Verification of fatigue load model for stay cables

Heikki Lilja

Finnish Transport Infrastructure Agency, Helsinki, Finland

Atte Mikkonen

SOFiN Consulting

Contact: heikki.lilja@vayla.fi

Abstract

The selection of an adequate fatigue load model for the design of a cable-stayed bridge is an important task, since the shape of the S-N-curve for stay cables is very sensitive to slight changes in stress ranges. On one hand too light a fatigue load model may lead to a theoretically unsafe structure, and on the other hand too severe a fatigue load model may easily lead to unnecessary costs and waste of material, compromising sustainability.

Eurocodes, in general, apply only to loaded lengths of up to 200 meters. The fatigue load models have been calibrated against beam models, and they currently lack the needed tools for application to medium to long-span cable-stayed bridges.

Some European countries, including Finland, have relatively high traffic loads (up to 76 ton vehicles allowed), which have not been accounted for in the background calculations for current presented fatigue load models.

In this paper, the different Eurocode fatigue load models (FLM1…FLM4) are discussed within the context of a case bridge with 250-meter main span. In addition, a method for verifying the fatigue load model based on the available traffic data and maximum allowed vehicle in Finland is presented. The presented method gives the decision makers an assurance that the chosen load model can be used economically without compromising the safety of the structure.

Keywords: Eurocodes, cable-stayed bridges, stay cable, fatigue, fatigue load model, B-WIM

1 Introduction

Generally, fatigue is not considered as a major problem for stay cables of medium to long span cable stayed bridges, since dead load is dominant for the bridge type; however, when excessively severe fatigue loads are unintentionally adopted, these will influence dimensioning of the cross section area of the cables and thus add material consumption.

Bridges with a span longer than 200 meters are already out of scope of Eurocodes, and the most commonly used fatigue load model FLM 3 is only applicable to loaded lengths of 80 meters. This study compares a project specific dataset of real traffic to Eurocode fatigue load models FLM1 to FLM4, obtained from one-week of bridge weigh-in-motion (bWIM) measurement.

The actual fluctuating stress ranges in stay cables are heavily dependent on the traffic composition and the structural configuration of the bridge