RESEARCH SUMMARY

DEPARTMENT OF TRANSPORTATION

LOCAL ROAD RESEARCH BOARD

JUNE 2025

Evaluating the Friction of Pavement Markings and Colored Pavement

Pavement markings make travel safer for all road users. However, the material used for retroreflectivity can be slicker than the surrounding pavement. To maximize the safety of bicyclists, motorcyclists and pedestrians, MnDOT and local agencies explored the friction values of different marking materials. Project results produced valuable information on relative friction between pavement and marking materials and, importantly, identified effective testing tools to evaluate and compare products.

What Was the Need?

Pavement markings are crucial for traffic flow and safety for all road users, especially at night or in other low visibility conditions. Retroreflective material reflects light back to its source, enhancing visibility at night. But the components of these materials can make the markings slicker than the surrounding pavement. This change in friction between the pavement and the markings may create a safety hazard for bicyclists, motorcyclists and pedestrians, especially when the markings are wet.

The friction and durability of pavement markings and colored pavement materials are improving. While MnDOT and local agencies use a variety of pavement marking materials, the differences in friction between the markings and pavement have not been investigated. To enhance the safety of all road users, the agencies wanted to explore and compare the friction values of various materials and the best equipment to measure friction.

What Did We Do?

A comprehensive review of past research on skid resistance and durability of pavement marking and colored pavement products explored latex, thermoplastics, preformed tape, epoxy-based material, methyl methacrylate (MMA) marking materials and other products. Researchers also reviewed NordicCert, a Scandinavian certification process for road marking materials, to inform consideration of a similar framework in Minnesota.

"We were uncertain of the quantitative friction values we should strive for and how to compare skid resistance of different pavement marking products. This work provides foundational insight into how to compare materials going forward to enhance the safety of vulnerable road users."

—ETHAN PETERSON, PAVEMENT MARKING AND CRASHWORTHY ENGINEER, MnDOT OFFICE OF TRAFFIC ENGINEERING

To understand how pavement markings impact vulnerable road users, researchers evaluated data from 351 motorcycle crashes, including pavement marking details, road surface conditions and weather. Additionally, a survey of road users gathered perspectives from bicyclists, motorcyclists and pedestrians regarding general experiences with pavement markings and any slipping incidents.

Preliminary testing determined the friction properties of pavement surfaces, pavement markings and colored pavement. The research team also tested and compared three types of friction-measuring equipment: a dynamic friction tester (DFT), which operates at variable speeds; a British Pendulum Tester (BPT), which is only used at very low speeds but is still representative of pedestrian and bicyclist experience; and a T2Go slow-moving wheeled friction-measuring device.

Pavement marking friction experiments at the MnROAD testing facility in November 2023 and June 2024 identified wear from traffic and winter conditions. Ten products installed on both concrete and asphalt pavements included latex with Type 1 beads, different epoxy formulations, Preform Thermo and MMA supplemented with beads, corundum, taconite, crushed glass and other materials. The research team used a DFT and a BPT for the friction measurements, and a Sideway-force Coefficient Routine Investigation Machine (SCRIM) to obtain continuous friction data.

What Did We Learn?

The analysis of motorcycle crash data showed a strong correlation between pavement markings and surface conditions, especially under adverse weather conditions. Similarly, all three vulnerable road user groups surveyed reported that pavement markings were slick when wet. All groups recommended marking material improvements, such as adding texture or roughness for better safety.

Preliminary tests revealed higher friction of epoxy pavement markings on dry concrete, but higher friction varied between the pavement and markings in wet conditions. The DFT and BPT produced consistent measurements, but the T2Go device measurements were inconsistent with the other two devices.

As in preliminary testing, the DFT and BPT produced comparable results in the MnROAD tests, as did the SCRIM. Average pavement marking friction decreased over time due to wear and environmental exposure. Materials such as corundum, crushed glass and locally available taconite increased the friction properties of epoxy- and MMA-based markings.

The NordicCert pavement marking certification system could provide a model for a similar certification system in Minnesota. While desirable pavement marking friction levels were not conclusively identified, researchers suggested a procedure used in the U.K. for providing options to correct any skid resistance problems.

What's Next?

MnDOT and local agencies can continue to monitor the pavement markings applied at MnROAD and evaluate various materials and friction enhancements across winter seasons and other varied conditions. The DFT could be the most cost-effective, consistent testing method. The SCRIM provides the most comprehensive friction measurements without the need for traffic control, but it may be cost-prohibitive.

About This Project

REPORT 2025-30
"Pavement Marking/Colored Pavement Friction Differential and Product Durability."
Find it at mdl.mndot.gov.

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PROJECT COST
$152,473

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