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CFRP Strengthening and Long-Term Monitoring of an Old Metallic Roadway Bridge in Melbourne

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Abstract

This study gives an overview on carbon fibre-reinforced polymer (CFRP) strengthening and wireless sensor network (WSN) monitoring of a 121-year-old metallic roadway bridge in Melbourne, Australia. A flat prestressed unbonded retrofit (FPUR) system was developed to apply prestressed CFRP plates to the steel cross-girders of Diamond-Creek Bridge. The bridge is subjected to daily passenger and heavy truck vehicles. Sets of laboratory tests were performed to examine the efficiency and fatigue performance of the proposed FPUR system, prior to its installation on the bridge. Furthermore, in order to demonstrate the efficiency of the proposed retrofit technique, the bridge was instrumented with different types of sensors (including strain gauges, temperature and humidity sensors), and short- and long-term measurements were performed. As for short-term measurements, the bridge was loaded by a 42.5-tonne semi-trailer before and after strengthening. For the long-term monitoring, a WSN system was used to monitor the prestress level in the CFRP reinforcements for at least one year. The CFRP plates were prestressed up to about 980 MPa (≈38% of the CFRP ultimate strength), which resulted in about 50% reduction in the maximum tensile stress in the bottom flanges of the strengthened I-girders. The results of the short- and long-term measurements in this study showed that the proposed FPUR system can be very effective for flexural and fatigue strengthening of such bridge girders.

Keywords: Wireless sensor network (WSN) system; long-term structural health monitoring (SHM); prestressed CFRP plates; metallic bridges.

1. Introduction

In Europe, approximately 30% of the metallic bridges are older than 100 years and nearly 70% of them are more than 50 years old [1]. Therefore, strengthening of such old metallic bridges has attracted much interest over the last decade. Carbon fiber-reinforced polymer (CFRP), a light material with a wide range of strengths and Young's moduli, has been used for strengthening concrete and steel members. CFRP materials have high corrosion and fatigue resistance [2]. Several studies have proven the effectiveness of using

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