to the rubber hardening.