Vibration analysis of vehicle - UHPFRC Wild bridge interaction

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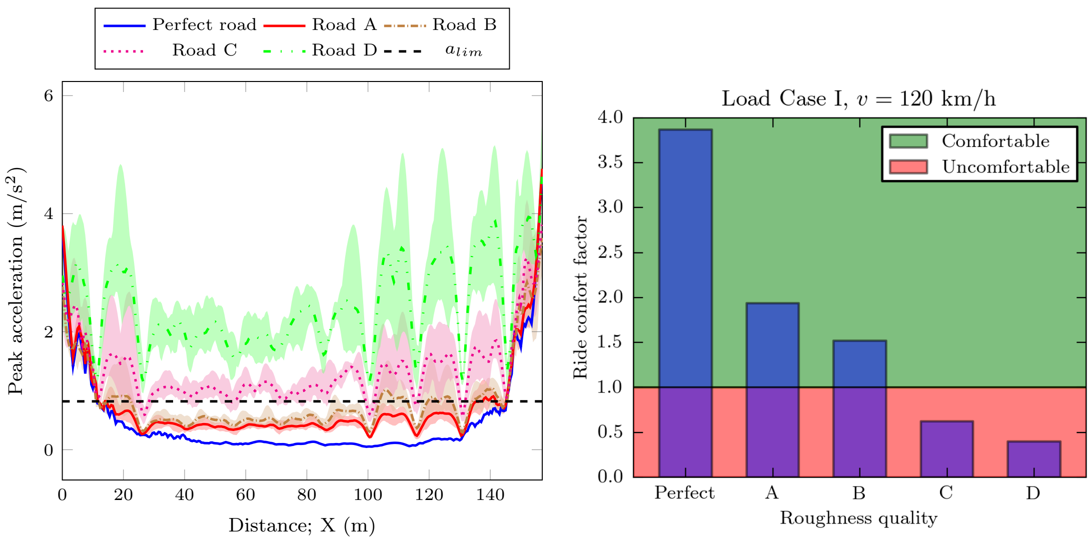
Abstract

Ultra High Performance Fibre Reinforced Concrete (UHPFRC) is a superior class of new cement base composites with the potential to achieve high performance in terms of bearing capacity and durability, which allows for more slender designs of bridge, such as the UHPFRC-Wild bridge analysed in this work. This implies an important increased susceptibility of both vehicle and bridge structures to traffic-induced vibrations. Therefore, the Serviceability Limit State (SLS) of vibrations cannot be neglected in the bridge design on the one hand, and the ride comfort and safety of the vehicles need to be evaluated on the other. This paper presents an assessment of vibration perceived by pedestrians and by vehicle users in the slender UHPFRC-Wild bridge under heavy traffic load. A fully coupled vehicle-bridge interaction model is developed, in which the vehicle is modelled as a multibody system and interacts with the bridge's finite element model by means of a contact implemented with the augmented Lagrange method. The road roughness surface is generated by considering the hypothesis of the isotropy and using the power spectral density proposed by [1].An extensive study is performed to explore the influence of different factors like as road surface quality, vehicle velocity on the vibration-based human perception. Results show the importance of the road surface quality on the human comfort. The vibrations of bridge are not only governed by the fundamental mode of the bridge as defined by [2, 3], but also are dominated by the driving frequency and other torsional modes of the bridge, especially in presence of the road roughness (see Fig 1(a)). Moreover, an important reduction of ride comfort is observed when the road roughness quality decreases (see Fig 1(b)).



(a) (b)

Figure 1: Vibration analysis: (a) Peak acceleration along the bridge, (b) Ride comfort factor

References

[1] ISO 8608:1995 . *Mechanical vibration - Road surface profiles - Reporting of measured data.* International Organization for Standardization (ISO), Gineva, 1995.

[2] BS 5400-2:2006. *Steel, concrete and composite bridges - Part 2: Specification for loads*. British Standard, UK, 2006.

[3] CEN. *EN 1992-2: Eurocode 2 - Design of concrete structures - Part 2: Concrete bridges*. European Committee for Standardization, European Union, rue de Stassart, 36B-1050 Brussels, October 2005.