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Autor: González, José L. / Sobrino, Juan A.
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Fatigue Reliability Evaluation of Cables in Cable-Stayed Bridges. Case Study: the Sama de Langreo Bridge.

José L. GONZÁLEZ

Civil Engineer
ENGITEC Eng. Consultants.
Andorra

He received his degree in 1997 at the Technical University of Catalonia, UPC. At present, he is working as a consulting engineer at ENGITEC in the highway and structural department.

Juan A. SOBRINO

Assistant. Prof.
Technical University of Catalonia
Barcelona, Spain

Mr. Sobrino received his PhD in Civil Engineering at the Technical University of Catalonia, UPC, in 1994. Currently, Mr. Sobrino is holding a position as an assistant Professor at the UPC. His research is focused on the reliability of existing structures and both load and resistance models. Apart from his research, Mr. Sobrino is running the engineering consultant company PEDELTA, S.L. specialized in bridge design and assessment.

Abstract

The current methods for the verification of the Cable Fatigue Limit State in cable-stayed road bridges are usually very conservative. An accurate and reasonably procedure for the evaluation of such Limit State from a probabilistic point of view based on structural reliability theory is presented in this paper.

A general fatigue resistance model for cables made up of “n” parallel elements (wires or strands) and a procedure for the prediction of traffic load effects in cables based on numerical simulations are proposed. The combination of resistance and loads effects may lead to estimate the damage due to fatigue in probabilistic terms.

Although the present work is focused on fatigue due to traffic loads, the general procedure can also be applied for railway traffic, wind effects or other variable loads. The method could also be used for other structural elements (anchorage, etc) which fatigue strength could be described with a fatigue limit.

The basic work is applied to a real case study: the Sama de Langreo Bridge in Spain (Figure 1), to illustrate the possibilities of the proposed methods. Experimental data has been collected to estimate the relevant statistical parameters for the steel cable fatigue resistance model. The stress amplitudes due to traffic have been obtained from numerical simulations using real traffic data (Figure 2). The simulations lead to calculate the fatigue failure probabilities for different traffic situations. The final results confirm very low failure probabilities in comparison with other Limit States.

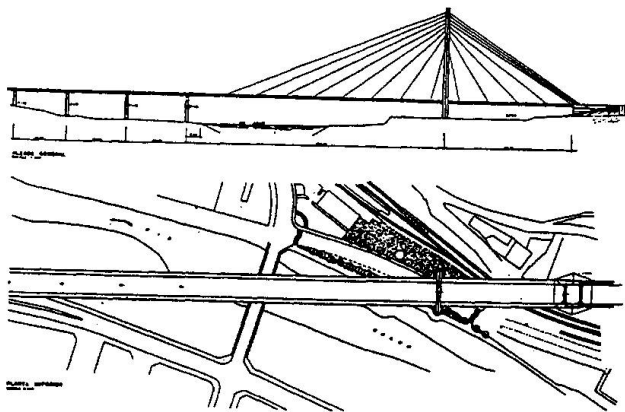


Figure 1. Sama de Langreo Bridge in Spain. Elevation

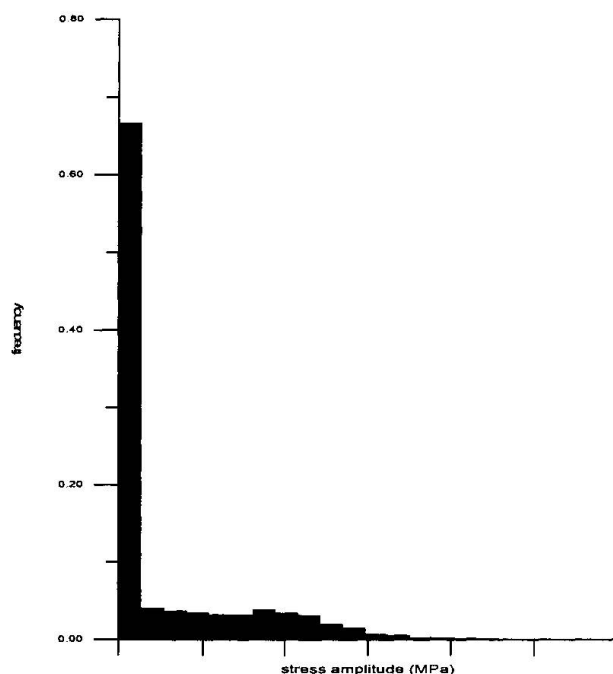


Figure 2. Stress spectra in a cable-stay of the Sama de Langreo Bridge under traffic loads, coming from numerical simulations

Although the present work is focused on fatigue due to traffic loads, the general procedure can also be applied for railway traffic, wind effects or other variable loads. The method could also be used for other structural elements (anchorage, etc) which fatigue strength could be described with a fatigue limit.

As conclusions, more investigation should be done to estimate fatigue strength of cables and cable-anchorage. More statistical data of fatigue parameters is required, in particular, for the fatigue limit. Strategic testing methods may be developed to obtain this information because of significant economical and safety implications. On the other hand, fatigue design traffic loads could be obtained or updated with the proposed procedure.