Fatigue Assessment of Composite Bridges in High Speed Railway Lines including Resonance Phenomena

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Summary

This work presents a fatigue assessment method, applicable in normal and in resonance conditions, based on the dynamic analysis of the bridge and on the linear damage accumulation method. The determined damage levels include the single train passages and the train crossings, the later determined by a new method based on a random simulation of the crossing point.

Keywords: Composite bridge, High Speed, Dynamic Analysis, Fatigue, Resonance

1. Introduction

Over the years, one aspect that has been regarded as one of the main disadvantages of using steel in railway bridges is its fatigue behaviour, which is highly dependant on the structural detailing and on the dynamic effects usually involved.

The fatigue analysis is particularly important in the design of high speed (HS) infrastructures, which must withstand the passage of longer trains, capable of travelling up to speeds of 350 km/h. In these conditions the passage of the train's regularly spaced axle loads can lead to resonance phenomena and, consequently, to a decrease of the fatigue life.

Recent advances on the dynamic behaviour of these type of bridges have been introduced in the new European standards, EN1991-2 [1] and EN1990–Annex A2 [2], reflecting the work undertaken by the ERRI D214 committee [3]. These include general guidelines for performing dynamic analysis and additional design rules required for structural and traffic safety and for passenger comfort.

Despite these improvements, the design codes are still rather incomplete concerning the fatigue assessment in resonance conditions, particularly in the specification of the traffic scenario. The Eurocodes propose three traffic mixes, based on 12 train types, suited for bridges that carry mainly standard traffic, heavy freight traffic or light traffic. No specific guidelines are given for bridges conceived for high speed passenger traffic.

This paper focuses on the fatigue assessment of the steel girders of a composite twin girder deck located on the French TGV Northern HS Line. The proposed methodology is based on the damage accumulation method, using the stress time histories from a dynamic analysis of the bridge to determine the damage caused by the high speed traffic. The damage includes the single train passages and the simultaneous effect of two trains, the later determined with a probabilistic method based on a random simulation of the crossing point.

Sensitivity analysis were performed to assess the influence of circulating speed, detail category and train crossings on the deck's fatigue behaviour.

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