Decision Method on Reasonable Design State of Self-anchored Suspension Bridge with Spatial Cables

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Summary

According to the inherent requirements of self-anchored suspension bridge with spatial cables subjected to loads, the global flow to determine its reasonable design state is clarified. Proceeding from that the internal force state (especially bending moments) of the girder should be reasonable, the method to calculate the vertical component force of hanger is obtained. Based on both the fundamental analytical equations of spatial main cable shape-finding and the method to calculate the vertical component force of hanger, the specific procedure and approach to find the shape of spatial main cable and to calculate the parameters of hanger in the reasonable design state are developed with ensuring the convergence. According to the condition that the hanger in the reasonable design state only inclines in the cross direction, the recursive formula to calculate the line shape change stiffness of spatial cable are deduced. Thus, the highly efficient and precise method with clear route and definite conception is established, which is convenient for programming and deciding the reasonable design state of self-anchored suspension bridge with spatial cables. The efficiency and accuracy of the method in this paper has been well demonstrated by the case study on the Hangzhou Jiangdong Bridge.

Keywords: bridge engineering; self-anchored suspension bridge with spatial cable; reasonable design state; calculation process; analytic method; stiffness of cable while it's shape changing

1. Introduction

Because of the three-dimensional shape formed by the main cables and hangers, the self-anchored suspension bridge with spatial cables could have a broader application for its better sight effect, anti-wind ability and dynamic performance[1][2]. Up to now, there are more than ten bridges which have been built up or are under construction, such as the Yongjong Grand Bridge in Korea[3], the San Francisco-Oakland Bay Bridge in America[4], the Liede bridge in Guangzhou[5] and the Jiangdong Bridge in Hangzhou[6].

During the designation of a suspension bridge, generally at first, the parameters of reasonable design state are determined according to the experience and overall arrangement of the bridge, such as the control point coordinates of the main cable (including anchorage point and IP point), ratio of sag to span, hanger arrangement and bridge deck line shape. Then, the line shape, force and unstrained length of the main cable, and the unstrained length of the hanger are calculated. Finally, the free state of the main cable can be successfully acquired by relating the above-mentioned results to the reasonable design state (the unstrained length of every structural part remains unchanged). Thus, it is crucial to decide the reasonable design state of a suspension bridge.

It was demonstrated in the literature[3] how to decide its reasonable design state of self-anchored suspension bridge with spatial cables, the Yongjong Grand Bridge in Korea. It was assumed that the vertical component force of each hanger was equal to the self-weight of the beam segment which the hanger loaded, and the reasonable design state was decided according to the following procedure: ①Regarding the main cable and each hanger as segmental straight line(supposed as n segments) and straight line, the coordinates of each separated node (including 2(n-1) unknown

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