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Fragility evaluation of nuclear power building using nonlinear 3 dimensional FEM Part-1 Ultimate seismic condition of building

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SUMMARY

The evaluation based on probabilistic safety assessment (PSA) is expected for nuclear power buildings because the risk of the occurrence of seismic ground motions beyond the design assumption cannot be denied. For the assessment, seismic ultimate analyses of the building are necessary.

In this paper, the seismic ultimate behavior was evaluated using an accurate three-dimensional nonlinear FEM model. In the model, the basemat and the soil were modeled by solid elements, and shear walls of the building were modeled by nonlinear layered-shell elements. The uplift behavior was estimated using joint elements between the basemat and the soil. The response analyses considering the maximum horizontal acceleration up to 3500Gal was done. Then, the influence on the response given by the vertical ground motion and the basemat uplift was evaluated. Moreover, the response was compared with that of the lumped-mass model, which is generally used for current seismic design. From the study, the following results were obtained.

1) The building reached the ultimate condition at 7 times of the design basis ground motion input. Shear failure was occurred 3500 Gal input.
2) The horizontal response of the structure for simultaneous horizontal and vertical input was almost the same as for horizontal only input, thus the effect of vertical input was relatively small. The vertical response of the structure for simultaneous input agreed well for vertical only input.
3) The effect of basemat uplift on the horizontal response was relatively small. However, the effect on the vertical acceleration was not small. The difference was considered as the vertical induced motion.
4) The shear strain of the lumped mass SR model exhibited almost the same level as the FEM model in O/S. However in E/B, the SR model overestimated damage compared to the FEM model.