



TECHNICAL SUMMARY

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LRRB PROJECT COST:

\$38,260



Investigators used ground penetrating radar to develop thickness profiles for the pavement sections evaluated.



RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

Stabilized Full-Depth Reclaimed Road Base Saves Time and Money

What Was the Need?

Full-depth reclamation (FDR) of existing pavements is widely used in Minnesota as an effective way to use less aggregate materials in road construction. Specialized construction equipment rubblizes the asphalt pavements and mixes the reclaimed pavement material with the existing aggregate base. This mixture is used as the base for a new asphalt roadway surface. The method saves resources and money, reduces the amount of materials transported on and off the site, and has long been a linchpin technology in green highway building.

FDR bases may be unstabilized or stabilized by mixing an additive to lightly bind the material. Observations suggest that pavements with stabilized FDR bases are performing very well in the field. Quantification of these performance improvements will provide valuable input for pavement designers. Minnesota designs pavements and bases using granular equivalency (GE) design parameters. Designers assign a value to the base material relative to that of standard aggregate; a 1.0 GE matches the strength of 1 inch of standard Class 5 aggregate. (Asphalt concrete has an assumed GE of 2.25.) Other transportation agencies do not use GE; as a result, Minnesota transportation agencies needed to establish GE design parameters for stabilized FDR bases.

What Was Our Goal?

This research project aimed to establish GE values for stabilized FDR (SFDR) and unstabilized FDR bases, and to identify freeze-thaw impact on their performance. This would allow more precise design and use of SFDR in pavement construction, saving money and resources while ensuring the durability of new pavements made with reclaimed material bases.

What Did We Do?

For this three-year study, investigators compared regular asphalt pavements, FDR pavements and SFDR pavements at seven Minnesota sites: two in Le Seur County, two in Pope County, two in Goodhue County and one in Olmsted County. Stabilized mixtures included emulsion, fly ash, fly ash with emulsion, Fortress additive or T15 Base One additive. A pavement section over simple Class 5 material at MnROAD was also tested for a Class 5 GE baseline.

At each county road site, investigators used ground penetrating radar to determine the thickness profile of the pavements. They also conducted falling weight deflectometer tests of stability and base stiffness modulus at each site multiple times every season. During spring thaw, investigators conducted falling weight deflectometer tests daily, then frequently throughout March and monthly for several months of the year thereafter, completing 13 to 18 tests per section per year with a focus on fall, spring and summer months.

Because there is no direct or well-defined method for finding GE values, researchers employed and compared three methods: an AASHTO method, a backcalculation method and MnDOT's Erland Lukanen method.

This study developed granular equivalency values for stabilized and unstabilized full-depth reclaimed bases. Stabilized, this recycled material outperforms virgin aggregate at considerably lower cost for material.

“We wondered how much stabilizing FDR was increasing its GE. Our suspicions were proven true: Stabilized FDR is stronger than Class 5 gravel. It also saves us money in transportation and grading costs.”

—Merle Earley,
MnDOT District 4
State Aid Engineer

“It’s really tough to determine GE for these recycled materials. However, pavements with stabilized full-depth reclaimed bases certainly perform as well as or better than regular Class 5 aggregate bases. How much better is tough to determine.”

—Joseph Labuz,
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Researchers tested pavement stiffness and response with a falling weight deflectometer. Results showed that stabilized full-depth reclaimed base performs better than unstabilized reclaimed or virgin aggregate bases.

What Did We Learn?

Researchers were able to assign GE values to SFDR and FDR bases.

GE. Both modulus and GE values are higher in pavements with SFDR bases than in those with unstabilized bases. The report includes GE graphs developed by various methods. GE values for all sites ranged from less than 0.25 to as high as 4.1, but standard values considered most pertinent fall into the ranges of 1.0 to 1.9 for SFDR. An average value of 1.5 GE can be safely assigned to any SFDR base.

Seasonal variation. As expected, FDR and SFDR bases prove stiffer in fall and winter than in spring or summer. Spring thaw remains the least-stiff period for all bases; freeze-thaw reduces stiffness. Modulus values show similar seasonal variation, but in general, SFDR outperforms unstabilized FDR and regular pavement bases. How much better stabilized sections perform remains difficult to quantify given varying environmental conditions at each site.

Determining GE. MnDOT’s Erland Lukanen method for calculating GE appears to be more reliable than the AASHTO or backcalculation methods. There is still no direct way to measure and assign GE values to materials.

Implementation

The difference in performance between SFDR and FDR bases is significant. If the GE for SFDR changes from 1.0 to 1.5 inches, this would provide 50 percent more carrying capacity to the existing base GE at a minimal cost. For example, engineers could reclaim an existing roadway and stabilize the top 4 inches to turn a 9-ton design into a 10-ton design with the same in-place structure. The cost of materials transportation is also reduced with FDR and SFDR projects. Based on this report’s findings, the Local Road Research Board recommends the development and use of GE design tables for SFDR.

This Technical Summary pertains to the LRRB-produced Report 2012-36, “Structural Evaluation of Asphalt Pavements with Full-Depth Reclaimed Base,” published December 2012. The full report can be accessed at <http://www.lrrb.org/PDF/201236.pdf>.