Evaluation of the contact area of lorry tyres in Eurocode's fatigue load model 4 (FLM4)

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Abstract

Fatigue considerations dominate the design of new, innovative steel bridge decks. Weighing bridge deck alternatives requires representative values for contact areas and contact stress distributions of the tyres of heavy vehicles. Fatigue load model 4 in the Eurocode EN 1991-2 (FLM4) provides tyre contact areas together with a set of axle loads. The literature survey presented herein shows that the length of the contact area in FLM4 is too large.

The consequence of using a more realistic – i.e. shorter – tyre contact length together with a non-uniform contact stress distribution that is observed in practice, is that the contact stresses increase. As a result, the load effect and the fatigue life of some bridge deck details reduce, as is shown by the analyses presented in this paper. A method is proposed for determining an updated tyre contact area for the FLM4 Eurocode model, leading to a more realistic fatigue damage analyses.

Keywords: Steel bridge deck, fatigue, FLM4, lorry, tyre contact area

1 Introduction

Crossings of many heavy vehicles – hereafter called lorries – may induce fatigue in road bridges. Practice has shown that especially steel bridge deck structures, such as orthotropic bridge decks, are vulnerable to fatigue degradation. Fatigue often dominates the design of steel bridge decks. The fatigue design of these structures requires information about the contact stresses due to tyres .

The Eurocode for traffic loads on bridges (EN-1991-2) provides different fatigue load models for the design of bridges. This paper focusses on fatigue load model 4 (FLM4). FLM4 is a load model used to design for finite life and it consists of a set of lorries, each containing certain axle loads F_a and axle distances. The loads are calibrated as to represent a certain fatigue damage for given S-N curves. The model contains three types of axle, each having rectangular tyre contact areas. Type A is a front axle, type B is a traction or rear axle that consists of two wheels with two tyres per wheel having a centre-to-centre distance of 320 mm and type C is a rear axle with wider contact areas. The centre-to-centre distance of the wheels of all axles is 2 m. The Eurocode load model, with its basis stemming from the years 1980-1990, assumes type B rear axles for many of the vehicle types. This is not representative for current traffic and therefore, the Dutch National Annex (NA) assumes type C for rear axles with a weight lower than 100 kN. This NA specification is used throughout this paper. Table 1 provides the number of tyres n, contact area length L, contact area width W, and range of tyre loads F_t for each axle type. A uniform distributed load is assumed for calculating the tyre contact stress, $\sigma_c = \frac{F_a}{nlw} = \frac{F_t}{lw}$.

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