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Seismic Performance of Self-Centering UHPC Retainers Applied to Medium-Small Span Concrete Bridges

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1 Abstract

Seismic resistant retainer is an important component for seismic design of the medium-small span bridges. However, it's difficult for the bridge engineers to design a reasonable transverse retainer due to deficiency of design detail in most of current seismic design specifications. Therefore, this paper proposed a prestressed prefabricated concrete retainer that utilize the ultra-high performance concrete (UHPC). Firstly, the structural characteristics and the seismic design method of the new proposed retainer is illustrated. The OpenSEES model of the case-study bridge were simulated by considering three different types of seismic resistant retainers. A total of ten high intensity ground motions were selected to conduct the nonlinear time history analysis (NTHA). Subsequently, to investigate the seismic performance of the proposed UHPC retainer, this paper performs the comparative study of seismic responses for different bridge components. It is concluded that, the proposed retainer can provide excellent displacement capacity and help to reduce the seismic damage of bridge piers significantly. In addition, the new retainer has strong ability to keep self-centering to help the bridge reducing the residual displacement of superstructure under strong seismic events. The proposed UHPC retainer is applicable to the rapid prestressed prefabricated construction process and has a clear load transfer mode under earthquake actions. Therefore, it is a good candidate to the multi-level performance-based seismic design of the medium-small span bridges.

Keywords: bridge engineering; seismic analysis; mechanical model; UHPC retainer; design method

2 Introduction

The medium-small span girder bridges in China used to adopt the plate-type elastomeric bearing (PTEB) which neither attached to the main girder nor anchored to the cap beam of the bridge columns[1]. Therefore, the bridge girder is easy to slide under the earthquake, resulting in violent collision between the main girder and the transverse retainers (shear key). Consequently, the damage rate of transverse retainer is much higher than that of the concrete piers. For example, in the 2008 WENCHUAN Earthquake, the damage rate of the concrete retainers for simple supported girder bridges is up to 16.8%, while the damage rate of concrete piers is only 2.4%[2]. However, due to the lack of detailed design method, the practical seismic design procedure of concrete retainer is mainly based on the subjective judgment of engineers.

Actually, it is particularly important to develop suitable seismic design for the retainers. On the one hand, if the restraint effect of the retainer on the main girder is too weak, the transverse displacement of the girder will be too large and even will lead to the girder falling. On the other hand, if this constraint effect is too strong, serious damages tend to occur for concrete columns. The

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