



## TECHNICAL SUMMARY

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### TOTAL PROJECT COST:

\$92,624

### LRRB COST:

\$46,312



Coarse aggregate rocks are smaller than 3 inches but too large to pass through a sieve with 1/4-inch-diameter holes.



## RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,  
RESEARCH & INNOVATION

# A Property-Based Specification for Coarse Aggregate in Pavement Applications

## What Was the Need?

Building durable road bases and pavements requires the use of high-quality aggregates, or mixtures of sand, gravel and crushed rock. Aggregates are often obtained from local supplies of natural rock, which may then be crushed and blended to meet certain specifications, including size. Coarse aggregates are those that will pass through a screen with 3-inch diameter holes but not pass through a sieve with 1/4-inch diameter holes.

Minnesota has numerous sources of aggregates, including gravel pits and rock quarries. To ensure aggregates from these sources are of a high enough quality to produce well-performing pavements, they are tested annually against certain specifications for abrasion resistance (resistance to crushing and degradation), percent spalling materials (the amount of rock in an aggregate that is easily weathered, is highly absorptive or reacts chemically with other mixture materials) and soundness (resistance to weathering and freeze-thaw deterioration).

Minnesota's current aggregate specifications have been in use since the 1930s, and it is possible that they could be improved by requiring tests for properties more directly related to pavement performance. Further, basing requirements on performance properties might allow the use of unified specifications applicable to both concrete and asphalt mixtures. However, before specifications can be modified, researchers need to better understand how well Minnesota aggregates meet current specifications.

## What Was Our Goal?

The objective of this study was to explore the possibility of improving and unifying Minnesota coarse aggregate specifications for asphalt and concrete by including additional requirements for properties that predict pavement performance.

## What Did We Do?

Researchers began by performing a literature review of coarse aggregate testing procedures commonly used in Minnesota and other states. Then they conducted an electronic survey asking researchers, engineers and other pavement industry professionals to rank a list of physical, chemical and mechanical properties of coarse aggregates as well as associated methods for testing them in order of their importance as indicators of aggregate quality.

Researchers then analyzed district testing data for 76 Minnesota local aggregate sources contained in Mn/DOT databases from the year 2000 onward to determine for both asphalt and concrete applications:

- How well Minnesota local aggregates satisfy current specifications, including requirements for abrasion resistance, percent spalling materials and soundness.
- What other aggregate testing procedures are commonly being used in Minnesota districts, and how well on average they predict aggregate quality as measured by current specifications.

*Researchers explored the possibility of improving and unifying Minnesota coarse aggregate specifications for asphalt and concrete mixes by including requirements for properties that more adequately predict pavement performance, such as compressive strength.*

*“This project created an important dialogue between asphalt and concrete engineers and geologists, including a discussion of the pros and cons of using various properties in coarse aggregate specifications.”*

—John Grindeland,  
Fillmore County Highway  
Engineer

*“Improvements in coarse aggregate specifications could eventually simplify construction processes and increase the use of local materials, saving Mn/DOT time and money.”*

—Magdy Abdelrahman,  
Assistant Professor, North  
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**Produced by CTC & Associates for:**

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A common test for measuring abrasion resistance is the Los Angeles abrasion test, used to evaluate how well aggregate stones remain intact when subjected to grinding in a rotating steel drum containing steel spheres.

Finally, researchers compared the quality of Minnesota aggregates to those of neighboring states with similar specifications, and discussed preliminary results with Mn/DOT engineers to examine their views on current coarse aggregate requirements.

### What Did We Learn?

Results showed that aggregate specifications in Minnesota and other states do not include tests for those properties identified by survey respondents as most important for predicting pavement performance, suggesting that improvements are needed. The aggregate property identified as most important for both asphalt and concrete mixtures was compressive strength, or the capacity of a material to withstand a force applied to its axis. Respondents also identified solubility as an important aggregate property for concrete performance; and aggregate coatings, asphalt affinity and integrity as significant for asphalt applications.

The analysis of historical testing data showed that, on average, Minnesota aggregates met both concrete and asphalt specifications more than 90 percent of the time. Aggregates met the abrasion resistance requirement more than 92 percent of the time, percent spalling materials more than 67 percent of the time and soundness more than 70 percent of the time. However, these averages do not reflect the fact that aggregate quality varied significantly between Minnesota districts, especially for asphalt applications. Further, some aggregate sources that were compliant with specifications on average varied significantly from one measurement to another, reflecting a lack of consistency that can affect pavement performance. This variability was slightly higher in Minnesota than in other states.

### What's Next?

This study, which resulted in three papers published in key transportation journals and conferences, comprises the first task in restructuring coarse aggregate specifications to be based more closely on the performance of asphalt and concrete mixes. A better understanding of available aggregate testing methodologies and those properties critical to evaluating aggregate quality will help maximize the use of local sources, which are sometimes rejected despite the fact that they may be suitable for low-volume applications even when not suitable for high-quality mixes. This will contribute to the sustainability of Minnesota's aggregate supply. Mn/DOT is receptive to modifying current specifications in the future, once better correlations are established between aggregate properties and pavement performance.

*This Technical Summary pertains to the LRRB-produced Report 2010-35, “A Property-Based Specification for Coarse Aggregate in Pavement Applications,” published October 2010. The full report can be accessed at <http://www.lrrb.org/PDF/201035.pdf>.*