Architecture and Performance of Energy Dissipators and Isolators in Bridges to Prevent Bridge Column Structural Damage

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ABSTRACT

Special devices can be used to minimize structural damage by energy dissipation or seismic isolation. This research considers High Force-to-Volume (HF2V), Symmetric Friction Connection (SFC), Asymmetric Friction Connection (AFC) and Linear-Elastic Isolators (LEI). Device architectures connecting column-to-deck and ground-to-deck are also compared. Bridge columns are assumed to remain elastic. Performance of bridge columns (peak and residual displacement) under 20 probabilistically scaled ground motions is assessed in spectral analysis (0.1-5.0sec) using reduction factors compared to a fixed, no-device case.

Energy dissipating devices have minimum column displacement reduction factors when placed between the column and the deck for rigid connection system periods up to ~2.5s. Above that fundamental period, dissipating devices connecting ground-to-deck provide the optimum configuration. Residual displacements obtained when the energy dissipators are placed between the column and the deck are larger than those of the ground to deck case for periods below ~3.7s. Above this 3.7s, frictional dissipators in the column to deck case are more efficient, but HF2V devices connecting ground to deck remain as the best alternative with no residual displacements.

The performance curves obtained in this research provide design guidelines for the best device and configuration applicable to a broad range of bridge structures.