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Seismic Retrofit using the Largest Viscous Damper in Japan

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ABSTRACT

The Tatara Bridge is a cable-stayed bridge with a center span 890m. The seismic verification analyses of the existing conditions were carried out with the aim of further improving the seismic performance of this bridge. The results of the analyses for the bridge revealed the considerable sway-mode vibration in longitudinal direction was dominant during large-scale earthquakes, and so seismic devices such as eight viscous dampers and stoppers were found to be necessary to mitigate the vibration. It was decided to install the largest viscous dampers in Japan with a damping resistance force of 2,000kN and a stroke of ±950mm at two towers. Before the installation, the performance tests assuming actual bridge conditions during earthquakes were conducted on one representative damper using a vibration table (length 20m × width 15m, maximum displacement ±1,000mm) owned by the National Research Institute for Earth Science and Disaster Resilience. Since the tests showed that one representative damper had the required performance, it was determined that the performance test was not necessary for the remaining seven dampers by considering a method of the performance verification. This paper describes the performance test of the representative damper and the performance verification method of the remaining seven dampers.

Keywords: Seismic Retrofit, Viscous Damper, Performance Verification, Seismic Verification, Cable-Stayed Bridge.

1 INTRODUCTION

Japan consists of four main islands and numerous surrounding islands. Two of the major islands, Honshu and Shikoku across Seto Inland Sea, are connected by Honshu-Shikoku Bridge Expressways which consists of three routes, Kobe-Awaji-Naruto Expressway, Seto-Chuo Expressway and Nishi-Seto Expressway (Figure 1). There are three cable-stayed bridges in the Nishi-Seto Expressway, the westernmost route of HSBE; Shin-Onomichi Bridge, Ikuchi Bridge, and Tatara Bridge. The Tatara Bridge (Spans: 270 m + 890 m + 320 m = 1480 m), which opened to traffic in 1999, is a 3-span continuous cable-stayed bridge with a composite box girder of steel and prestressed concrete as shown Figure 2.

The HSBE is undergoing seismic retrofit of the long-span bridges, which are important structures with no alternative route, because of the anticipated occurrence of large-scale earthquakes. As the result of seismic performance verification of the Tatara Bridge, it was found that the adjacent viaduct may collapse due to large displacement in longitudinal direction of Tatara Bridge [1].

As an improvement in seismic performance, it was necessary to install viscous dampers with damping resistance force 2,000 kN and stroke ±950 mm, which is the largest in Japan to control the

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