



## TECHNICAL SUMMARY

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### PROJECT COST:

\$170,055



This truck laying down fly ash on RPM will be followed by a road reclaimer with tines for blending them together.



RESEARCH  
SERVICES SECTION

# Using Fly Ash to Improve Recycled Pavement Foundations

## What Was the Need?

To minimize costs and environmental impact, Minnesota often recycles existing pavements during road reconstruction using methods like full depth reclamation where the hot-mix asphalt pavement is pulverized with a portion of the aggregate base to create a blend of recycled pavement material. This serves as the new pavement foundation and is compacted and overlaid with fresh HMA. Similarly, when an unpaved road with a gravel surface is upgraded to a paved road, the existing road surface gravel can be blended with recycled power plant ash and then compacted to form a new base layer.

These recycled materials may contain aged asphalt binder, fines and other elements that affect the strength and stiffness of the pavement base. To address this issue, another recycled material called fly ash—a byproduct of coal-burning power plants that is self-cementing when it reacts with water—can be blended with RPM and RSG to increase their strength and stiffness. The use of these stabilized materials in Minnesota, referred to as SRPM and SRSG, is still relatively new, and the Local Road Research Board has been involved in ongoing research to establish their performance, required design specifications and environmental impact.

## What Was Our Goal?

The goals of this study were to:

- Develop a practical method to design local roadways using SRPM and SRSG as base layers by establishing their gravel equivalency, or the thickness of these materials needed to achieve a strength and stiffness equivalent to traditional sand and gravel.
- Evaluate the performance of SRPM and SRSG in two field projects.
- Assess the environmental impacts of these materials using both field data and predictive computer modeling applied to laboratory data.

## What Did We Do?

Researchers began by collecting samples of RPM and RSG from two demonstration projects in Minnesota and mixing some of these with Class C fly ash to create samples of SRPM and SRSG. They evaluated the strength and stiffness of all samples with resilient modulus and California bearing ratio tests before and after a series of freeze-thaw cycles.

Researchers then monitored pavement performance at the two field sites from which they had collected RPM and RSG. These projects had used fly ash-stabilized bases, and researchers instrumented the resulting SRPM and SRSG to measure temperature, frost depth and water content. They also made annual surveys of in situ pavement modulus using a falling weight deflectometer, and recorded signs of rutting and other distress.

Finally, researchers evaluated the environmental impact of these materials by placing pan lysimeters beneath field project roadways to collect and test water percolating from base layers for chemicals that might have leached from the fly ash. Researchers also tested SRPM and SRSG field samples in the laboratory for the same chemicals and applied computer modeling to this data to predict groundwater impact.

## What Did We Learn?

Results showed that fly ash-stabilized bases are strong, durable and cost-effective. The resilient modulus of SRPM and SRSG increased significantly with fly ash content. To account for this increase, researchers developed a design procedure for selecting SRPM

*continued*

*“This project gave us a way to quantify the performance of recycled fly ash during design by providing simple conversions of required thicknesses from Class 5 aggregate to fly ash-stabilized recycled materials.”*

—John Siekmeier,  
Mn/DOT Senior Research  
Engineer

*“Fly ash stabilization has proven itself to be capable of providing a durable foundation for construction equipment and local traffic before and during paving, and shows promise for providing long-term pavement support.”*

—Tuncer Edil,  
Professor, University of  
Wisconsin—Madison  
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**Produced by CTC & Associates for:**

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Researchers collected samples of fly ash to mix in the laboratory with samples of RPM and RSG; these stabilized samples were tested for stiffness and strength over five freeze-thaw cycles.

and SRSR base thicknesses that achieve the same structural capacity as a conventional Class 5 base course. The effects of freeze-thaw cycles were expected to be negligible once offset by increased stiffness caused by curing.

Falling weight deflectometer field data confirmed the efficacy of SRPM and SRSR, with moduli for one site remaining stable over four years despite several seasons of freezing and thawing. On the other site, SRSR resilient moduli decreased slightly during the first year but remained stable thereafter.

Environmental monitoring showed that in general contaminant levels were below limits permitted by U.S. Environmental Protection Agency and Minnesota regulations. In some cases, concentrations measured in base percolation (but not in groundwater) modestly exceeded these standards. However, computer modeling showed that under most conditions these concentrations are expected to decrease with time and become diluted with distance from the roadway, yielding groundwater that meets environmental standards.

### What's Next?

Researchers recommend periodic monitoring of field sites for five to 10 years to assess the long-term performance of SRPM and SRSR. They recommend additional environmental research to establish the safety of these materials as well as specifications limiting chemical concentrations in fly ash.

The LRRB has just issued another [report on the strength and environmental impact of recycled materials](#). Previously the LRRB demonstrated [ash utilization in low-volume roads](#) and developed a [screening tool to assess fly ash risks](#). Further fly ash environmental evaluation [has been proposed](#). Minnesota is also involved in an effort to investigate whether [using high carbon fly ash to stabilize recycled pavement materials can help reduce carbon dioxide emissions](#).

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*This Technical Summary pertains to the LRRB-produced Report 2009-27, “Use of Fly Ash for Reconstruction of Bituminous Roads,” published August 2009. The full report and appendices can be accessed at <http://www.lrrb.org/PDF/200927.pdf> and <http://www.lrrb.org/PDF/200927A.pdf>.*

*Full reports for the related LRRB studies referred to in this report can be found at <http://www.lrrb.org/PDF/200932.pdf>, <http://www.lrrb.org/PDF/200712.pdf> and <http://lrrb.org/PDF/200503.pdf>. Research Services is preparing an “Innovation Update” on fly ash; please contact [research@state.mn.us](mailto:research@state.mn.us) for this document.*