Approach for the mathematical calculation of the damping factor of railway bridges with ballasted track

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Abstract

A realistic prognosis of railway bridge vibrations during high-speed traffic must not only rely on the right choice of an adequate calculation model for both bridge and train but primarily on the use of dynamic model parameters which reflect reality appropriately. Concerning the damping characteristics of the used bridge model, the standard prescribes damping factors to be applied in calculations that are considered as lower bound values of the actual damping factors of bridges. Thus, measured damping factors often exceed normatively prescribed values significantly. This contribution presents a new approach, making the damping factor of railway bridges with ballasted track calculable. Comparing this approach, normatively prescribed and measured damping factors of existing bridges illustrates the apparent deviation between standard and measurement. It is also shown that this new approach provides results that are close to reality.

Keywords: bridge dynamics; railway bridges; ballasted track; model design; damping factor.

1 Introduction

New challenges for bridge engineers accompany the swift expansion of the high-speed rail network: Under high-speed traffic, railway bridges tend to show excessive vibration responses, which can cause severe negative consequences such as damage to the bearing structures due to material fatigue, destabilisation of the ballast bed, distortion of the track and even the risk of derailment. Consequently, railway bridges must be investigated computationally regarding their dynamic behaviour under high-speed traffic to identify occurring and potentially dangerous resonance events and take measures to avoid them.

A close-to-reality calculation of bridge vibrations due to dynamic strains requires realistic calculation models of both bridge and crossing train and appropriate input parameters. Generally speaking, more detailed models reflect reality more closely, but they are at the same time inefficient due to a very high calculation time. However, comparisons between measured and calculated bridge vibrations are often characterised by considerable discrepancies, whereas dynamic calculations overestimate the actual responses. This gap between measurement and calculation constitutes a complex research issue and can be traced to several causes. One major cause, which is the main focus of this contribution, is found in the dynamic values of the bridge: Due to strict normative specifications in the EN 1991-2 [1] and lack of knowledge (concerning the ballasted track), conservative damping values have to be used in dynamic calculations. These normatively prescribed damping values are considered as lower bound of the actual damping factors bridges.