Texas A&M Transportation Institute

Texas Department of Transportation

PROJECT SUMMARY REPORT

0-7038: Develop Bridge Weigh-in-Motion Approach to Measure Live Loads on Texas Highways

Background

The concept of bridge weigh in motion (B-WIM) is to instrument a bridge such that the measured data may be processed to obtain truck axle information (average speed, number of axles, and axle spacings) and weight information (axles and gross). B-WIM (compared to pavement weigh in motion) is potentially less disruptive to traffic, more durable, more economical, safer to install, and able to produce accurate truck-traffic data and bridge assessment information.

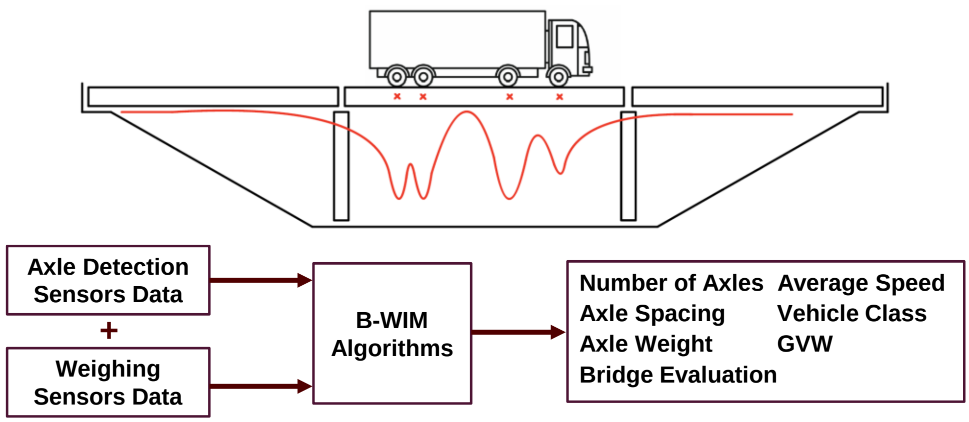

Figure 1. Bridge Weigh-in-Motion System.

This project realized these advantages through the development of a B-WIM system (Figure 1) that included extensive experimental testing followed by field validation on in-service bridges. In addition, the project developed an approach to identify bridge parameters from the B-WIM data, such as distribution factors and composite action, which were used for site-specific load ratings.

What the Researchers Did

The researchers reviewed the relevant literature and the current state of the practice. A preliminary B-WIM system was developed and evaluated on a testbed bridge. Thereafter, the system was tested and successfully validated on three in-service highway bridges. This included data comparisons with nearby independent portable weigh-in-motion systems on two of these in-service bridges. Truck traffic data were collected and used for live load analysis. The three bridges were also evaluated with refined load ratings using the B-WIM data. Finally, recommendations and guidelines for future B-WIM implementation were established.

What They Found

The researchers developed a B-WIM system that can be implemented on Texas bridges. To achieve this, the researchers established specific sensor types, sensor locations, and algorithms

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necessary to identify accurate *truck axle* information. Similarly, this information was established for accurate *truck weight* information. In addition, approaches to *evaluating the bridge* itself using this B-WIM data were established.

B-WIM recommendations for accurate *truck axle* information are as follows:

- Use vertical strain gauges on the beam web at the supports (sampling at least 500 Hz). The first derivative (rate of change) method using a peak-picking algorithm is the recommended data-processing technique.
- Attach strain gauges on the underside of the bridge deck near the quarter span at both ends (sampling at least 500 Hz). The second derivative method using a peak-picking algorithm is the recommended data-processing technique.
- Load cells at the bridge bearings are a great approach for newly constructed bridges or bridges under rehabilitation. These data can be processed similarly to the deck strain gauges.

B-WIM recommendations for accurate *truck weight* information are as follows:

- Attach strain gauges on the bottom surface of all beams at midspan. The area method (load versus time) for data processing can be used to calculate the gross vehicle weight (GVW). These sensors are also used for other B-WIM functions, such as truck lane detection and side-by-side detection.
- Use the deck strain gauges or the load cells to determine the truck axle weights. The axle weights can be totaled for a second source of the GVW.

B-WIM recommendations for *bridge evaluation* using B-WIM data are as follows:

- The midspan strain gauges can be used for automated site-specific load ratings of notional trucks or actual trucks crossing the bridge.
- B-WIM data have the potential to reduce the uncertainty of existing bridge behavior using many of the already developed field-testing approaches.

What This Means

This research study developed and quantitatively evaluated the concept of B-WIM for future application on Texas highways. The researchers identified the following value to Texas with future B-WIM implementation:

- Increased level of knowledge through greater breadth and depth in the estimation of truck-traffic data, as well as the response of certain bridge features to typical traffic loading.
- Improved bridge management and policy through enhanced bridge performance data.
- Increased safety to the public through estimation of truck-traffic data without lane closures.
- Reduced cost to the state for obtaining truck-traffic counts, GVW, and axle load spectra data, which is partly due to reduced roadway user costs to the public.

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