

Uplifting Slide Bearing (2) – Verification Tests of Seismic Response –

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Summary

A new type of slide bearing characterized by horizontal and inclined sliding surfaces was developed. With the application of this bearing, which will be referred to as Uplifting Slide Bearing, girders are allowed to move on the horizontal sliding surface during temperature changes while sliding takes place on the inclined sliding surface for large displacement response in case of strong earthquakes. The kinetic energy of the superstructure will be transformed to the gravitational potential energy during the sliding on the inclined sliding surfaces, thus controlling the seismic response and the distribution of inertia force. In order to evaluate the influence of this impact, component tests as well as shaking table tests using a shaking table were performed. As a result, we could verify the characteristic of a collision at the beginning of the inclined sliding surface.

Keywords: bearing, potential energy, slide, friction, impact load, seismic isolation, seismic response, continuous girder, component test, shaking table test

1. Introduction

The Hyogo-Nanbu earthquake of 7.3 magnitude hit Japan in 1995 and caused significant damage to lifeline structures, long bridges and elevated bridges. In particular, many old bridges adopted a simple supported structure had severely collapsed. Because of this, most of new bridges built after the earthquake was built with a continuous girder system having seismic isolations¹⁾. The seismic isolation system ensures a high level of safety during an earthquake by absorbing energy as the bearings deform. In addition, a multi-span continuous girder system can significantly improve the seismic performance by making it an indeterminate structure and reducing a number of girder ends. During ordinary conditions however, indeterminate forces are induced in continuous girders by the thermal expansion and contraction, and therefore, it may be sometimes difficult to adopt such a multi-span continuous system. At the same time, their expansion joints tend to become larger as the girders largely displace during an earthquake, resulting in a weak point in maintenance. Furthermore, seismic isolation bearings generally have a higher initial cost and life cycle cost. Under this situation, we developed a new type of bearing²⁾ has been developed which ensures a safety during earthquakes, while restricting the amount of seismic displacements, enabling displacements to be controlled and minimizing indeterminate forces due to thermal effects.

2. Design Concept

A hybrid bearing so to call Uplifting Slide Bearing which has both horizontal and inclined sliding surfaces has been proposed (See Fig. 1). During an ordinary condition, the horizontal sliding bearing supports vertical reactions from the superstructure. During an expansion and a contraction of girders due to thermal effects, no other than friction force is applied to the piers as the bearings slide horizontally. On the other hand, during an earthquake, the superstructure displaces horizontally, and when the displacement exceeds the clearance, it touches the inclined surface and then moves upward along the inclined sliding surface. This behavior is