Seismic Performance of the High-Pier Long-Span Continuous Rigid Frame Bridges Composed of the Ultra-High Performance Concrete

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Summary

Structural overweight is a significant defect to limit the development of the traditional long span rigid frame bridges. Thus, an alternative ultra-high performance concrete (UHPC), named as reactive power concrete (RPC), has been proposed to improve this problem. The previous researches mainly focused on the material experiment of RPC component and some meaningful conclusions were obtained from the experiment. However, on the one hand, the weight loses of the RPC superstructure can apparently increase the span of the bridge and decrease the seismic force of the high-pier; on the other hand, the high performance of the RPC can strengthen the seismic capacity of the RPC piers to promote the seismic behavior of the whole bridge. Therefore, in this study, three contrastive schemes are designed to compare with the original design scheme which is a typical high-pier long-span (HPLS) continuous rigid frame bridge composed of normal concrete (NC). In addition, a simple economic analysis is conducted to select the optimum scheme. It is concluded that it is more efficient and effective to choose the UHPC as the main material for the HPLS bridges. Even though the UHPC can be applied to all components of the bridge which performs the best seismic behavior, it is more economic and appropriate for using UHPC only on the superstructure.

Keywords: ultra-high performance concrete (UHPC); reactive powder concrete (RPC); seismic performance; earthquake; high-pier and long-span (HPLS)

1. Introduction

With the development of the national highway transport net, more and more government investments are partial to the mountain zones, where deep valleys are found everywhere. In order to conquer this special topography, we are able to extend the span of bridge. It is such a good option for the application of the high-pier long-span (HPLS) continuous rigid frame bridges in valley zones. However, on the one hand, the seismic damage investigation of bridges in 2008 Wenchuan Earthquake shows that the HPLS bridges suffered huge damage, such as span collapse, crushing of column concrete and destruction of expansion joint [1]. In addition, it should be noted that, most of the HPLS bridges are the significant and controlling projects of the highway or railway system. Consequently, indirectly, these earthquake damages can lead to more unwanted deaths and serious economic losses. On the other hand, the overweight of the dead load impeded the development of large span concrete bridges. Previous research indicates that the dead load accounts for about 60% of the total load for the medium-span and pre-stressed concrete bridges, but this ratio will increase up to 85% for the large span pre-stressed concrete bridges [2]. As is known to all, the top-heavy structural character is so detrimental to the seismic performance of bridge that it is significant and necessary to seek a new way to reduce the weight of conventional superstructure and improve its structural behaviour. Traditionally, lightweight concrete girder and steel box girder were applied

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