Dynamic Behavior of Bridge VMS Support Structure to Natural Wind and Truck-Induced Wind Gusts
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Abstract: The effect of fatigue due to wind-induced loads on highway overhead sign support structures is dependent on the structure’s vibration characteristics. The design fatigue load equation for natural wind and truck-induced wind gusts in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals were developed for sign structures with specific natural frequencies of vibration, modal shapes of vibration and damping values that are typically associated with cantilever type sign support structures. Prior research has shown that sign structures with different vibration behavior such as bridge type sign and variable message sign (VMS) support structures have a different response to fatigue loading, and therefore use of the Support Specifications’ fatigue design equations may overestimate or underestimate the true fatigue effect. This research experimentally investigated the structural dynamics of an in situ bridge type VMS support structure to natural wind and truck-induced wind gusts. The determined vibration properties were compared to the vibration characteristics used to develop the AASHTO natural wind and truck-induced wind gust design fatigue load equations.

The Tested Highway Overhead Bridge VMS Support Structure

Structural Dynamic Experimental Instrumentation

Natural Wind Gusts Excitation

Operational Modal Analysis of the Response

Response due to Truck-Induced Wind Gusts

Summary and Conclusions

Response of the VMS bridge were compared to the structural dynamic constants used to develop the AASHTO natural and truck-induced wind gusts provisions.

1. Natural wind excitation AASHTO model showing close agreement with experimentally collected data with respect to gust frequencies.
2. Dominate vibration due to truck-induced wind gusts was in the horizontal direction as apposed to the vertical direction specified by AASHTO.
3. Aerodynamic damping showing a significant effect on the structural response.
4. Critical damping in response to truck events equal to 0.36% for horizontal vibration (mode 2) and 0.12% for vertical vibration (mode 3).