Uplifting Slide Bearing (3) －Development of the Analytical Model－

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Summary

A new type of slide bearing, called "Uplifting Slide Bearing", was developed [1]-[5]. It has characterized by horizontal and inclined plane sliding surfaces. Girders are allowed to move on the horizontal plane slide surfaces during temperature changes, what is more, the sliding takes place on the inclined plane slide surfaces for large displacement response in case of strong earthquakes. Unfortunately, the impact phenomena were observed from the experimental tests with the shaking table to check the new system.

In this paper, the analytical model to simulate the Uplifting Slide Bearing actions including the impact phenomena was proposed by using the several non-linear springs. Results of comparison with experimental tests, the analytical results were well corresponding to the experimental test results including the impact actions.

Keywords: bearing, potential energy, slide, friction, impact load, seismic isolation, seismic response control, continuous girder bridge, nonlinear dynamic response analysis, spring model

1. Introduction

In Japan, due to the Hyogo-Nanbu earthquake of 7.3-magnitude that occurred in 1995, huge damage was caused to lifeline structures, long-span bridges and elevated bridges. In particular, many old bridges designed with a single supported structure had severely collapsed. Because of this, the Japanese highway design specimen was revised [6], and most of the new bridges built after the earthquake were constructed with a continuous girder system to improve seismic isolations. The seismic isolation system ensures high level of safety during earthquake by absorbing energy as the bearings deform. In addition, a multi-span continuous girder system can significantly improve the seismic resistance 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 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, a new type of bearing has been developed which ensures safety during earthquakes, while restricting the amount of seismic displacements, enabling seismic displacements to be controlled and minimizing indeterminate forces due to thermal effects.

2. Design concept

A hybrid bearing, which has both horizontal and inclined sliding surfaces, has been proposed (See Fig. 1). During an ordinary condition, horizontal sliding bearing supports vertical reactions from the superstructure as shown in Fig.1 (a). During expansion and 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

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