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Wireless structural health monitoring of stay cables under two consecutive typhoons

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Abstract. This study has been motivated to examine the performance of a wireless sensor system under the typhoons as well as to analyze the effect of the typhoons on the bridge's vibration responses and the variation of cable forces. During the long-term field experiment on a real cable-stayed bridge in years 2011-2012, the bridge had experienced two consecutive typhoons, Bolaven and Tembin, and the wireless sensor system had recorded data of wind speeds and vibration responses from a few survived sensor nodes. In this paper, the wireless structural health monitoring of stay cables under the two consecutive typhoons is presented. Firstly, the wireless monitoring system for cable-stayed bridge is described. Multi-scale vibration sensor nodes are utilized to measure both acceleration and PZT dynamic strain from stay cables. Also, cable forces are estimated by a tension force monitoring software based on vibration properties. Secondly, the cable-stayed bridge with the wireless monitoring system is described and its wireless monitoring capacities for deck and cables are evaluated. Finally, the structural health monitoring of stay cables under the attack of the two typhoons is described. Wind-induced deck vibration, cable vibration and cable force variation are examined based on the field measurements in the cable-stayed bridge under the two consecutive typhoons.

Keywords: structural health monitoring; wireless sensor system; cable-stayed bridge; cable force variation; vibration responses; PZT dynamic strain; wind; typhoon

1. Introduction

For a cable-stayed bridge, critical damage may be occurred in main structural components such as deck, cable, and pylon due to stiffness-loss, crack growth, and concrete degradation. Around the world, many researchers have attempted to develop structural health monitoring (SHM) systems for cable stayed bridges (Ko and Ni 2005, Rice and Spencer 2009, Cho *et al.* 2010a, Jang *et al.* 2010, Spencer and Cho 2011, Ho *et al.* 2012a). For the cable stayed bridge, the loss of cable force is a severe damage type which may lead to the instability in the cable-anchorage subsystem and eventually the failure of the bridge system unless appropriately treated. Therefore, the cable forces should be secured by a suitable monitoring system that can identify the loss of cable force and assess its effect on the serviceability of the bridge system.

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