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OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

TECHNICAL SUMMARY

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PROJECT COST:
$40,000

Under the right conditions, taconite-based Rapid Patch can be mixed in and poured from a bucket or a wheelbarrow to repair concrete pavements.

Taconite-Based Pavement Patches Show Promise for Pothole Repair

What Was the Need?

The Minnesota pothole season hits hard in late winter and early spring as freeze-thaw cycles and traffic together turn small pavement problems into fissures and potholes. Full-depth replacement is expensive and time-consuming. Careful cleaning and filling with hot-mix asphalt can work, but in winter is impractical or even impossible.

The typical response is throw-and-go: Drive a truck with a mound of cold-mix asphalt in back, fill the hole with a shovel, pat the asphalt down, then move on to the next pothole five minutes later. A maintenance crew can do scores of these repairs in one shift, but they may not last. Patches bond poorly to asphalt, are vulnerable to freeze-thaw, and can be damaged and loosened by snowplows. Many patched potholes have to be refilled within a week.

A durable patch—something that lasts six months or more and can be done quickly—would optimize patching crew time and reduce inconvenience to the driving public.

Taconite-based pothole repair methods seem to be durable and potentially cost-effective. Both Rapid Patch for concrete and the microwave method for asphalt appear well-suited to Minnesota repair conditions and will offer quick, relatively permanent pothole solutions if the technology can be refined further.

What Was Our Goal?

This study evaluated two potentially durable patching technologies that employ taconite tailings—magnetite containing aggregate left over from the mining and processing of taconite for steel manufacturing. Taconite industry byproducts are plentiful in Minnesota. Rapid Patch, a water-activated taconite mix, was studied for rigid and flexible pavement repair. The microwave method, employing a magnetite-enhanced mix and a 50,000-watt truck-mounted microwave unit that heats both the pavement and the patching material, was evaluated for flexible pavement repair only.

What Did We Do?

Investigators began by conducting a literature search on various pothole patching technologies and their performance and durability. They reviewed lab testing from their own previous research on the two candidate methods and selected sites for field evaluation.

In October 2012 they performed five microwave repairs and three Rapid Patch repairs on U.S. Highway 53 in Minnesota. At the same area they also evaluated patching performed with an infrared heater method and an on-site recycler that uses recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS) in its hot mix. Investigators also patched three potholes with Rapid Patch and three with the microwave method on Grand Avenue in Duluth, Minnesota, where infrared patching had been conducted with little success. The research team documented performance of all patches for more than two years and some until August 2015.

What Did We Learn?

Taconite-based repairs appear durable. Many lasted three years, and though some cracked, the repairs remained in place.

Rapid Patch can perform well for years and best suits deep holes and concrete pavements in cool to moderate ambient temperatures. Challenges include clumping and inadequate blending of dry and liquid constituents, which are mixed on-site with a small

continued

"These two approaches offer essentially permanent repairs. They last a season, and some of the repairs lasted almost three years. With the microwave repairs, the pavement around the hole becomes part of the repair, creating a bond that is really critical."

—Lawrence Zanko,
Senior Research Fellow,
University of Minnesota
Natural Resources
Research Institute

"There are more ways to patch than just sitting in the back of a truck and throwing bituminous mix into holes. Some work better with concrete, some with bituminous. These taconite-based mixes can make durable patches."

—Sue Lodahl,
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The truck-mounted microwave unit (top left) heated both the pavement and the new patching material made from Minnesota taconite mining byproducts, creating a durable bond between pavement and fill. The repair was then monitored over several months.

drill-powered paddle, adding time to the process; rapid setting and poor handling in warm conditions; and brittle behavior at thin edges of applied patches. Some observed difficulties may have resulted from deviations from the recommended blending recipe. Below are specific performance details:

- Rapid Patch used around a steel manhole cover in Duluth was cracked but still intact in August 2015.
- A deep saw-cut repair on a bridge on U.S. Highway 169 in 2010 continues to perform well.
- In transverse joint repairs, Rapid Patch performed well compared to the asphalt recycler in 2012 and repairs made with taconite compounds in 2014.

The microwave method heats pavement enough to make existing pavement part of the repair material, creating an excellent and durable bond, and so suits asphalt repair in all ambient temperatures, including very cold. Single repairs appear durable enough to avoid multiple visits and concomitant costs and inconveniences. Conclusions about the microwave method include the following:

- Effective repair compounds can be made from inexpensive and abundant recycled materials, such as RAP or RAS.
- Microwave repair at 50 kilowatts takes longer than typical repairs; increasing microwave power to 75 kilowatts or 100 kilowatts may shorten repair time.

Investigators identified challenges with other methods of pothole repair. Infrared methods heat pavement unevenly to depths of 1 and 1-1/2 inches only, limiting malleability necessary for a good bond. Hot-mix recyclers can be effective, but RAP quality varies from batch to batch, leading to uneven performance.

What's Next?

Rapid Patch and microwave promise long-lasting performance. Six months, even a year, proved readily attainable. Investigators from the Natural Resources Research Institute will further refine Rapid Patch to simplify mixing, increase its flexural properties with fibers, and develop an automatic application system that would circumvent on-site mixing. Microwave users managed to get patches done in less than 15 minutes. Higher power microwaves may reduce installation time to seven or eight minutes.

This Technical Summary pertains to Report 2016-03, "Evaluate and Develop Innovative Pavement Repair and Patching: Taconite-Based Repair Options," published January 2016. The full report can be accessed at mndot.gov/research/TS/2016/201603.pdf.