Efforts of Seismic Retrofit：The Future Challenge of Innoshima Bridge Beyond 40 Years of Service

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Abstract

Innoshima Bridge, which was opened for traffic in 1983, is a three-span, two-hinged stiffening truss girder suspension bridge with a center span of 770 meters, featuring a double-deck structure with the upper level for motor vehicles and the lower level for bicycles and pedestrians. In response to large-scale earthquakes, the bridge is required to have the performance that limits seismic damage to a minimum and enables a swift rehabilitation of its functionality. The results of the seismic performance evaluation revealed damage to various members in the bridge. Therefore, it is decided to conduct seismic retrofit to the damaged members, such as installation of viscous dampers to reduce the seismic forces, addition and replacement of the structures around the wind tongues, and some other reinforcements. This paper presents a report on the seismic performance verification and retrofit design of Innoshima Bridge.

Keywords: suspension bridge; double-deck structure; seismic performance verification; seismic retrofit design; viscous damper.

1 Introduction

Japan consists of four main islands and numerous surrounding islands. Two of the main islands, Honshu and Shikoku across Seto Inland Sea, are connected by Honshu-Shikoku Bridge Expressways, which consist of three routes, Kobe-Awaji-Naruto Expressway, Seto-Chuo Expressway and Nishi-Seto Expressway (Figure 1). Innoshima Bridge (spans: 250 m + 770 m + 250 m = 1,270 m) (Figure 2), opened to traffic in 1983, is the first suspension bridge of the Honshu-Shikoku Bridges on the Nishi-Seto Expressway, the westernmost route of Honshu-Shikoku Bridge Expressways. As shown in Figure 3, Innoshima Bridge is a 3-span, 2-hinged stiffening truss girder suspension bridge, featuring a double-deck structure (Figure 4) with the upper level for motor vehicles and the lower level for bicycles and pedestrians.

Two tower links are installed on each main tower location (at the side and center span), and two end links are installed on each anchorage location. One wind shoe and one wind tongue are installed at each main tower location (at the side and center span) and each anchorage location.

The seismic design of the bridge at the time of construction was based on the original seismic design code [1]. However, according to the latest findings, an inland near-field earthquake was not considered in this code, and there is a concern that a large-scale earthquake exceeding the original design seismic force would occur. In response to large-scale earthquakes, such as the anticipated Tonankai-Nankai earthquakes in the near future, the bridge is required to have the performance that limits seismic damage to a minimum and enables a swift rehabilitation of its functionality [2] as an important structure with no alternative route.