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Fragility evaluation of nuclear power building using nonlinear 3 dimensional FEM Part-2 Fragility evaluation

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SUMMARY

The evaluation based on the probabilistic safety assessment (PSA) is expected for nuclear power buildings. It is because that the risk of the occurrence of the seismic ground motions beyond the design assumption cannot be denied.

In part-1 the seismic ultimate behavior was evaluated using an accurate three-dimensional nonlinear FEM model. In part-2, the building fragility evaluation of the seismic PSA was carried out using the 3 dimensional nonlinear FEM model based on the result of part-1.

In this paper, as the fracture modes, the shear failure of the web wall and the flexural failure and the compressive failure of the flange wall were assumed. The fragility curves of the FEM model and lumped mass sway-rocking (SR) model in each analysis case were calculated as follows. First, the failure probability was plotted on a diagram for each input acceleration level where analysis was conducted. The failure probability is calculated by considering the aleatory uncertainty of the response and strength value. Next, the plotted points are approximated by a lognormal cumulative distribution function using the least squares method, which is taken to be the fragility curve. From the study, the following results were obtained.

1) In terms of the failure mode of the envisioned reinforced concrete seismic walls, shear failure led to flexural failure and compressive failure. So, the failure probability and fragility curve is decided by the shear failure of the walls.
2) In the evaluation of shear strain, the difference between the fragility evaluations for horizontal input only and simultaneous horizontal and vertical input was small, and the effect of vertical input was relatively small.
3) The effect of basemat uplift on fragility evaluation was relatively small.
4) In the fragility evaluation, the lumped mass sway-rocking (SR) model exhibited a tendency to estimate damage largely compared to the FEM model.