Researchers tested five types of waste quarry fines (inset) as a sustainable solution for stabilizing Iowa's unpaved roads.

RESEARCH SOLUTIONS

Recycled quarry byproducts may help Iowa's unpaved roads last longer and perform better

Iowa's unpaved roads provide essential connectivity for rural and agricultural communities across the state. However, extreme temperature changes and heavy equipment can damage and erode the unbound aggregates on the roads' surface, leading to potholes, ruts, and other problems. In the hunt for a cost-effective and environmentally sustainable solution, researchers found that combining the aggregates with quarry fines—the small particles that remain after the usable stones from a quarry have been extracted and crushed—can improve the roads' performance and reduce the need for routine maintenance.

THE NEED

Granular, or unpaved, roads provide much-needed access for Iowa's rural communities. Lower traffic volumes allow these roads to be surfaced with loose aggregate, which costs less to construct and maintain than paved roads. However, the vehicles that do travel on granular roads include heavy agricultural equipment. The weight of these vehicles, as well as the actions of seasonal freeze-thaw cycles, can break down the aggregates over time and cause them to blow or wash away. Without the protection of the aggregate surface, the lower layers of the road are more prone to developing distresses like ruts and potholes.

To repair and minimize these problems, maintenance crews have traditionally added more aggregates to the roadway surface. But as these dwindling natural resources become more costly and harder to find, Iowa's county engineers have begun to explore new and innovative ways to prolong the life of the aggregate surface layer.

Chemical stabilizers are one option, but they can be expensive and

(continued)

"This research showed that byproducts from local quarries may offer county engineers an economical option for stabilizing the unpaved roads in their area."

— **BRIAN MOORE,**
Secondary Roads Research Engineer,
Iowa County Engineers Association Service Bureau

challenging to apply. Alternatively, waste quarry fines are natural, prevalent, and inexpensive. The byproducts of quarrying, these fines are typically considered too small for most construction applications. To learn whether and which types of waste fines could be successfully combined with surface aggregates to help unpaved roads last longer, Iowa DOT collaborated with a team of researchers to perform a variety of tests to quantify the fines' benefits.

RESEARCH APPROACH

First, the researchers considered materials from 19 quarries across the state, ultimately selecting five types of fines for further investigation. Four of the fines had textures ranging from sandy to granular, while the fifth—a clay slurry produced as a byproduct of the mining operations that extract fracking sand—was denser and heavier as a result of its high water content.

Next, a series of laboratory tests helped the researchers evaluate the characteristics of the fines and match them with appropriate aggregates. At test sites in Boone and Jones counties, researchers created nine test segments on unpaved roads with relatively high traffic volumes. Seven segments were constructed with fines added to the aggregate, and two existing stretches without fines were used for control purposes. The researchers conducted a series of durability tests and monitored the performance of each segment over several seasons.

Finally, to determine the cost-effectiveness of adding waste quarry fines, researchers compared the higher initial construction costs with the potential benefits of less frequent routine maintenance, including fewer repair-related travel delays.

WHAT IOWA LEARNED

The test segments with added fines generally performed better than the segments without added fines. However, whether fines would be a valuable addition for a specific road depends on a variety of factors, including the amount of materials needed, hauling costs, and the distance between the source quarry and the jobsite.

Moisture content directly affected the hauling costs of the fines; the clay slurry weighed the most and consequently cost significantly more to transport than any of the other four fines evaluated. After the study concluded, the clay slurry supplier stopped offering the clay slurry and instead sells aggregates that have been pretreated with clay slurry and dried—an improvement that reduces costs associated with hauling water and should help make the clay treatment more comparable to the other fines in cost.

PUTTING IT TO WORK

While waste quarry fines offer a promising solution for stabilizing unpaved roads, the array of economic and situational factors that must be considered make for a highly individual and localized decision. As an added tool in a road agency's toolkit, this technique offers significant benefit for the right situations. Additional research into other types of quarry materials, different aggregate-fine ratios, and longer-term performance would help local road managers make better-informed decisions about whether and which types of fines to use.

ABOUT THIS PROJECT

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