



RESEARCH SERVICES SECTION

TECHNICAL SUMMARY

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PROJECT COST:

\$212,995



A water truck and road-reclaimer blended the ash, water and reclaimed pavement materials on 7th Avenue in Waseca.



Demonstration of Ash Utilization in Low Volume Roads

What Need Did We See?

When doing construction on a road that is not expected to have a lot of traffic, it can be very expensive to haul away poor-quality soil or existing road material and replace it with new, more stable base materials. Using poor base materials, however, can result in a bumpy road with a shortened pavement life.

An alternative is to stabilize the existing base materials using fly ash, a by-product of coal-fired power plants that is normally landfilled. Fly ash is self-cementing: It chemically reacts with soil (or recycled pavement material, or road surface gravel) and water to form a strong and stable base for hot-mix asphalt pavement. This can increase pavement life, permit use of a thinner HMA layer, and improve ride quality.

Pavement reconstruction using fly ash to stabilize recycled materials costs considerably less than traditional total reconstruction; some estimates of this savings run as high as 66 percent. While fly ash has been used to strengthen soils for more than 20 years, its long-term effectiveness in road reconstruction has previously been largely undocumented in Minnesota. There are also environmental concerns about its use, and Mn/DOT has not yet established design guidelines for fly ash stabilization. A systematic demonstration and implementation effort is needed to achieve widespread acceptance.

What Was Our Goal?

This study was undertaken to assess the effectiveness and environmental suitability of using fly ash to stabilize Minnesota's local roads. Through field demonstrations, investigators aimed to provide documentation for the effectiveness of fly ash as a stabilizing agent for recycled pavement material and for road surface gravel.

What Did We Do?

The project involved two field demonstrations:

- **Reconstruction of a city street in Waseca.** Crews pulverized 0.5 km (0.3 miles) of existing asphalt, gravel and soil to a depth of 300 mm, spread fly ash (10 percent by dry weight) evenly over the surface, then mixed the ash with water and the reclaimed pavement materials. This mixture was compacted and covered with 75 mm of HMA.
- **Construction of a flexible pavement on a gravel country road in Chisago County.** Fly ash was spread in strips over 3.5 km (2.2 miles) of existing gravel, mixed into 254 mm of the gravel layer with water, compacted, and then covered with two layers of HMA.

Researchers took samples of the subgrade both before and after the fly ash was mixed in, and created additional mixtures in the laboratory of fly ash and the base materials. They used numerous tests to determine the strength and stiffness of the pavement, and to see how it reacted to freeze-thaw cycles (which also involved installing weather and other sensors at the sites). Laboratory tests included resilient modulus and California bearing ratio measurements, and field activities included soil stiffness, soil penetration and falling weight deflectometer tests.

Investigators installed a pan lysimeter beneath the pavement at both sites to monitor moisture movement through the pavement. They tested the liquid for trace element concentrations, and performed additional leaching tests for comparison on the mixtures created in the laboratory.

“We demonstrated that you can create a satisfactory base for asphalt pavement using in situ recycled material with fly ash stabilization. This provides a cost-effective option for reconstruction projects.”

–Tuncer Edil,
Professor, Civil and Environmental Engineering,
University of Wisconsin

“Fly ash is particularly useful for city and county roads that have lower traffic volumes, since agencies need to use locally available materials and keep costs down.”

–John Siekmeier,
Mn/DOT Senior Research Engineer

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Researchers installed water content and temperature sensors to monitor the subgrade and road surface gravel on the newly paved County Road 53 in Chisago County for moisture and trace element levels.

What Did We Learn?

These tests showed that adding fly ash to either reclaimed pavement materials or road surface gravel significantly improved stiffness and strength. The resilient modulus at the end of construction was about 1.7 to 3 times higher for the ash-treated material than for the untreated material. This performance did not degrade over a single winter season.

There is concern that repeated freeze/thaw cycles may reduce resilience: laboratory tests reduced performance by 50 percent. However, this is still an improvement over the results of the same testing on the untreated recycled pavement material and road surface gravel.

The chemical analysis of the leached moisture showed that none of the trace elements normally associated with health risks exceeded the U.S. Environmental Protection Agency's maximum contaminant levels or the health risk levels established by the Minnesota Department of Health.

This project also served to refine testing procedures; this will streamline subsequent studies, which are needed to further develop these techniques.

What's Next?

This project is a step toward the broader goal of increasing the acceptability of fly ash use in Minnesota's low-volume roads. Engineers will need a framework of design procedures, construction guidelines, and source and availability characterizations to use when incorporating fly ash stabilization into various pavement systems.

Investigators are continuing to monitor these demonstration sites for freeze-thaw performance and trace element levels. LRRB has funded a second project to quantify the benefits of pavement design using fly ash: Does fly ash allow the HMA layer thickness to be reduced while retaining the same pavement life?

Additional Mn/DOT and national research efforts are aimed at more comprehensively establishing the environmental impact of fly ash use. Mn/DOT is currently implementing statewide a [screening tool](#) for hazard evaluation prior to the use of new types of recycled materials, and a follow-up study on the leached moisture from fly-ash-stabilized roadbeds that have been in place for 10 or 20 years has been proposed to establish long-term impacts.

This Technical Summary pertains to the LRRB-produced Report 2007-12, "Demonstration of Ash Utilization in Low Volume Roads," published May 2007. The full report can be accessed at <http://www.lrrb.org/PDF/200712.pdf>.