**Predicting Structural Properties of a Steel Railway Bridge using Laser Doppler Vibrometry**

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ABSTRACT

Steel railway bridges are indispensable to the safety, serviceability, and sustainability of the U.S. freight and rail

network. Reduction in the stiffness of steel railway bridges is responsible for their strength-related and

serviceability-related failure modes. Recent advances in the development of remote sensing techniques such as

laser Doppler vibrometry (LDV) have enabled bridge engineers to assess the structural performance of bridges

with the information that conventional visual inspection cannot provide. In this paper, experimental work and

data analysis on the identification of structural parameters (generalized stiffness, generalized mass, and generalized

damping) of a steel railway bridge under the application of a moving commuter train, using a portable

LDV system, are presented. Background and train-induced vibration measurements (velocity and displacement)

at the midspan of the bridge girder were measured. Time-domain displacement measurements in free vibration

and forced vibration were used to identify the frequencies representing background noise (55.67 Hz), train

loading (0.996 Hz), and the fundamental mode (8.698 Hz) of the bridge, using a single-degree-of-freedom bridge

model. From the analysis, the damping ratio of the bridge was found to be 1.322% and the train speed to be

57.1706 mph (25.5575 m/s). A bounding approach was proposed to address the uncertainties in our calculations

by providing the upper bound and the lower bound values of generalized stiffness, generalized mass, and

generalized damping of the bridge. Monitoring the change in these structural properties can better assist decision

makers in routine maintenance and asset management of steel railway bridges and other critical civil

infrastructures.

**Keywords:** laser doppler vibrometry (LDV), steel railway bridge, dynamic displacement, bounding approach