Dynamic Model for Free Standing Fuel Racks under Seismic Excitation Considering Planar and Non-slide Rocking Motion

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Abstract

A free-standing rack (FS rack) is a type of a spent nuclear fuel rack, which is just placed on a floor of a pool. For this characteristic, seismic loads can be reduced by fluid force and friction force, but a collision between a rack and another rack or a wall must be avoided. Therefore, it is necessary for designing an FS rack to figure out how it moves under seismic excitation. In this research, a dynamic model of an FS rack is developed considering seismic inertial force, friction force and fluid force. This model consists of two sub-models: a translation model, which simulates planar translational and rotational motion; and a rocking model, which simulates non-slide rocking motion.

First, simulations with sinusoidal inertial force were conducted, changing values of a friction coefficient. Next, to validate this dynamic model, a miniature experiment was conducted. Finally, the model is applied to a real-size FS rack and actually observed seismic acceleration. It is found that translational movement of a rack varies depending on the value of friction coefficient in the simulation with sinusoidal and actual acceleration.

Also, simulation results are similar to the experimental results in the aspects of translational and rocking motion provided friction coefficient is selected properly. Through this research, the knowledge is acquired that friction force plays a significant role in a motion of FS rack so that estimating and controlling a friction coefficient is important in designing an FS rack.