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A new method for cable shape finding of self-anchored suspension bridges

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1 Abstract

This paper proposes a new overall coordinate method (OCM) to determine the cable shape of self-anchored suspension bridges. In this method, the initial cable shape between adjacent clamps is assumed to be linear and the target cable shape is calculated by iterations based on the overall equilibrium of forces. This method is used to calculate the cable shape of the Chishui Bay Bridge in Hebei Province by MATLAB, and the results are compared with the measured data. The comparison shows that the OCM has a fast convergence speed and high accuracy.

Keywords: self-anchored suspension bridges; shape of cable; overall mechanical analysis; coordinate system; ChiShui Bay Bridge.

2 Introduction

The self-anchored suspension bridge is geometric nonlinear and complicated. In the early 18th century, Euler concluded that the cable shape is a parabola under a load that is uniformly distributed along the span and whose horizontal component force is calculated as a constant value[1]. Gilbert then investigated problems of a cable under a uniform stress[1], and Bernouilli proposed that the cable in the finished stage has a catenary shape[2]. Subsequently, the catenary method and parabola method were combined by Shen to determine the shape of the unloaded main cable of suspension bridges with higher precision[3]. With the understanding of the structural system and mechanical characteristics of suspension bridges improving, engineers proposed that the cable shape of a self-anchored suspension bridge in the finished stage is segmental catenary, and Tang promoted the segmental catenary method (SCM)[4]. Then, Kim proposed a new algorithm that combines the target configuration under dead load method and successive substitution of the initial force method based on elastic catenary elements and the Newton iteration method[5]. In order to simplify the calculation, Sun proposed a simplified segmental catenary unit method[6-7].

The calculation method of cable shape finding is constantly revised based on the widely used segmental catenary method. The Specifications for Design of Highway Suspension Bridge in China (JTG/T D65-05-2015) uses the SCM to calculate the cable shape of both self-anchored and ground anchored suspension bridges[8]. This paper proposes a new overall coordinate method (OCM) to improve the accuracy and efficiency of the cable shape finding of self-anchored suspension bridges.

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