Influence of nonsymmetric train loading in the dynamics of high-speed bridges

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ABSTRACT

The design of high-speed railway bridges often involves the need to carry out transient calculations in which the structural response is simulated under the action of both *normative trains* and *real trains*. At the European level, *Eurocode EN1991-2* stipulates the requirements for such analyses. Incidentally, there exist certain real trains whose axle load distribution is not symmetrical, and within the framework of research project *InBridge4EU* (inbridge4eu.eu) the structural response to such non-symmetrical trains (NST) is currently being analysed. Particularly, it is investigated whether time-step integration may yield significantly different results when an NST is circulated over a bridge in one direction of travel, or in the opposite direction.

To answer this question, a set of 20 NST for V>160 km/h retrieved from previous project *In2Track3* have been analysed. In some cases, these NST are markedly non-symmetrical, featuring a single, noticeably heavier locomotive. In other cases they are moderately non-symmetrical, formed by coupled *multiple units*. These vehicles have been analysed on a large set of bridges following previous work [1]. The main hypotheses of said reference have been followed here. By carrying out the simulation in one direction of travel and in the opposite direction, the differences between the max. expected acceleration in both cases have been assessed, setting a min. relevance threshold of 10%. Cases of accel. < 1.0 m/s^2 are discarded.

The conclusions of this study point out that in general, for markedly NST, the so-called “push-mode” (with the locomotive at the end of the formation) predominates, although isolated cases were detected where the “pull-mode” case was dominant (with locomotive at the beginning), see figure. Besides, for markedly NST cases but also for moderately NST, situations occur where the ascending slope of a resonant peak develops and is truncated by the max. speed of the vehicle, causing one of the two modes to predominate significantly. Therefore, such situations may be relevant for bridge assessment under real trains.

It has been therefore shown that for NST it is necessary to carry out bridge dynamic analyses considering both directions of travel, providing that such trains are effectively compatible with push and pull modes. Financial support of project ***InBridge4EU***, funded by ***Europe’s Rail Joint Undertaking*** under *Horizon Europe* research and innovation programme under *Grant Agreement No. 101121765* (HORIZON-ER-JU-2022-ExplR-02), is gratefully acknowledged.

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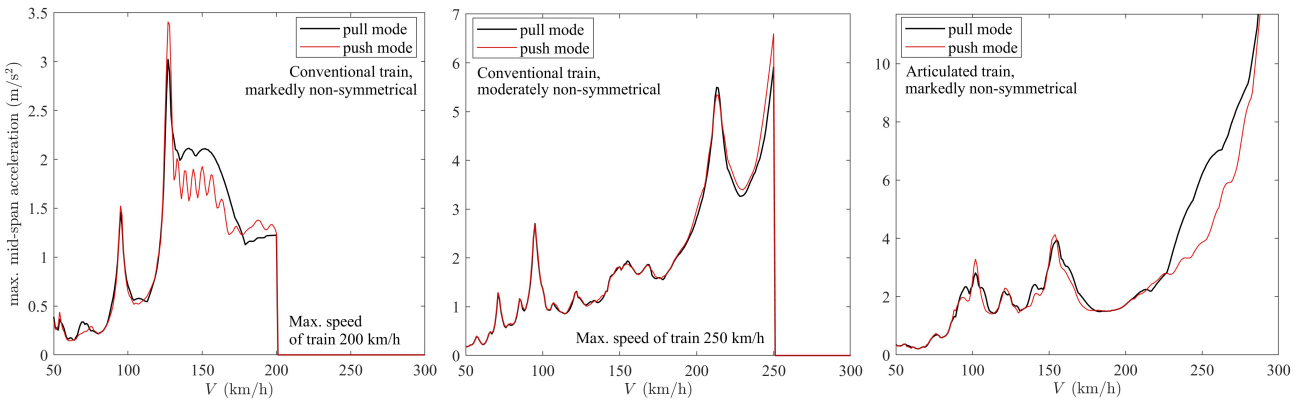

References

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