

Understanding Vehicle-Bridge Interaction through Field Measurements and Model-Based Simulations

PhD Proposal by:

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Abstract

Although the qualitative and empirical approaches that define today's bridge engineering practice have served the profession well over the past five decades, they are wholly incapable of operating under the current fiscal pressures or answering the calls for more efficient and transparent resource allocation. Principal among the shortcomings of current design and assessment approaches is their inability to accurately address the effects of trucks (perhaps the largest demands bridges experience) on the dynamics of the coupled vehicle-bridge system (vehicle-bridge interaction) and consequently on bridge performance. Furthermore, this lack of understanding represents a key barrier to meeting the needs of emerging connected vehicle technology, specifically truck platooning. Truck platooning, which involves virtually connecting trucks into a train with extremely small headway between vehicles, not only drastically changes the level of live load on bridges, but it also creates a more steady-state dynamic loading that cannot simply be accounted for with an amplification factor.

The objectives of this research are to (1) characterize the parameters that exert significant influence over the level of vehicle-bridge interaction (VBI), (2) identify any shortcomings with current design and assessment methodologies related to their treatment of dynamic amplification and propose modifications, and (3) identify bridge vulnerabilities associated with truck platooning and make recommendations related to implementation strategies and policies.

Field testing will be performed, whereby an in-service bridge and a vehicle are instrumented, and responses from both are captured synchronously while the vehicle is traversing the bridge. The resulting data will then be used to inform and "calibrate" FE models, thus ensuring that the models can accurately simulate VBI. Once confidence in the FE models is established, objectives (2) and (3) can be achieved through parametric studies and simulation of platooning scenarios. Parameters to be investigated will include road profile roughness, vehicle speed, bridge configurations (span length/width, girder spacing, skew, bridge type, etc.), and dynamic characteristics (e.g. modal frequencies, mode shapes, and damping of natural modes of vibration).

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