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A Case Study on Performance of Isolated Bridges under Near-Fault Ground Motion

Authors : Daniele Losanno, H. A. Hadad, Giorgio Serino

Abstract : This paper presents a numerical investigation on the seismic performance of a benchmark bridge with different optimal isolation systems under near fault ground motion. Usually, very large displacements make seismic isolation an unfeasible solution due to boundary conditions, especially in case of existing bridges or high risk seismic regions. Hence, near-fault ground motions are most likely to affect either structures with long natural period range like isolated structures or structures sensitive to velocity content such as viscously damped structures. The work is aimed at analyzing the seismic performance of a three-span continuous bridge designed with different isolation systems having different levels of damping. The case study was analyzed in different configurations including: (a) simply supported, (b) isolated with lead rubber bearings (LRBs), (c) isolated with rubber isolators and 10% classical damping (HDLRBs), and (d) isolated with rubber isolators and 70% supplemental damping ratio. Case (d) represents an alternative control strategy that combines the effect of seismic isolation with additional supplemental damping trying to take advantages from both solutions. The bridge is modeled in SAP2000 and solved by time history direct-integration analyses under a set of six recorded near-fault ground motions. In addition to this, a set of analysis under Italian code provided seismic action is also conducted, in order to evaluate the effectiveness of the suggested optimal control strategies under far field seismic action. Results of the analysis demonstrated that an isolated bridge equipped with HDLRBs and a total equivalent damping ratio of 70% represents a very effective design solution for both mitigation of displacement demand at the isolation level and base shear reduction in the piers also in case of near fault ground motion.

Keywords : isolated bridges, near-fault motion, seismic response, supplemental damping, optimal design
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