CLEAR ROADS
research for winter highway maintenance

RESEARCH BRIEF

NOVEMBER 2019

EVALUATING THE PERFORMANCE OF MOBILE RWIS TECHNOLOGIES

RESULTS SUMMARY

Researchers rigorously tested accuracy and other features of four mobile sensor devices in a controlled test area and in live traffic during winter weather conditions. Their evaluations will help agencies make informed decisions in selecting mobile RWIS sensors.

PROJECT DETAILS

Project Title: Mobile Technologies for Assessment of Winter Road Conditions

Project Number: CR16-03

Project Cost: $152,379

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Project Champion: Kyle Lester
Colorado Department of Transportation
kyle.lester@state.co.us

Investigator: Mark Gallagher
SRF Consulting
mgallagher@srfconsulting.com

Mobile road weather information system (RWIS) sensors are becoming an increasingly valuable tool for winter maintenance agencies. While stationary RWIS installations—environmental sensor stations—have been widely used for more than two decades, the capabilities of new mobile RWIS sensors have advanced substantially in the past few years. Mounted on the exterior of a winter maintenance vehicle (such as on a side mirror or trailer hitch), mobile sensors collect data on air temperature, pavement temperature, pavement conditions and other parameters as the vehicle moves along its route. Agencies can use this data to make decisions for specific roadways with greater precision than is possible using traditional RWIS data, which is limited to reporting conditions near fixed stations.

Need for Research

Clear Roads agencies are increasingly using mobile sensors to stay on top of rapidly changing weather and pavement conditions. A survey conducted for this study found that among the 23 Clear Roads states responding, 18 had deployed at least one mobile sensor, and seven states had deployed them widely (more than 80 sensors in their fleet). Laboratory studies have evaluated mobile RWIS sensor performance, but few tests have compared several devices simultaneously in the field. Clear Roads initiated this project to provide a simultaneous, comparative field study of several different systems that would allow agencies to make informed purchasing decisions based on how the devices perform in real-world conditions.

Objectives and Methodology

This project had two principal goals: to evaluate and compare the accuracy of several commonly used mobile sensors and to assess the practical aspects of using each device.

Researchers surveyed Clear Roads member states to learn about their current and planned use of mobile sensors. Based on the survey results, researchers selected four mobile sensors to test: the **Lufft MARWIS**, the **Teconer RCM411**, the **High Sierra Mobile IceSight** and the **Vaisala DSP310**. Three of the sensors use mobile phones to transmit data, while the High Sierra sensor employs a laptop with a Java application.

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Researchers built an adjustable rig onto a trailer to allow all four mobile sensors to be tested simultaneously, each at its optimum mounting height. The rig was used in live traffic as well as closed-course testing.

To test the four sensors simultaneously, researchers constructed a test rig on a trailer, with the sensors mounted near each other so that each sensor was detecting the same area of pavement. Adjustable cross bars allowed each sensor to be mounted at its optimum height.

Testing was conducted in two phases. Phase 1 evaluated sensor accuracy at measuring the following parameters:

- Air temperature
- Relative humidity/dew point
- Pavement temperature
- Water film height
- Friction coefficient (grip)
- Pavement surface condition using qualitative measures (e.g., dry, moist, wet, ice, snow, slush, frost)

Phase 1 testing was conducted in a closed-course environment at Minnesota DOT's MnROAD test facility, which offered four different pavement types: concrete, aggregate, asphalt and chip seal. Sensor readings for pavement and air temperature, relative humidity, and water film height were compared to baseline measurements from reference devices. Researchers used qualitative observations to establish a baseline for pavement surface condition.

In Phase 2, researchers assessed practical aspects of sensor use:

- Sensor mounting, including effects of height on performance
- Ease of sensor software use (integration with other systems)
- Sensor data outputs and terminology
- Sensor performance in real-world traffic conditions

Phase 2 tests were conducted on a live-traffic route in the Twin Cities metropolitan area. The route included local, county, state and interstate roadways with a mix of pavement types as well as single, two- and three-lane facilities. Tests were conducted at prevailing traffic speeds. Phase 2 included 20 runs along the test route.

Results

During rigorous testing across a wide range of winter conditions, the four sensors performed similarly in both quantitative and qualitative areas. No sensor was shown to be universally the best or worst across all parameters. Researchers ranked the devices' accuracy at measuring individual parameters, but they noted that the differences in value used to determine the rankings were often very small.

Researchers noted that because of the generally similar efficacy across all tested sensors, other factors—such as cost, parameters measured, ease of installation, and type of user interface—may be more significant to agencies in their purchasing decisions.

Benefits and Further Research

The extensive side-by-side testing conducted through this project gives agencies a wealth of data to help them select the mobile RWIS sensors that best fit their needs. The final report facilitates comparisons by gathering key information on the four sensors together in one document.

Researchers noted that key differences across sensors made comparisons more challenging. To help address this issue, the researchers developed standardized recommendations for future sensors. They developed an easy-to-use standard for categorizing pavement surface states tied to simpler descriptions—ice, snow, wet, dry—and suggested categorizing friction and mobility impact into a few basic levels as well. If sensor manufacturers adopt this approach, it would provide agencies with a clear and consistent standard for decisions about roadway treatments.

> "The results of this project will help Clear Roads states decide among different mobile sensors, and they provide a framework for us to work with manufacturers to develop simpler ways to describe pavement surface conditions."

Project Champion Kyle Lester
Colorado Department of Transportation
kyle.lester@state.co.us

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