

Seismic Strengthening Design and Construction of Rocking Piers of a Road Bridge

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1 Abstract

On April 14, 2016, an earthquake of magnitude 7.3 hit in Kumamoto Prefecture, Japan. 12 bridges were damaged and could not be restored in a short time, significantly impacting the transportation of relief supplies through emergency roads to the disaster areas. Among them, an expressway bridge supported by rocking piers collapsed, which had never occurred in past earthquakes. The collapse was caused by the failure of restraint details on an abutment. The rocking piers, however, failed to prevent the superstructure from falling subsequently, because the pier joints with the girders and pile caps were all hinges that provided no restraint to superstructure. With this collapse as a starting point, seismic strengthening of bridges with rocking piers has started being implemented all over Japan. The authors' company launched a strengthening project in July 2017. Among the expressways under our management, the Tomei Expressway has the largest traffic volume. Any bridge falling of the expressway may cause enormous damage. This paper presents a strengthening design and construction of a bridge in the Tomei Expressway for its rocking piers. The rocking piers were strengthened by installing braces between each two neighboring piers. In addition, based on a nonlinear dynamic analysis, the pile caps under the piers were strengthened by thickening the cross section area and rigidizing their joints with the piers using reinforced concrete, in order to provide sufficient shear and bending capacity. The pivot bearings of the piers that support the girders were also strengthened, by installing restrainers and side surface steel plates. The strengthening construction was started in August 2018 and completed in March 2019.

Keywords: expressway bridge; rocking pier; seismic strengthening; bearing restrainer; reinforced concrete; anchor; bracing system; rigid connection; nonlinear dynamic analysis

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