Testing a Friction Measurement System in Polk County

What Was the Need?
Winter maintenance in Polk County, located in northwestern Minnesota, primarily consists of plowing. While salt and sand are used at intersections, curves and hills, deicing chemicals on open stretches of road can sometimes cause blowing snow to form ice on the wet pavement surface.

Some friction measurement systems can identify these icy patches and detect the slipperiness of a given road section. Measuring friction on roads during and after snowfalls has a wide range of potential benefits. These measurements, reported as friction coefficients, can be used to provide road condition information for travelers and to schedule winter maintenance operations. The data also provides a way to quantify performance so an agency can know how well it is maintaining roads in winter, which can improve safety if shortcomings are identified and addressed. Collecting data about winter maintenance performance can also help to address any public and legal concerns related to winter maintenance operations.

Researchers had previously developed a friction measurement system for cars and tow plows that used GPS and wheel speed measurements on the vehicle to calculate friction coefficients. While the system worked quickly and reliably, it required acceleration or deceleration of at least 0.3 meters per second before it could update the friction coefficient. Without this acceleration or deceleration, no readings could be taken.

Polk County needed to test an improved system that could collect data whenever the snowplow is operating to determine if information was adequate and useful, and to determine whether the system would be reliable under real-world plowing conditions.

What Was Our Goal?
The goal of this project was to install such a friction measurement system on two snowplows in Polk County and to compare the actual surface condition after plowing to dry road conditions.

What Did We Do?
Researchers improved the original system by installing an instrumented wheel near the snowplow’s front axle and developing an algorithm to compensate for the snowplow’s vibrations, which could corrupt measured data. They built a wooden model of the system to test the concept and determine an adequate slip angle (the angle between the wheel’s direction of travel and the direction it is pointing).

The system was fabricated out of steel and installed on two Polk County plows at the start of winter 2012 for testing. Based on Polk County’s requests, the user interface was kept simple. Two microprocessors—one near the friction wheel and one in the truck cabin—provide data acquisition, signal processing, and data recording and display. One switch turns these microprocessors on and off, and a second raises and lowers the friction wheel. The operator instructions for the system are a single page.

Researchers tested a friction measurement system on two snowplows in Polk County, Minnesota. This system would help quantify winter maintenance performance and help optimize maintenance operations. The data collected could also provide travelers with road condition information.
What Did We Learn?

The data collected showed that Polk County’s roads were in better condition than anticipated; results confirmed that current winter maintenance practices are generally sufficient to keep the roads in navigable condition. This data will be valuable for public communications purposes.

When the preliminary system was mounted on a pickup truck, it successfully detected the start and end of an artificial slippery patch. These tests revealed that a 6-degree slip angle was adequate to detect changes in friction coefficient.

The friction measurement system operated as expected during the first snowstorm. However, during a subsequent inspection, the plain bearings in the pivot that raises and lowers the instrumented wheel failed on both plows. Researchers speculated that the oscillations from a relatively coarse seal coat aggregate on the road caused the failure.

The system was rebuilt with larger ball bearings and reinforced mounts, but it also failed after a few days of work.

A lack of funding, communication challenges and the distance between Polk County and the Twin Cities, where the research team is based, prevented further repairs to the system as part of this project.

What’s Next?

There are no current plans for further LRRB-funded research on this project. The road condition data collected should be useful to Polk County even though the project fell short of the county’s goal of collecting a year’s worth of data.