An experimental study of cable tension identification based on measurements of mode shapes

Zhan-hang Liu, Lin Chen, Li-min Sun

Department of Bridge Engineering, Tongji University, Shanghai 200092, China

Yi-qing Zou

Liuzhou OVM Machinery Ltd., Liuzhou 545006, China

Contact: liuzh1016@gmail.com

Abstract

Cable tension identification based on mode shapes extracted from vibration measurements is a relatively new method. In this method, the cable is equivalent to a beam model hinged at its ends and under axial tension with an unknown length to eliminate the effects of boundary conditions. This study focuses on the influences of sensor arrangement in the measurements on the accuracy of the tension identification. For this purpose, full-scale cable experiments have been carried out, where a number of sensors were attached to the cable to record cable acceleration during artificial excitation. The eigenvalue realization algorithm (ERA) has then been applied to identify the mode shapes and frequencies of the cables from the multiple acceleration measurements. The effects of different sensor arrangement schemes and cable tension identification method based on higher-order modes are compared and discussed.

Keywords: cables; tension identification; experimental study; ERA; mode shapes.

1 Introduction

Cables are important structural members of cable-supported bridges. Accurate identification of cable tension is of great importance for safety assessment and maintenance decisions. At present, the methods of cable tension identification mainly include pressure gauge method [1], pressure sensor method [1], three-point bending method [2], magnetoelastic method [3], Fiber Bragg Grating Sensor method [4], and vibration method [5]. Among them, the vibration method is widely used because of its accuracy and convenience. Cable tension identification based on mode shapes is a relatively new method popular in recent years. This method is particularly advantageous in terms of accuracy for short cables with complex boundaries [6][7].

The basic theories of the vibration method mainly include the string theory and the beam theory. However, both theories are derived based on the boundary of hinged ends, and the direct use for measurement of complex boundary types has a large error.

In recent years, Chen et al. [6][7][8] proposed a cable tension identification method based on mode shapes extracted from vibration measurements and conducted the theoretical analysis. As a relatively novel method, this method

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