Title Comparison of Seismic Performance of a Conventional Bridge System in Afghanistan

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Abstract

In this study, the seismic performances of an isolated highway bridge and a conventional bridge have been investigated. These bridges are located in high seismic hazard area. The isolated bridge is located in Keshim district of Badakhshan province of Afghanistan, whereas the conventional bridge is located in Taloqan district of Takhar province. The realistic seismic response behaviors of these bridges are simulated by nonlinear 3D models. The models are capable of simulating flexural yielding of piers, bi-linear behavior of isolation bearings, elastic perfect plastic behavior of elastomeric bearings of conventional bridge and other important nonlinear behaviors of these structures. Seismic response of bridges are evaluated under 7 sets of ground motion records, where each set has two horizontal components applied in longitudinal and transverse directions of the bridges, but the vertical components are ignored. The representative ground motions are selected such that their average response spectrum approximately resemble to the design spectrum of (MCE) with PGA of 0.56g. The numerical results from nonlinear time history analysis reveal that isolated bridge system is effective in reducing the displacement demand of the deck and the force demands of the piers. The normalized base shear in each pier of conventional bridge is nearly two times larger than that of isolated bridge. Large earthquake force transmitted to the piers where flexural yielding occurs in the weak direction of the conventional bridge piers. The relative deck displacement of conventional bridge exceeds the bearing deformation limit causing severe pounding between deck and abutment wall. Due to this compressive pounding force, the abutment back-fill material exceeds the yielding deformation limit. The residual deck displacement of conventional bridge in transverse direction is much higher than the bearing deformation limit because of the absence of restrainers. The isolated bridge is associated with lower deck displacement. However, the relative deck displacement of isolated bridge slightly exceeds the expansion gap at abutment location where light pounding occurs between deck and abutment of the bridge, but the compressive pounding force does not exceed the yielding deformation of the abutment back-fill material. The piers of isolated bridge remain elastic in both directions when the lower lateral force transferred to them. In conclusion, the base-isolated bridge performs better, since isolation bearing eliminate ductility demand of the piers and decrease deck displacement. The performance of isolated bridge can be further improved by providing a knock of element at the abutment back-wall location.

Keywords Isolated Bridge; Conventional Bridge; Lead Rubber bearing (LRB); Non-linear Time History Analysis; Response spectrum