RESEARCH SUMMARY

DEPARTMENT OF TRANSPORTATION

LOCAL ROAD RESEARCH BOARD

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Evaluating Taconite as a Lower Cost Friction Treatment

High friction surface treatments (HFSTs) on Minnesota roads are composed of imported, industry standard calcined bauxite aggregate. This material is expensive, and producing it is energy-intensive. Taconite aggregate, a by-product of the Minnesota mining industry, is a potential alternative to calcined bauxite that is less expensive. This research compared taconite and calcined bauxite in field skid resistance performance testing to determine the feasibility of using taconite in place of calcined bauxite in HFST applications.

What Was the Need?

Taconite rock from the Mesabi Iron Range is one of the hardest natural geological materials available for use in HFST as a friction aggregate. HFST is the method of enhancing pavement skid resistance to reduce the number of vehicles that lose control at susceptible roadway locations such as horizontal curves, bridge decks, ramps or intersection approaches. Because it is a local product, it is potentially a less expensive friction aggregate alternative to calcined bauxite with a smaller environmental footprint. Previous research of HFST aggregates found that taconite was the best-performing natural aggregate. Before considering adopting this by-product, the Local Road Research Board and MnDOT wanted to assess its friction capabilities and compare the material to the skid resistance performance of synthetically produced calcined bauxite in HFST applications.

What Did We Do?

Pavement test sections composed of the industry standard HFST calcined bauxite, taconite and a control were established on a straight segment of a low-volume two-lane road near Duluth, Minnesota. For more than four years, investigators measured friction properties using a

"Results suggest taconite could offer comparable safety benefits while reducing environmental impacts and providing potential cost reductions. Further research is needed for more performance comparisons with calcined bauxite."

—VICTOR LUND, TRAFFIC ENGINEER,
ST. LOUIS COUNTY PUBLIC WORKS DEPARTMENT

dynamic friction tester (DFT), a British Pendulum (BP) skid resistance tester and MnDOT's locked-wheel pavement friction tester (LWPFT). DFT and BP tests were conducted twice each year (in the spring and fall), and the LWPFT test was performed annually.

A life cycle assessment (LCA) and additional environmental testing of HFST systems using taconite and calcined bauxite compared the environmental impacts on human health, ecosystems, natural resources, cumulative energy demand, climate change and water use. Whereas taconite friction aggregate is produced by only drying and screening taconite tailings to meet HFST specifications, calcined bauxite is commonly produced overseas by heating bauxite up to 2900° to 3000° F.

Additional testing included a demonstration of Sideway-force Coefficient Routine Investigation Machine (SCRIM) technology, which measures friction continuously and provides more complete measurements.

What Did We Learn?

Friction numbers in HFST test sections with taconite and calcined bauxite were 40% to 50% higher than friction numbers in the chipseal control test section. Taconite friction numbers were comparable to those for calcined bauxite—averaging only 6% lower friction results—demonstrating the two aggregates wear and maintain their friction performance similarly.

LCA results indicated an HFST system using taconite had a significantly lower impact on all environmental impact categories, ranging from a 55% lower impact for ecosystems to a 31% lower impact for natural resources. Using epoxy resin to bind taconite tailings accounted for nearly 95% of taconite's environmental impacts. The majority of impacts for calcined bauxite were due to the use of epoxy resin, preparation of the calcined bauxite and an ocean freighter transport from China.

Overall, the most significant impact may be the productive use of a Minnesota mining by-product as a source of high-quality friction aggregate that eliminates the need for its disposal.

The BP results exhibited greater variability and had a low correlation with the DFT testing results. SCRIM testing demonstrated detailed friction and pavement texture information over short distances and along horizontal curves. Further, the SCRIM results were consistent with DFT results, lending more credibility to the DFT measurements. While SCRIM is costly, its continuous friction testing capability would add valuable data to future relevant research and testing.

The HFST classification essentially applies only to calcined bauxite since no other natural aggregate can meet the minimum specifications for an HFST. Going forward, agencies should consider referring to taconite as an enhanced friction treatment.

What's Next?

Field testing results indicate that taconite can provide comparable friction performance to calcined bauxite with a smaller environmental footprint. While cost was not analyzed as part of this project, taconite's availability in Minnesota suggests it would be less expensive than manufactured and imported calcined bauxite.

Ongoing research should focus on taconite installations in higher stress environments, including curves, and in areas with higher traffic volumes, high-speed traffic, vertical grades and high truck volume to provide better performance comparisons with calcined bauxite.

About This Project

REPORT 2025-41
"Taconite as a Lower Cost Alternative High Friction Surface Treatment to Calcined Bauxite for Low-Volume Roads in Minnesota."
Find it at mdl.mndot.gov.

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