Abstract

In the context of this Doctoral Thesis the problem of vertical vehicle-structure interaction in High-Speed simply-supported railway bridges is addressed. The analysis of the dynamic effects experienced by bridges under the circulation of railway vehicles has been classically approached using models of constant moving loads. In these models the vehicle axles are represented using concentrated forces with constant modulus, equal to each of the static axle loads. This implies neglecting the vehicle-structure interaction effects (*i. e.,* vehicle masses inertial effects and suspension systems energy dissipation mechanisms) that couple the vehicle internal degrees of freedom with the bridge deck oscillations.

When interaction models of the vehicles are used, the resonant response of the bridge, in terms of the deck vertical displacement and acceleration, may be substantially reduced, entailing an important repercussion on the verification of the Serviceability Limit States of the structure. As an alternative to the use of complex interaction models, Eurocode 1 proposes a simplified methodology based on increasing the overall structural damping of the bridge in order to take into account the attenuation of its resonant response due to vehicle-structure interaction effects, while using constant moving load models for the vehicle representation. The amount of additional structural damping to be considered when calculating the bridge response depends on the bridge span according to this methodology.

The research work developed in this Thesis pursues two complementary objectives: (i) to assess the minimum and maximum beneficial effects associated to the vehicle-structure interaction on the bridge response, taking into account the space of possible design situations and the most common vehicle interaction models; and (ii) to determine if it is possible to adopt a simplified model which incorporates the vehicle-structure interaction effects in the design of new simply-supported structures or in the retrofit of existing ones from a conservative standpoint.

First, a thorough sensitivity analysis, based on an analytical formulation, has been performed, with the aim of determining the set of nondimensional parameters that govern the bridge dynamic response, and quantifying the influence of the vehicle-structure interaction effects on the bridge resonant amplification in an extensive space of possible scenarios. Then, in order to show the practical application of the nondi-

mensional study, a set of representative cases is selected. The principal tendencies detected in the previous study are shown in several bridge models under the circulation of different commercial trains, and the relevance of the interaction effects in the verification of the Serviceability Limit States, in particular on the deck transverse acceleration, is highlighted.

The principal conclusion derived from the work developed is that due to the variability in the mechanical characteristics of the railway vehicles and bridge structures, vehicle-structure interaction may nearly not affect the maximum bridge response in the range of velocities of study. Therefore it is not recommendable to propose a simplified methodology to take into account the bridge resonant response attenuation due to the interaction effects from a safety perspective. The analysis of the interaction effects on a bridge structure would require the use of an interaction model, with the level of complexity demanded by each actual study, particularized to each project scenario.

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