



RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

TECHNICAL SUMMARY

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PROJECT COST:

N/A (Included in regular
Mn/DOT operations)



MnROAD cell 31, now in place for six years, had two transverse cracks after the third winter of testing, but otherwise showed no signs of distress.

Recycling Mining Materials as Durable Aggregates

What Was the Need?

Highway construction requires high-quality aggregates—crushed rock used in road foundations and pavements. Because these aggregates are becoming scarce in many parts of the country, new sources are needed. One possible source is taconite, a sedimentary rock consisting of iron mixed with various minerals. Each year, about 125 million tons of taconite waste are produced from Minnesota's Mesabi Iron Range as a byproduct of iron ore mining. Such mining requires blasting through very hard layers of taconite bedrock, called overburdens, to get to the more iron-rich minerals beneath them. Taconite byproducts include rocks of various sizes as well as tailings, which are sand-sized particles that result from crushing these rocks. The largest taconite rocks—2-inch stones with flat shapes and rounded edges—are sometimes used as railroad ballast, but until recently most taconite waste was landfilled.

Researchers evaluated an iron mining byproduct called taconite for use in roads as a high-quality aggregate and found it to be durable. MnROAD test sections using taconite performed as well as or better than those using conventional aggregates.

However, there was little information available on taconite use in construction design specifications. Consequently, Mn/DOT began a partnership in 2004 with the Minnesota Department of Natural Resources to evaluate taconite aggregates for use in asphalt and concrete mixtures. Part of this evaluation included construction of test sections at [MnROAD](#), a test facility for researching pavement materials that includes a traffic-bearing stretch of I-94. The current project is part of ongoing monitoring of these test sections.

What Was Our Goal?

The goal of this project was to assess taconite for use as an abundant and high-quality aggregate by evaluating the long-term performance of several MnROAD test sections using it.

What Did We Do?

Researchers evaluated the performance of five MnROAD test sections: two built in 2004 and three in 2008. The 2004 cells were constructed on MnROAD's Low Volume Road, or LVR, which tests an 80,000-pound truck traveling about 80 laps per weekday on the inside lane. These sections included cells 31 and 54, paved with asphalt and concrete mixtures incorporating taconite aggregate, respectively.

For the 2008 test sections, two cells were constructed on the MnROAD Mainline, which carries live I-94 traffic for all but three days each month. During the project, a third cell was added on the LVR. These included cell 6, constructed on the Mainline with a 2-inch layer of fine aggregate asphalt mixture incorporating two taconite tailing sources, placed over a 5-inch-thick concrete pavement; and cells 23 and 87, constructed on the Mainline and LVR, respectively, with a base consisting of taconite railroad ballast.

With the exception of cell 87, which did not successfully bear truck traffic for reasons unrelated to the taconite (the rock underneath failed), researchers monitored test sections regularly for performance, collecting data two to four times per year on cracking, rutting, ride quality, faulting and friction. They also tested pavement strength using a falling weight deflectometer and [conducted laboratory tests](#) on taconite materials used in cells 6 and 23, including evaluations of gradation and specific gravity.

continued

"Taconite could supply a high-quality aggregate for roadway use that would lead to cost savings for Mn/DOT and would benefit the environment."

—Tim Clyne,
MnROAD Operations
Engineer, Mn/DOT
Materials and Road
Research

"Laboratory tests have shown taconite aggregates to be tough, durable materials, performing as well as or better than conventional aggregates."

—Eddie Johnson,
Research Project Engineer,
Mn/DOT Materials and
Road Research



The taconite used in this study was delivered via specialized trailers that can travel by rail or semi-tractor, demonstrating a promising option for future long-distance hauling of taconite aggregates to road construction projects where local aggregates are scarce.

Finally, researchers conducted a field experiment in Otsego, Minnesota, to evaluate the usefulness of microwave technology for heating materials while patching potholes. Researchers used non-taconite patching materials with a view to establishing a baseline for future testing of taconite as a more suitable patching material.

What Did We Learn?

Results showed that taconite aggregates can be used successfully to construct high-quality aggregate base, asphalt and concrete pavement layers.

The test sections constructed at MnROAD have performed as well as or better than those built using conventional aggregates. Skid resistance in particular has been exceptional in the taconite cells, and other parameters such as ride quality and the amount of rutting and cracking have been satisfactory. Laboratory tests showed that material properties of the taconite aggregates and mixtures have generally been as good as or better than those of traditional aggregates. Based on these results, Mn/DOT has developed standard specifications for the use of taconite materials in roads.

The pothole demonstration project showed that microwave technology can be used to patch potholes, with the test patch performing well over time. However, the patching operation will need to be made more efficient for this process to gain widespread use.

What's Next?

Researchers will continue to monitor test sections and will also evaluate the performance of thin lift hot-mix asphalt pavements using taconite via the recently initiated project ["Performance of Taconite Aggregates in Thin Lift HMA."](#) They will also continue to investigate the use of taconite aggregates for pothole patching and testing properties of the rock to make the process more efficient.

Produced by CTC & Associates for:

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