

Research Spotlight

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MDOT innovation leading to faster, longer-lasting pavement repairs

Current methods of patching pavement must evolve to meet increasing mobility demands. To address this need, MDOT has been testing a new generation of rapid set full-depth pavement repair materials. Initial results are promising. The new materials are cost-effective and achieve faster early-age strength gain, allowing earlier opening to traffic.

Problem

Patching aging pavement, an integral part of roadway preservation, can interrupt traffic.

That's why fast set repair mixes, which allow earlier opening to traffic (OTT), have been an important part of concrete patching strategies. Prior to 20 years ago, MDOT used fast set mixes with high cement content and calcium chloride additives to accelerate the early-age strength gain. Although the cost of these mixes was moderate, their service lives did not meet MDOT expectations. The fast-acting calcium chloride also made it challenging to place and finish the fresh concrete before it began to set up. Additionally, calcium chloride can be corrosive to reinforcing steel. Because of these constraints, MDOT no longer uses the mixes.



New rapid set mixtures are showing user-friendly characteristics, good potential for durability and OTT times within six hours of batching.

The standard patching mixes that MDOT has been using for the past 20 years are more durable, containing a moderate cement content and minimal (non-chloride) set accelerators. That means that there is a higher likelihood that the repairs will achieve their anticipated service life of 15 years—and a more manageable work time for the fresh concrete. Moderate in cost, these accelerated mixtures are adequate for most patching scenarios. But with normal

“The new rapid set patching mixtures meet our mobility objectives and are demonstrating that they are durable as well. When applied strategically, they can be a cost-effective alternative to extend the service life of an aging roadway while still meeting our mobility demands.”

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cure times of 18 to 72 hours, these patching mixtures are less than ideal when ultra-fast early-age strength gain is required (in less than eight hours) in order to meet traffic mobility requirements.

MDOT has sought to achieve a new generation of mixes for cast-in-place patches that are rapid setting for earlier OTT and are also durable, user-friendly and cost-effective.

Approach

Though durable, precast concrete pavement panels have very specialized applications and are not feasible for widespread pavement repair applications. However, because of the factory-like production of precast panels, time is essential in their curing—and that means fast set mixes are the norm. After discussions with precast industry representatives, MDOT staff formulated an innovative theory: Could the materials used in the precast industry to accelerate early age strength gain also be used in the field to enhance the strength gain of cast-in-place patching concretes?

Research

Based on this theory, MDOT staff designed a new suite of patching mixtures containing traditional coarse and fine aggregates along with selected non-chloride accelerator and rapid hardening admixtures. When preliminary field trials proved encouraging, MDOT approached researchers at the University of Michigan’s Concrete Pavement Performance Center of Excellence to evaluate accelerated means toward qualifying whether these mixtures have the durability characteristics necessary to last 15 years in the harsh Michigan roadway environment.

In the lab, the university has been focusing on two key areas: how each of the admixture components function within an overall mixture and the durability of these materials. Researchers evaluated admixture components, varying the ingredients in efforts to fine-tune the rapid set mixes for optimum performance. To address durability, they are using high-resolution microscopy and an absorption and salt-scaling durability test (a modified version of a RILEM test) to analyze rapid set repairs. Researchers also are testing for shrinkage, warping and curling.

Meanwhile in the field, five MDOT preventive maintenance contracts demonstrated these new rapid set mixes in more than 600 full-depth pavement repairs. Additionally, the new rapid set mixes were used in approximately 100 localized full-depth repairs administered by in-house maintenance crews.

Results

Rapid set repairs in the field are achieving the necessary early-age strength gain required to meet the demanding mobility requirements, demonstrating OTT times of six hours. They also are performing well within the targeted work time of one hour (from batching to placing) and require no major modifications to established

construction procedures.

Lab tests thus far indicate potential that the new rapid set patches can last as long as MDOT’s current concrete patching mixes.

Thanks to the ongoing lab evaluations, researchers continue to refine the new rapid set mixes as field performances are analyzed.

Value

Instead of using very expensive fast set proprietary mixes with limited application, MDOT developed a new generation of rapid set mixes that will allow the agency to construct concrete patches in restricted time frames. Because these new mixes are still about 50 percent more costly than the current standard patching mixes, MDOT will target their use only on high-traffic corridors. For example, instead of stopping work on Saturday for patches to cure by Monday morning, crews can make a carefully timed switch from the less expensive mixes to these rapid set mixes and continue construction all the way to Sunday night. The high-traffic route then can be opened for Monday morning commuters, with weekend production nearly doubling.

Research Administration

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