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Ultimate Seismic Capacity and Fragility Assessment of Elbow Piping Components in Seismically Isolated NPPs

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To adopt the seismic isolation system for the protection the nuclear power plants (NPPs) against to the strong seismic events, the ultimate seismic capacity of interface pipes crossing isolated & non-isolated structures,should be evaluated comprehensively especially in terms of the seismic fragility. To evaluate the seismic capacity of interface pipes in the isolated NPP, firstly, we should define the failure mode and failure criteria of critical pipe components. For the interface pipes in the seismically isolated NPPs, the failure mode may become different from the conventional failure modes of ordinary pipes because of the extremely large relative displacement between the support anchors which are located in the isolated and non-isolated structures, respectively. Hence, in this study, we performed the dynamic tests of elbow components which were installed in a seismically isolated NPP, and evaluated the ultimate failure mode and failure criteria by using the test results. To do this, we manufactured 25 critical elbow component specimens and performed cyclic loading tests under the internal pressure condition. For the tests, we generated the seismic input protocol of relative displacement between the ends of elbow component. Finally, the ultimate seismic capacity and fragility were estimated for the critical elbow components in the interface piping system. From the result, we found that the tested elbow components were very good sustainability & ultimate seismic capacity against to the earthquake loading since that more than 34 times of 0.5g earthquakes were required to make a penetration crack at the most critical point.