Study of The Fatigue Problem of The Side Suspender of Multi-span Cable-stayed Suspension Bridge

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Summary

Because of the giant stiffness difference between cable-stayed system and suspension system, the side suspender (which means the outermost suspender) of the cable-stayed suspension bridge will suffer large stress amplitude during its operational period. If not handled properly, the side suspender would damage because of fatigue problem. This paper summarizes the main aspects that influent the fatigue problem of the side suspender, including the quantity of suspenders in the binding region, the cross-sectional area of the side suspender, the rise-span ratio of the main cable, the central buckle, the height of the stiffening girder, and the stiffness of mid-tower. A finite-element model, with a span arrangement of 304+1024+1024+304m, is established to study the influence of those aspects to the stress amplitude of the side suspender. Some results and useful recommendations about the prevention of the fatigue damage of the side suspender are presented.

Keywords: multi-span; cable-stayed suspension system; side suspender; fatigue.

1. Introduction

Accompanied with the evolution of cable supported bridges, the idea of combining the suspension system with the cable-stayed system has occurred, although this system has not been chosen for actual construction of a major bridge since the days of the Brooklyn Bridge [1]. Roebling introduced some cable-stays in suspension bridges to reduce deformability, using cable-stayed system as just a strengthen part for suspension system. Through the rational arrangement of the cable-stayed and suspension part, engineers today can design a more economical and mechanical system to have those two parts work together. Nowadays, cable-stayed suspension bridge is recognized as one of the most feasible structural concepts for bridges with super long spans [2] [3].

In the binding region of the stay cables and the suspenders, because of the giant stiffness difference between suspension system and cable-stayed system, the side suspender of the cable-stayed suspension bridge will suffer large stress amplitude under live loads. Therefore, if the stress amplitude is greater than the endurance limit of the suspender material, suspender would damage because of fatigue problem. In this paper, the fatigue problem under operation state of the side suspender is studied, based on the analysis of one three-tower cable-stayed suspension bridge. Various parameters that impact the stress amplitude are studied in order to find effective measures to reduce the stress amplitude of the side suspender.

2. Structure modelling

The cable-stayed suspension bridge considered in this paper has three towers, with a span arrangement of 304+1024+1024+304m, and each side span has two auxiliary piers. The 1024m main span is composed by the 304m cable-stayed parts on each side and the 416m suspension part in the middle. The rise-span ratio of the main cable is 1/6.65. Structural arrangement is shown in Figure 1; Table 1 shows the main parameters for the bridge.

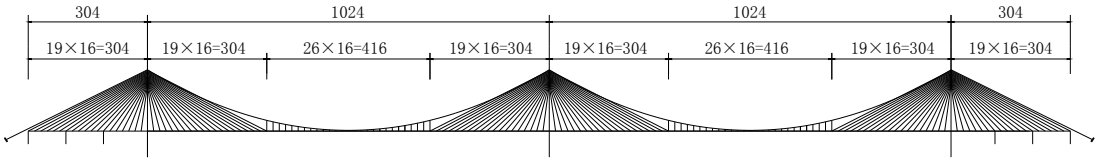

Fig. 1: Structural arrangement of the multi-span cable-stayed suspension bridge(m)

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