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Piping Fragility Composed of Different Materials by Using OpenSees Software

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Abstract : A failure of the non-structural component can cause significant damages in critical facilities such as nuclear power plants and hospitals. Historically, it was reported that the damage from the leakage of sprinkler systems, resulted in the shutdown of hospitals for several weeks by the 1971 San Fernando and 1994 North Ridge earthquakes. In most cases, water leakages were observed at the cross joints, sprinkler heads, and T-joint connections in piping systems during and after the seismic events. Hence, the primary objective of this study was to understand the seismic performance of T-joint connections and to develop an analytical Finite Element (FE) model for the T-joint systems of 2-inch fire protection piping system in hospitals subjected to seismic ground motions. In order to evaluate the FE models of the piping systems using OpenSees, two types of materials were used: 1) Steel 02 materials and 2) Pinching 4 materials. Results of the current study revealed that the nonlinear moment-rotation FE models for the threaded T-joint reconciled well with the experimental results in both FE material models. However, the system-level fragility determined from multiple nonlinear time history analyses at the threaded T-joint was slightly different. The system-level fragility at the T-joint, determined by Pinching 4 material was more conservative than that of using Steel 02 material in the piping system.

Keywords : fragility, t-joint, piping, leakage, sprinkler
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