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Coupling Effects of the Ballast Track Infrastructure on the Dynamic Response of Structurally Independent Railway Bridges

J.C. Sánchez-Quesada[1], A. Romero[2], P. Galvín[2,3], E. Moliner[1] and M.D. Martínez-Rodrigo[1,*]

[1]Universitat Jaume I, Mechanical Engineering and Construction Department, Avda. Sos Baynat s/n, Castellón, 12006, Spain

[2]Universidad de Sevilla, Escuela Técnica Superior de Ingeniería, Camino de los Descubrimientos s/n, Sevilla, 41092, Spain

[3]Laboratory of Engineering for Energy and Environmental Sustainability, Universidad de Sevilla, Camino de los Descubrimientos s/n, Sevilla, 41092, Spain

*Corresponding Author: M.D. Martínez-Rodrigo. Email: mrodrigo@uji.es

ABSTRACT

This paper is devoted to track-bridge interaction phenomena in railway bridges of short simply-supported (SS) spans composed by ballasted tracks. These structures may experience high vertical acceleration levels under operating conditions. In particular, the coupling effect exerted by the ballast track shared by structural parts that are theoretically independent, such as consecutive simply-supported spans or twin adjacent single-track decks, is investigated. Experimental evidence shows that in these cases there may be an important vibration transmission from the loaded to the unloaded track, and that the interlocked ballast granules couple some of the lowest modes of vibration to an important extent. To this end a detailed three- dimensional (3D) Finite Element (FE) model of an existing bridge is implemented where the ballast in weakly connected regions is simulated as transversely isotropic material, in order to represent in a simplified manner, the degraded state due to the relative motion between the disconnected structural parts. First, the bridge numerical model is updated from the ambient vibration response of the structure previously measured by the authors. Second, a sensitivity analysis is performed on the properties of the degraded ballast and their effect on the first five modes of vibration of the bridge is discussed. Finally, the response of the bridge under operating conditions is computed numerically, compared with the response measured experimentally in the time and frequency domains and conclusions are extracted regarding the model adequacy.

KEYWORDS

Railway bridges; ballast track; resonance; Finite Element model; modal updating; experimental measurements; bridge dynamics

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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