Research on Vehicle-Bridge Interaction Dynamics since 1990s

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Abstract

Impact factors that are more rational for bridges were proposed in 1995 using the vehicle-bridge interaction (VBI) element derived, by which the term VBI first appeared. Resonance and cancellation conditions were proposed for highspeed (HS) railway bridges, by which the optimal span length L was proposed to be 1.5 times the carriage length. Based on the VBI, the vehicle scanning method (VSM) for extracting bridge frequencies was proposed in 2004, which was followed by a huge amount of research not restricted to our research group, but all over the world. Extension was made to construction of mode shapes and detection of damages, damping ratios, etc., of the bridge. Later, pavement roughness was resolved by using the residual of dual vehicles, while vehicle' frequency eliminated by using the vehicle-bridge contact point response. Research continues to grow nowadays on applications to thin-walled beams and railway bridges.

Keywords: bridge; damage; damping; frequency; mode shape; vehicle; vehicle-bridge interaction; vehicle scanning method.

1 Introduction

The journey to research on vehicle-bridge interaction (VBI) problems and vehicle scanning method (VSM) for bridges since the 1990s has been very interesting and rewardable. Partly due to the construction of long-span bridges worldwide and the promotion of high-speed railways in some countries, research on VBI problems continues to grow in a rapid speed.

2 Impact factors for bridges

In bridge engineering, the impact factor *I* to account for vehicle's dynamic amplification is

$$I = \frac{R_{dm}(x) - R_{sm}(x)}{R_{sm}(x)} \tag{1}$$

where $R_{dm}(x)$ and $R_{sm}(x)$ are the maximum dynamic and static responses, respectively, at point *x* of the beam. What attracted us first to this subject is that the impact formula of the AASHTO Specifications (1989) did not look meaningful from the point of physics, in that the impact factor *I* is related to a static parameter, i.e., span length *L*, but not any dynamic parameter of the bridge. In this regard, a dynamic parameter called the speed parameter *s* was adopted instead:

$$s = \frac{\pi v}{\omega L} \tag{2}$$

which is a combination of vehicle speed *v*, frequency ω and span length *L* of the bridge. The span length *L* for simple beams should be interpreted as the characteristic length for continuous beams. Both the non-dimensional impact factor *I* and speed parameter *s* can be related by

$$I = as \tag{3}$$

where *a* is a coefficient specific for each condition. Using the VBI element presented in [1], a set of im-

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