

Experimental Studies on Seismic Performance of Rigid-frame Extradosed Cable-stayed Bridges

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1 Abstract

With the aim of further understanding the seismic performance of extradosed cable-stayed bridges, this paper presents an experimental investigation of a three-pylon rigid-frame extradosed cable-stayed bridge by conducting 1/20 scaled longitudinal shake tables model tests at the laboratory of Tongji University, Shanghai, China. The design, construction and testing protocol of the test model are firstly introduced. Observation of the seismic damage situation and empirical data on the seismic responses of the test model are then provided. The test results show that: (1) severe seismic damage appeared at the bottom and upper parts of piers and damage at the bottom parts were much heavier; (2) no damage was observed on short pylons; (3) structural stiffness degradation occurred when $PGA \geq 0.4g$; (4) the vibration of the short pylon almost has no contribution in the displacement at the pylon top.

Keywords: extradosed cable-stayed bridge; shake table test; model design; longitudinal destructive test; seismic damage.

2 Introduction

Extradosed cable-stayed bridges, considered as an intermediate bridge structure between continuous girder bridges and cable-stayed bridges, prove to be an economical choice for medium span bridges and are becoming more and more popular in the world [1], especially in China, where more than 50 extradosed cable-stayed bridges have been built in the last 20 years [2].

However, China is one of the active seismic zones in the world. In the past, the 1976 Tangshan earthquake (M7.8), the 1999 Chi-Chi earthquake (M7.3) and the 2008 Wenchuan earthquake (M8.0) took place and resulted in severe damage of bridges, which provided the routes for the post-earthquake

rescue. With the collapse of bridges, the transport routes were cut off and the emergency rescue was hindered. Since the demand of extradosed cable-stayed bridge construction has increased greatly, assessing the seismic performance of them for various seismic hazard levels is of paramount importance now.

So far, there have been some studies carried out by researches around the world to investigate seismic performance of extradosed cable-stayed bridges. D. Kim [3] evaluated the seismic risk for small and medium scaled earthquakes on an extradosed cable-stayed bridge with and without lead rubber bearings (LRB). Q. Hao [4] studied the dynamic characteristics and seismic responses of a semi-floating system extradosed cable-stayed bridge