Analysis of a Cable-Stayed Bridge: The Case of "The Baluarte Bridge"

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Summary

The study of special bridges, such as cable-stayed bridges, has received a lot of attention along the years. Further, the continuous development of new materials, algorithms of analysis and construction technologies has allowed the designers to conceive more challenging designs. This is the case of the Baluarte bridge, the longest cable stayed bridge in North America, located in a mountain area in the northwest of Mexico. The bridge has a mid span of 520m, two lateral spans of 250 and 354m, respectively, and is intended to connect a highway through a canyon of about 390m depth. The aim of this study is threefold, first to predict the modes and frequencies of the bridge with a three-dimensional finite element model, second to analyze the behavior of the stays, and third to study the structural behavior of the bridge during the construction and service stages. The implications of the results of the analyses are discussed in detail.

Keywords: Cable-stayed bridge; dynamic analysis; stays; damping; creep; shrinkage.

1. Introduction

The Baluarte bridge is called to be one of the icons of Mexican bridge engineering, due to its particular features and location. It will be the longest cable stayed bridge in North America and will be located in the Pacific mountains of Mexico. Currently, the bridge is under construction. Its design and construction projects were developed by The Ministry of Transportation and Communication of Mexico. The bridge will connect a new highway through a ravine of about 390m depth, and will join the northern states of Sinaloa and Durango. The construction of the bridge will help to reduce the travelling time between these two states, detonating the modernization and commerce in the Northwest of Mexico.

Due to the importance of this structure, a strict control in all the stages that involve the construction of the bridge must be implemented. An important part of such control is the evaluation of the dynamic properties (i.e., modal shapes and frequencies) of the bridge or individual components of it, as is the case of the cables. The dynamic properties obtained with a mathematical model can then be used to complement experimental results from ambient or pull-back vibration tests and identify possible changes in the dynamic properties due to the influence of fatigue, prestress losses, corrosion, etc. Also, these properties can be used to develop full aeroelastic models of the bridge to be tested in a wind tunnel.

Another key factor of the control is the evaluation of the structural behaviour of the structure under the construction stage. During this crucial stage, the structure will be subjected to temporary loads, changes in the materials and geometric characteristics that could affect its behaviour. The construction stages have a significant influence on the final form of the structure and redistribution of the internal stresses.

With the aim of addressing the above mentioned issues, the dynamic behaviour of the Baluarte bridge is predicted by using a three-dimensional finite element model, also the behaviour of isolated stay cables and the possibility of using additional damping devices is explored. Finally the analysis

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