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LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

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LRRB PROJECT COST:
$36,000

Class 5 modified aggregate allows for limestone with larger particle sizes, reducing fines produced by crushing.

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# Using Larger Gradation Limestone Aggregates in Bases Saves Money, Improves Pavement Performance

## What Was the Need?

To ensure the quality of its roadway foundations, MnDOT sets specifications concerning the gradation—or allowable particle sizes—for the aggregates that compose them. With too many fine particles, aggregates will tend to absorb and hold water, leading to damage caused by expansion and contraction during seasonal freezing and thawing. Currently MnDOT typically requires that aggregates for road base meet Class 5 specifications so that they consist primarily of rocks that are 3/4 inch or smaller.

*Using a larger gradation for limestone aggregate bases not only improves the performance of pavements and their resistance to freeze-thaw cycles, but may be less expensive than crushing rocks to meet standard Class 5 specifications.*

In Olmsted County and other areas of southern Minnesota, preparing aggregate that meets Class 5 specifications requires crushing large limestone rocks available for use in this area. This process results in an excessive amount of fine particles produced during crushing, placing and rolling. Research was needed to see if larger particle sizes should be allowed to offset this effect. Consequently, in 2000 the Minnesota Local Road Research Board and MnDOT constructed pavement test sections on Olmsted County Road 104 and CR 117 to compare Class 5 limestone aggregates to two alternative gradations allowing larger particle top sizes. Because two previous five-year study phases failed to show significant differences in the performance of these sections, a third five-year study was performed to continue monitoring from 2010 to 2015.

## What Was Our Goal?

The goal of this project was to continue monitoring CR 104 and CR 117 to evaluate the effect of larger limestone aggregate base particle size on pavement performance.

## What Did We Do?

Researchers monitored performance of three test sections on CR 104 and CR 117 for five years and compared results to data from two previous five-year studies.

Section 1 used a standard Class 5 crushed limestone base; section 2, a permeable aggregate base with a particle top size of 3 inches; and section 3, a Class 5 modified base with a particle top size of 2 inches.

Monitoring included traffic volume counts to record the effects of traffic loads; automated and visual pavement surveys of cracking, rutting and other forms of distress; and periodic falling weight deflectometer testing of base stiffness and cone penetrometer testing of base strength.

## What Did We Learn?

While neither of the original five-year studies showed a significant difference in road deterioration across the three test sections, in Phase 3 a marked variation across sections began to appear. Both subsections of section 1 had moderate-to-severe transverse cracking, while sections 2 and 3 had only individual, low-severity transverse cracks. Section 1 also showed the worst roughness of the three sections and the most rapid decline in

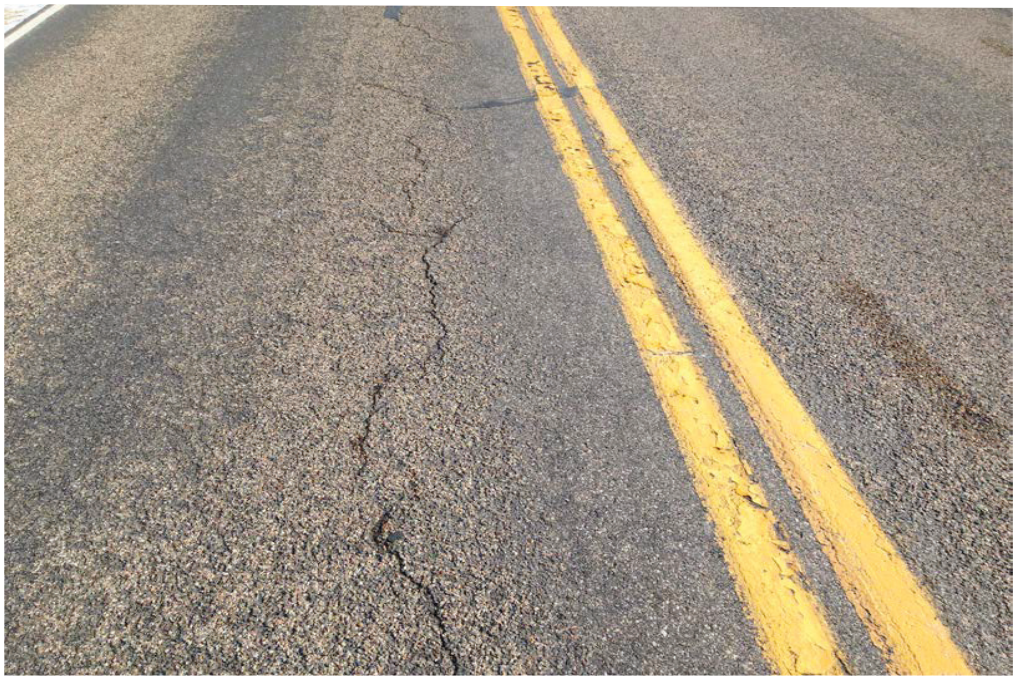
*continued*

*"Class 5 modified aggregate allows water to drain more easily and quickly than Class 5, making it less susceptible to freeze-thaw damage."*

**—Michael Sheehan,**
Director, Olmsted County Public Works

*"This project is a great example of MnDOT working with local agencies to maximize the effectiveness of materials available to them locally."*

**—Matt Lebens,**
Research Project Engineer, MnDOT Office of Materials and Road Research



After 15 years of study, researchers began to see marked differences in deterioration between test sections, including wheelpath cracking in subsections of section 1.

ride quality, and is nearing functional failure due to roughness alone. Across all sections, sawed and sealed segments had worse ride quality.

Of the other sections, section 3 performed the best, with good ride quality ratings and the highest measured stiffness, in spite of having the highest traffic of the three sections. Section 2 also performed well, suggesting that the permeable aggregate base material used in its foundations may facilitate drainage and provide resilience despite offering somewhat less support than the Class 5 modified base used in section 3. Researchers also found that these sections lose less stiffness and recover better during the spring thaw, which should lead to less pavement damage and longer life span.

## What's Next?

Overall, results indicate that the Class 5 modified base material is the best performing of the three base types and may be considered an effective substitution for conventional Class 5 crushed limestone base materials of the type commonly available in Olmsted County. Consequently, MnDOT has updated its standard specifications to allow a new gradation category named Class 5Q, which would allow the Class 5 modified base used in section 3. Further, local agencies in southern Minnesota counties are regularly using Class 5 modified limestone bases on projects. MnDOT is now conducting an additional five-year (Phase 4) study to clarify and verify the results that have already been obtained and to continue monitoring the test sections' deterioration until failure.

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