Analytical study of a 4-Span Bridge with Advanced Materials

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Abstract

As part of a major study on the seismic response of bridge systems with conventional and advanced details, a large-scale specimen of a four-span bridge incorporating several innovative plastic hinges was recently studied on the shake tables at the University of Nevada, Reno. The bridge model included six columns, each pair of which utilized a different unconventional detail at bottom plastic hinges: superelastic shape memory alloys combined with polyvinyl fiber concrete, post-tensioned columns, and columns with built-in rubber pads as base isolators. The upper plastic hinges were of conventional reinforced concrete (RC) construction. Experimental results showed a superior performance of the innovative details compared with conventional RC in terms of damage and residual displacements. Aiming for a widespread implementation of the innovative details the engineering practice, a comprehensive understanding of the mechanics involved in the innovative details implemented in the bridge is crucial. An analytical model of the bridge was developed on OpenSees to study the performance of the bridge specimen. Several elements and solution algorithms from the OpenSees library were attempted and incorporated in the model of the bridge to replicate the response of different plastic hinges. Diverse formulations such as gap and contact elements were implemented to simulate the bridge-abutment interaction. Prior to finalizing the design, the OpenSees model was used to select the location of different piers and the shake table testing program. Post-experimental analyses show good agreement between the measured and calculated results overall. This article presents the modeling process and the correlation between the calculated and measured results.