Experimental study on vibration behaviour and reinforcement effect of an existing bridge retrofitted by ground anchor

LIANG, Yufan  
Master Student, Department of Civil and Environmental Engineering, Waseda University, Tokyo, Japan.

Abstract

Bridges are strategic structures playing important roles in road and railway networks. Large-scale earthquakes have occurred in recent years, such as the Southern Hyogo Prefecture Earthquake in 1995 (M7.3), the 2008 Wenchuan Earthquake (M8.0), the 2011 off the Pacific Coast of Tohoku Earthquake (M9.0), and so on. They brought destructive damage to numerous construction structures including seismic designed bridge structures. Many bridges, designed and constructed based on the old “Specifications for Highway Bridges”, cannot meet the demand of increasing high-level earthquake resistance at present.

Therefore, the ground anchor retrofit method, one of indirectly retrofitting methods, has been adopted to improve the seismic performance of the existing structures such as port facility, dam, slope, and so on. According to the previous researches, the retrofit method by connecting ground anchor to the superstructure of bridge was proved to be the most effective one to improve the seismic performance of the whole bridge system by using numerical analysis. The aim of this work is to further verify the reinforcement effect of this method by conducting shaking table tests.

In this study, the prototype bridge was a typical highway bridge as shown in Figure 1. The bridge was a 5-span continuous steel plate girder bridge with a total length of 200 m. The pier pillars were constructed of reinforced concrete and the foundation was constructed of concrete piles built on Type II ground. One of the bridge piers and the portion of superstructure weigh supported by the pier were considered in this study. The scale of the model was 1:16. To investigate the vibration behavior and seismic performance of the structure, response accelerations, displacements and strains were recorded in the experiment. The detail of the experimental model and the instruments arrangement are shown in Figure 2 and Figure 3. Three types of waves were used as the input ground motions in this study. Sine waves were used to investigate the vibration properties, and the Type 1 and Type 2 seismic design waves were used to verify the seismic performance of the structure.

The ground anchor retrofit method has effective action to improve the seismic performance of bridge associating with the reinforcement amount in this test. The main findings are as follows: The response acceleration, the displacement of the superstructure and the deformation of the bearing were reduced by the introduction of ground anchor. These high performances by test result are almost the same as that by previous simulation result. To obtain more reinforcement effect, the number of ground anchors, stiffness and strength of tendons, direction and angle of the ground anchor axis, and dampers should be considered in future work.
LIANG, Yufan / MVS 2014

Figure 1. Prototype bridge & concerned pier (P1)

Figure 2. Experimental model (front view & side view) and instruments arrangement

Figure 3. Photo of the experimental model

References


