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Cold Retrofit Method Study for Fatigue Cracking of Steel Bridge

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Abstract

Lots of steel bridges have endured performance challenge from fatigue cracking problem. Therefore, research on retrofit methods for fatigue cracking in steel bridge is very important. To avoid introducing new fatigue details during retrofit process, cold retrofit study is encouraged and focused in this paper by two experimental studies. The first is cold retrofit for orthotropic steel bridge deck. Fatigue test of a full-scale orthotropic steel bridge deck was conducted and different retrofit methods were applied to the fatigue damaged deck, including drilling stop holes and bonding steel plate. Test result shows bonding steel plate is an effective retrofit method. The second is cold retrofit for steel girder with gusset plates for lateral braces, since out-of-plane distortion often happens in the web gaps between the flange plates and vertical stiffeners, which leads to initiation and propagation of fatigue cracks. Fatigue test was carried out to study the fatigue mechanism and to verify the effectiveness of cold retrofit method, as well as the fatigue performance of post-retrofitted details. Different retrofit methods were experimentally studied, including drilling stop holes, bonding or bolting angle steel. The study result shows cold retrofit method can retard distortion-induced fatigue cracks. Based on the experimental study above, bonding angle steel method was applied to orthotropic steel deck of a long span cable-stayed bridge.

Keywords: steel bridge; fatigue crack; cold retrofit method; orthotropic steel bridge deck; distortion-induced fatigue; full-scale fatigue test.

1 Introduction

Steel bridges are vulnerable to suffer fatigue damage due to the coupled actions of traffic load, environment effect, construction quality and insufficient consideration of fatigue in the previous design. Fatigue cracks seriously affect the service safety of steel bridges. More than 40 welded bridges collapsed between the year of 1938 and 1940, causing serious economic and life loss [1]. In Canada, the superstructure of a three-span continuous steel plate girder bridge built in 1965 had to be replaced because of large quantities of fatigue cracks [2]. Since reform and economic development in China, lots of highway steel bridges have been built in the past three decades. Due to the improper fatigue design, poor weld quality, and increasing vehicle load and traffic volume, fatigue problems were also occurred in some steel bridges, even some newly-built steel bridges, such as Humen Bridge, Haicang Bridge, Jiangyin Yangtze River Bridge [3-4].

Several research projects on retrofit methods of fatigue cracks in steel bridges have been conducted in USA, Japan, Canada and other countries, many researchers have conducted pioneering research work to develop effective retrofit methods [2]. Kolstein installed stop hole on the fatigue crack hole, and bolted steel plate on the cracking region by the high tensile bolts [5]. Test result showed the fatigue life of strengthened structure is 20 times of the original

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