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EVALUATION OF EUROCODE DYNAMIC AMPLIFICATION FACTORS – CASE STUDY

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Summary: The transition to more sustainable mobility systems is a significant priority for achieving the goals set by the European Green Deal, which aims to make Europe the first climate-neutral continent by 2050. Railways play a crucial role in this effort, but it is essential to improve the resilience and capacity of the current network, particularly the lifeline structures such as bridges. In this context, understanding and accurately evaluating the dynamic amplification factors (DAFs) for railway bridges is of paramount importance. DAFs quantify the additional stresses and displacements induced by dynamic loads compared to static loads, accounting for the impact of train speed, bridge properties, and track irregularities. Research on train–bridge dynamic interaction (TBDI) has long been a focal point in railway dynamics. Moving trains induce significant vibrations in bridge structures, potentially affecting their integrity and serviceability. The vibrations are influenced by several factors, including the natural frequencies of the bridge, vehicle speed, and track conditions. To account for these dynamic effects, various models and methodologies have been developed over the years. Recent research has employed advanced vehicle-bridge interaction (VBI) models to simulate the dynamic behavior under varying conditions, including pavement irregularities and vehicle dynamics. Traditional methods for calculating DAFs often rely on empirical formulas provided by design codes, which can be overly conservative or insufficiently accurate for specific scenarios. For example, the Eurocode EN 1991-2 specifies dynamic factors based on span length and other parameters, but these may not capture the complex interactions in modern high-speed railway systems. Advanced numerical simulations, such as those using VBI models, offer a more precise evaluation of DAFs by simulating the dynamic behavior of both the train and the bridge under various operational conditions. Studies by Ludescher and Brühwiler, and by Deng and Cai highlight the limitations of existing codes and the benefits of detailed VBI analysis. The primary objective of this work is to evaluate the dynamic amplification factors (DAFs) for high-speed railway bridges. This involves analyzing the dynamic properties of the bridge and railway vehicles, incorporating different rail irregularities to understand their impact, and determining the DAFs for various operational scenarios. Additionally, the study aims to compare the calculated DAFs with those provided in the Eurocodes to evaluate the conservatism of the current standards, and ultimately offer insights and recommendations for the design and maintenance of railway bridges to enhance their resilience and performance under dynamic loads.