

Evaluation of torsional response of a long-span suspension bridge under railway traffic and typhoons based on SHM data

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Abstract. Long-span cable-supported bridges are flexible structures vulnerable to unsymmetric loadings such as railway traffic and strong wind. The torsional dynamic response of long-span cable-supported bridges under running trains and/or strong winds may deform the railway track laid on the bridge deck and affect the running safety of trains and the comfort of passengers, and even lead the bridge to collapse. Therefore, it is eager to figure out the torsional dynamic response of long-span cable-supported bridges under running trains and/or strong winds. The Tsing Ma Bridge (TMB) in Hong Kong is a suspension bridge with a main span of 1,377 m, and is currently the world's longest suspension bridge carrying both road and rail traffic. Moreover, this bridge is located in one of the most active typhoon-prone regions in the world. A wind and structural health monitoring system (WASHMS) was installed on the TMB in 1997, and after 17 years of successful operation it is still working well as desired. Making use of one-year monitoring data acquired by the WASHMS, the torsional dynamic responses of the bridge deck under rail traffic and strong winds are analyzed. The monitoring results demonstrate that the differences of vertical displacement at the opposite edges and the corresponding rotations of the bridge deck are less than 60 mm and 0.1° respectively under weak winds, and less than 300 mm and 0.6° respectively under typhoons, implying that the torsional dynamic response of the bridge deck under rail traffic and wind loading is not significant due to the rational design.

Keywords: torsional response; long-span suspension bridge; railway traffic; typhoon; structural health monitoring

1. Introduction

Long-span cable-supported bridges are flexible structures susceptible to various types of loads such as highway and railway traffic and winds. Heavy trains running deviating from the longitudinal central line of the deck generate eccentric forces acting on the deck which would induce torsional response of the bridge. If a long-span railway bridge is built in a wind prone area, the bridge will also experience torsional vibration due to aerodynamic effects. The torsional vibration of the bridge due to running trains or strong winds or both may deform the railway track

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