Optimum Design of Long-Span Cable-Supported Bridges Using Robustness Index

Mohammad Shoghijavan, Uwe Starossek

Hamburg University of Technology, Structural Analysis and Steel Structures Institute, Hamburg, Germany

Contacting author: mohammad.shoghijavan@tuhh.de

Abstract

The target of this study is to use a practical method for the optimization of cable distance in cable–supported bridges using the robustness index. The proposed optimization method minimizes the cost of the bridge construction and guarantees a certain level of robustness. The reserve-based robustness index, applied in this study, considers the redistribution of forces after the failure of structural elements. For finding the optimum distance of cables, a simplified bridge model is considered. Cable-loss scenarios are considered in the design process and the dynamic effect of cable rupture is taken into account. Then, the critical design load of the cables and the maximum bending moment acting on the girder after the cable failure are calculated and incorporated into the bridge design. The effect of other influential factors, such as the bending stiffness of the girder and the axial stiffness of the cables, on the optimum design of the system is also investigated.

Keywords: Cable-Supported Bridges; Optimum Design; Robustness Index; Cable-Loss Scenario.

1. Introduction

In the family of bridge systems, the cable supported bridges are distinguished by their ability to overcome large spans [1]. Cable-supported bridges, including suspension bridges and cable-stayed bridges, are widely used because of their aesthetic typologies and their economic efficiency. Several studies have been conducted concerning the optimum design of cable-stayed and suspension bridges [2-4]. In [2], a strategy to optimize the cable system of multi-span cable-stayed bridges with crossing stay cables has been presented and a general approach to minimize the steel volume in cables has been performed. The presented approach optimises the number of cables, their anchorage positions, and prestressing forces.

Cao et al. [4] used a computationally efficient optimal design approach for suspension bridges. Their result showed that the parameters characterizing the size and geometry of the pylon and the main cable are very sensitive to the price ratio, and the most economical approach to strengthen the lateral stiffness of the pylon is to increase the stiffness of the cross beam.

Cable-supported bridges are usually statically indeterminate structures, and their structural behavior is greatly influenced by cable forces as well as the vibration of the girder. However, the accurate calculation of cable forces and girder behavior needs advanced analysis techniques and the use of modern computers. In the absence of the mentioned requirements in the past, engineers tried to use as few cables as possible to make structural analysis easier. Therefore, the distance between cables was relatively long and

https://doi.org/10.2749/guimaraes.2019.1199