Structural control of high-speed railway bridges by means of fluid viscous dampers

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Abstract

The dynamic response of structures is an important aspect to consider, especially at resonance. Particularly, bridges traversed by trains are at risk, due to the repeated loading with regular interval from the axle and bogie spacings. If the risk of resonance is not accounted for in the design, the vertical acceleration of the bridge deck may exceed the allowed limits of comfort and safety. Hence, alternative, sustainable measures for reducing the vibrations in bridges are required to solve these challenges. This paper presents studies of fluid viscous dampers used to control the dynamic behaviour of high-speed railway bridges. A finite element model is used to investigate the response of an existing bridge, both prior to and after the installation of dampers, and the influence of some parameters on the efficiency of the dampers are analysed. The results from this paper show that the vertical deck acceleration is sufficiently reduced using the proposed solution.

Keywords: resonance; dynamic response; vibrations; bridges; high-speed trains; damper retrofit.

1 Introduction

High-speed train passages over railway bridges may induce excessive vibrations in the bridge deck. When the repetitive and equidistant axle forces cause the forcing frequency of the train to get close to or coincide with the natural frequency of the structure, resonance occurs. At resonance, the vertical deck displacement and acceleration are highly amplified. According to laboratory tests conducted by the European Rail Research Institute (ERRI) [1], the ballast starts to destabilize at an acceleration of approximately 0,7g. Thus, if a safety factor of 2 is employed, the vertical acceleration of a ballasted railway bridge deck must not exceed 3,5 m/s^2. This value has been

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