8th World Conference on Structural Control and Monitoring (8WCSCM)
Orlando, FL, USA 5-8 June 2022

Evaluation Of Seismic Response Characteristics Of Bridges With Rocking Isolation Bearing System (Ribs)

Yoshihiro TAJIRI, Xinhao HE, Unjoh SHIGEKI

The application of isolation bearings on bridges has been recognized as an effective seismic response modification measure. However, when the earthquake exceeds the design expectation, the conventional rubber-type isolation bearings could introduce a higher reaction force transmitted to the substructure as the seismic response displacement increases, implying difficulties in controlling the maximum response displacement of the substructure. According to past earthquake reports, it was found that when the rocking motion of the conventional pin bearings, followed by the pulling-out of their anchor bolts, was observed, the damages to the substructure and to the flange of the girder were significantly mitigated. This can be attributed to the reduction of the inertia forces transmitted from the superstructure to the bearings when the rocking motion occurs. Motivated by this seismic isolation effect, a new rocking isolation bearing system (RIBS) was proposed, in which the maximum horizontal reaction force is adjusted by the height and width of the bearing and the energy is absorbed by the collision at the bottom of the bearing during its rocking vibration. In this study, the dynamic characteristics and the maximum response control effectiveness of an example bridge featuring such a RIBS were analytically investigated. Eighteen design ground motions corresponding to the maximum considered earthquake (MCE) specified in the design specifications in Japan and a set of harmonic ground motions with various amplitudes and periods were used as inputs. In this context, some findings are listed as follows: (1) Even though the intensity of ground motions increases, the increase of pier response is effectively mitigated due to the fuse mechanism of RIBS, which limits the maximum reaction force. (2) By utilizing the rocking mechanism of the bearing, the seismic responses of the bridge show insensitive against various dominant periods of earthquakes; obvious resonance peaks under harmonic excitations were not observed. (3) At the moment that the pier displacement reaches the maximum, the phase differences between the bearing rotation angle and the pier displacement are always in the vicinity of 90 degrees, implying desirable seismic response control effectiveness.