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A study on the damage development process of steel rigid frame bridge piers with rocking columns

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Abstract

In the Hanshin Expressway, seismic retrofitting measures have been carried out since before, and the measures have also been carried out without exception on bridges with rocking piers. However, some bridge of rocking piers were collapsed in 2016 Kumamoto earthquake. Kumamoto earthquake revealed the instability and fragility of rocking piers. In this study, the damage development process of steel rigid frame piers with rocking columns was evaluated by pushover analysis. As a result of the study, it was verified that in the examination target bridge pier, the rocking column was not damaged ahead of other components. From these results, the target bridge pier has sufficient seismic performance and it has extreme low probability to occur severe damage that leads to collapse.

Keywords: Rocking column, steel rigid frame pier, pushover analysis, seismic performance evaluation

1 Introduction

In the Kumamoto earthquake which occurred in April, 2016, the maximum seismic intensity of 7 was observed, and the large aftershocks continued afterwards. It caused severe damage about houses and infrastructure facilities, and two bridges resulted in collapse (excluding those due to slope failure, etc.). Since one of these bridges was the overbridge (the name is the Furyo First Bridge) which crossed the Kyushu Expressway, some sections of the expressway were lost the function as an emergency transportation route. Figure 1 shows the collapse situation of the Furyo First Bridge [1]. The said bridge (hereafter referred to as rocking bridge) had bridge piers (hereafter referred to as rocking piers) composed of rocking columns (Figure 2 shows the definitions of name in this paper). Pivot bearings were installed at the upper and lower ends of the rocking column. These bearings have vertical support function and rotational function, but do not have horizontal force support function. Therefore, the rocking bridge has a structural characteristic that it becomes unstable when large displacement beyond the allowable rotation angle is generated [2]. Though the lateral displacement restraint equipment's were installed in the abutment of the bridge for seismic retrofitting, they were destroyed by the large seismic force. The collapse

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