



DEPARTMENT OF
TRANSPORTATION

RESEARCH SERVICES & LIBRARY

TECHNICAL SUMMARY

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PROJECT COST:

\$80,000



Roadside WIM cabinets contain equipment that captures information on vehicle counts, speed, and axle weights and distribution.

Evaluating Weigh-in-Motion Systems for Accuracy and Durability

What Was the Need?

MnDOT's Office of Transportation System Management currently uses weigh-in-motion (WIM) system components from two manufacturers: International Road Dynamics (IRD) and Kistler. When vehicle axles pass over WIM sensors embedded in pavement, the sensors transmit electrical signals to WIM controllers, which convert the signals into usable data about vehicle speed, axle weights, axle spacing, vehicle types and traffic counts. MnDOT-owned software then converts the proprietary data from multiple manufacturers' components into uniformly formatted, comparable data.

A number of factors, including weather, pavement conditions and traffic, can cause WIM systems to lose accuracy over time. MnDOT recalibrates WIM systems up to two times each year, when monthly statistical trends suggest the need. Sensors also degrade and fail over time, and are typically replaced every four to seven years. Controllers may last 10 years or more.

On its road system, MnDOT uses IRD controllers and Kistler sensors. When the agency replaces sensors, it considers instruments from other manufacturers. Recently MnDOT began evaluating WIM sensors from Intercomp, which markets its sensors as more durable and accurate than others. MnDOT wanted to compare the performance of Intercomp products with Kistler and IRD systems.

What Was Our Goal?

The goal of this study was to evaluate the accuracy and durability of Intercomp, IRD and Kistler WIM systems. MnDOT wanted to know how well the sensor-controller systems from each manufacturer perform and how frequently they need to be recalibrated or replaced.

What Did We Do?

Researchers began by examining the accuracy of the results reported by Intercomp. The team analyzed Intercomp's test data and then ran tests with MnDOT test vehicles at the MnROAD test facility, expanding the analysis of data collected to consider the influence of axle types and environmental factors on sensor readings.

After the evaluation of Intercomp sensor test results, the research team studied and compared IRD systems with Intercomp sensors. Team members evaluated the sensors within each system for self-consistency to determine how consistent sensors in the same system were with one another. Then they compared measurements from both systems.

In the final phase of testing, researchers intended to compare Kistler systems with Intercomp sensors at MnROAD. However, when one of the Intercomp sensors failed, investigators instead compared Kistler systems with IRD sensors to determine which of the two systems offered more accurate data and performed reliably longer before requiring recalibration.

Researchers compared the performance of current WIM sensors with new sensors. Results suggest that the two current vendor systems perform consistently, but it is unclear which system's sensors are more accurate or more durable. Improvements to a new vendor system are necessary before it can be implemented.

“We will consider monitoring the long-term performance of these systems. We didn’t really see calibration drifting, but this testing didn’t have a long runtime. We may be able to tie performance to what type of winter the systems experience.”

—**Benjamin Timerson**,
Transportation
Data and Analysis
Program Manager,
MnDOT Office of
Transportation System
Management

“Kistler and IRD sensor systems performed similarly and did not need recalibration during the three- or four-month evaluation period. But they were different, and we are not sure which is more accurate.”

—**Diwakar Gupta**,
Professor, University of
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WIM sensors embedded in pavement record the speed, axle weights, axle spacing and number of vehicles as they pass. The sensors then send signals to WIM controllers in roadside cabinets that collect and format the information into usable data.

What Did We Learn?

Irregularities in weight slips and test truck weight data led Intercomp to use weights reported by MnDOT in the analysis. Investigators found Intercomp’s test results reliable, but when they used the true weights of test trucks, investigators were unable to reproduce Intercomp’s results. Intercomp only examined weights from a three-month period, making its conclusions on reliability at different temperatures and traffic speeds unreliable. Intercomp sensor errors varied with axle type; for some axles, the sensors underestimated weights, and for others, they overestimated.

In the second phase of the study, IRD sensors produced consistent measurements between its sensors, but Intercomp sensors did not provide self-consistent readings; different Intercomp sensors at times reported significantly different results. IRD and Intercomp systems provided different measurements for the same vehicles as well, but actual weights, speeds and vehicle counts were unknown, making accuracy impossible to assess. The Intercomp sensor failure one month into testing prevented researchers from estimating recalibration and replacement period expectancies.

In the phase three analysis, both Kistler and IRD systems were self-consistent. Each system returned similar vehicle counts over a four-month evaluation period, but generated different weight and speed measurements. As with the previous comparison, researchers could not assess comparative accuracy. Kistler sensors generated more errors, but it is unclear whether this suggests IRD sensors are more accurate or Kistler sensors are more sensitive to errors.

What’s Next?

Researchers shared results with MnDOT and offered recommendations for ways to further evaluate and compare the performance of the three WIM systems. They also suggested that MnDOT obtain more data from Intercomp to develop a more detailed evaluation of its system’s performance. Intercomp may be able to use the results from this study to engineer improvements to its sensors and controllers.

Investigators also offered suggestions for determining when recalibration is required, including consideration of several daily measures in addition to monthly statistical trends based on the assessment of sensor readings taken once or twice each month.

This Technical Summary pertains to Report 2018-03, “Weigh-in-Motion Sensor and Controller Operation and Performance Comparison,” published January 2018. The full report can be accessed at mndot.gov/research/reports/2018/201803.pdf.