



## ABSTRACT

Fluid–structure interaction (FSI) under seismic excitation can induce sloshing that significantly affects the dynamic response of buildings with rooftop water tanks or swimming pools, necessitating accurate modeling for reliable seismic assessment and design. This study investigated explicit FSI modeling using the Solid Elements method in SAP2000, in which solid elements represented the fluid domain and gap link elements coupled the fluid with its container. A total of six numerical models were developed and analyzed using nonlinear time-history analysis.

The first two models, a grounded tank and an elevated tank, were used to validate the Solid Elements approach against manual sloshing calculations, showing excellent agreement in maximum fluid displacement with discrepancies of only 0.001% and 0.031% after parameter adjustments; however, manual methods remained highly simplified and could not reliably capture other structural responses. The third and fourth models were adapted from previous experimental studies involving a suspended tank and a three-story building with a rooftop tank under sinusoidal and sweep excitations. Numerical analyses overestimated responses at higher amplitudes. Adjusted damping ratios of 1.4%–3.9% improved agreement with experiments, with the Solid Elements method closely matching displacement trends, while the Joint-Based and Additional Dead Load methods produced larger displacements, averaging 13.62% and 13.81% higher, respectively.

The fifth and sixth models examined a three-story prototype and a nine-story reinforced concrete building with a rooftop pool incorporating base isolation. Lead rubber bearings and high-damping rubber bearings reduced sloshing by 26.224% and 57.675%, respectively, whereas natural rubber bearings increased sloshing despite greater global displacement reduction; in the real full-scale model, lead rubber bearings reduced inter-story drift by up to 19.33% at upper floors. Although computationally more demanding, the Solid Elements method was the only approach capable of explicitly capturing sloshing and was therefore essential for accurate seismic FSI modeling.

**Keywords:** Fluid-Structure Interaction (FSI), Solid Elements, Gap Link, Sloshing Effect, Damping Ratio