Arranging geometric configuration of cable-stayed bridges taking fatigue into account

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Summary

Correct design of cable-stayed bridges is a key issue in bridge engineering in order to reach structural efficiency, maintaining adequate structural performance during time, respecting safe life. A good performance design of cables in strand bridges could be reached locally by adopting specific structural details in order to minimize fatigue stresses, and globally by geometrical optimization of cables. This paper introduce the general problem of optimal arrangement for cable-stayed bridge taking into account fatigue phenomena. Parametric analyses related to various geometric configurations of the cables are developed and some new insights for arranging geometric configuration of cable-stayed bridges are shown.

Keywords: Steel bridge; fatigue; cable-stayed; long-span.

1. Introduction

A large number of cable-stayed bridges has been built all over the world in the last half a century. This kind of bridges is on a rapid growth mainly for the development of computer technology, high strength steel cables, orthotropic steel decks and construction technology. Because of its aesthetic appeal, and the rapid and easy erection, the cable-stayed bridge is considered as most suitable for medium to long span bridges with spans ranging from 200 to about 1000 m. Because of their huge size and complicated nonlinear structural behavior, the analysis of cable-stayed bridges is much more complicated than that of conventional bridges, such as truss and girder bridges. The sources of nonlinearity in cable-stayed bridges mainly include the cable sag, beam-column and large deflection effects. But few studies concerns with the analysis of cable-stayed bridges arranging and optimizing the geometric configuration of cables taking fatigue into accounts.

This study is focused on the optimal system of cables arranged in a typical long span cable-stayed bridge: the main objective is to determine the pattern of suspension that minimizes the variation of normal stress, in cables and anchors. The fatigue failure of a material that occurs as a result of stress oscillation brought about by repeated application of an intermittent load that in bridges is related to traffic load [1], [2]. Introducing this problem, often marginal in normal design practices, the aim is to verify the appropriateness of a given configuration of wire among a variety of arrangements. A previous study on the effect of fatigue on arrangement of hangers in tied arch bridges was developed by some of the authors [3].

The following study follow the instructions contained in the Eurocodes regarding the application of loads [4] and assessment of the state of fatigue in structural elements [5]. The structural analyses were performed with commercial software MIDAS / Civil 7.40 [6], which allows to manage the moving loads in a simple, directly defined load models under Eurocode law and automatically determine the worst configuration of traffic by the use of influence lines.

The search for the optimal configuration of the support system, which minimizes the variation of normal stress is made in relation to a fixed structural system consisting in the girder and the pylons with two cable systems contained in a vertical plane; with this reference two alternatives are

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