

MAINTENANCE

RESEARCH 2017

INNOVATIONS FROM STATE DOTs

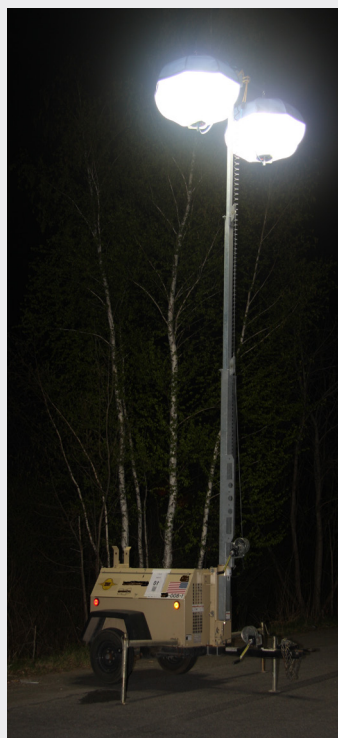
Lighting Advances Improve Nighttime Work Zones

NEW JERSEY

While work zone lighting helps make workers more visible at night, it can also create glare and visual distractions for drivers. To address these safety issues, New Jersey DOT investigated how to reduce glare from excessively bright lights while maintaining a sufficient level of illumination for workers in various nighttime work zone environments.

Researchers surveyed safety engineers and conducted technical analyses of illumination systems and signage materials. They identified several important safety measures, finding that strategic placement of illumination devices, control of lighting intensity, and use of dynamic speed display signs are critical in reducing visual chaos in nighttime work zones.

Based on the research results, New Jersey DOT incorporated a list of best practices into guidelines for work zone planning staff and contractors who perform road repair and construction work. Benefits of implementing these project findings include an anticipated decrease in work zone crashes. **Final report.**



Balloon lighting is a modern tool for illuminating nighttime work zones.

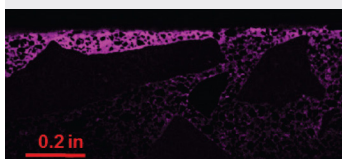
Source: New Jersey DOT

The eight maintenance research projects

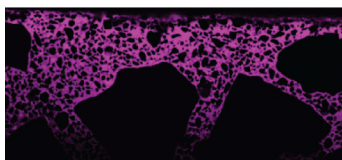
highlighted on these pages were selected by the Research Advisory Committee of the American Association of State Highway and Transportation Officials (AASHTO). They comprise two high-value projects from each of the four AASHTO regions, funded primarily through the State Planning and Research (SPR) Program.

As the nation's cornerstone state research program, SPR provides Federal Highway Administration funding to the states to address top concerns and identify solutions at the state level. States further address areas of common concern through the Transportation Pooled Fund Program.

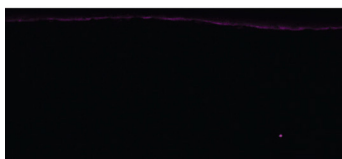
This publication and its companion featuring high-value safety research complement *Research Makes the Difference 2017*, a compilation of award-winning transportation research across all fields. All of these publications may be found at research.transportation.org.



Untreated Control



Sealer A



Sealer B

Source: Alabama DOT

X-ray scans reveal chloride penetration of different sealers.

Research Identifies Effective Concrete Bridge Deck Sealers

ALABAMA

In areas where ice and snow are common, bridges require deicing to keep routes clear. In such areas, preventive maintenance is needed to keep concrete bridge decks from deteriorating. Deck sealers provide a protective barrier on bridge deck surfaces to slow chloride ingress and reduce moisture.

Alabama DOT currently uses a custom-produced sealer product. To expand its options, the department evaluated the performance of five bridge deck sealer products, including four epoxy-based sealers and one sodium silicate sealer. After applying the sealers to concrete lab specimens representing three common bridge deck mixes, researchers evaluated the waterproofing performance of the samples subjected to simulated traffic and to saltwater. Several lab techniques helped measure the chloride resistance of each of the test samples.

Two epoxy sealers outperformed the other products due to their effectiveness in forming a relatively impermeable and abrasion-resistant surface film. The sodium silicate sealer performed poorly compared to the epoxy-based products and was not recommended. These findings gave Alabama DOT the information needed to expand the range of sealers it currently uses, as well as to evaluate other deck sealer products in the future. **Final report.**

New Techniques for Stabilizing Subgrade Soil Extend Pavement Life

TEXAS

In recent years, Texas DOT has found pavements heaving and cracking prematurely in areas with high-sulfate soils. Crews typically treat these subgrade soils with lime before constructing roads on them, but research has found that lime stabilizers react with water, clay, and sulfates in the soil to induce subgrade expansion and damage the pavement structure. Some failures have occurred within three or four years of paving, and others within just a few months, forcing miles of pavement restoration.

Texas DOT, which has over \$100 million worth of pavement constructed on high-sulfate soils, enlisted a research team to develop and field-test new treatments for these soils. One potential solution was to let treated subgrade mellow over an extended period before paving to prevent the expansion effect. Working with researchers, crews built pavement test sections over high-sulfate soil on U.S. Highway 82 in Grayson County. The subgrade of one test section was treated with fly ash and the other with lime ash; both were left to mellow for seven days before paving.

For the last two years, investigators have conducted ongoing tests on the pavements. These evaluations include site surveys, ground-penetrating radar, and falling weight deflectometer readings on each test section every month. The roads have been performing well so far, and if proven effective, the new soil stabilization approach could prolong pavement life by 30 to 40 percent. This would provide a substantial savings to Texas DOT in maintenance and construction costs as a result of not having to rehabilitate roadways as often.

[Project web page.](#)



Source: Texas DOT

Chemistry of the subgrade soil impacts pavement life.

Stream Restoration Techniques Show Promise for Bridge Maintenance

OHIO

Streams change shape over time, with flowing water eroding streambeds and banks and depositing sediment elsewhere in the channel. This is a challenge for bridge designers, who must engineer structures that remain in a fixed location.

When shifting sediment becomes problematic for a structure—causing problems like bridge scour and embankment erosion—maintenance crews dredge sediment or add riprap (loose coarse stone) to protect channel banks and bridge abutments. These methods are typically not self-sustaining, however, and lead to repeated impacts to the environment. Ohio DOT decided to explore whether natural channel design practices used in stream restoration could be used to provide sustainable solutions to channel maintenance problems, especially for smaller bridges maintained by county crews.



Source: Ohio DOT

Investigators found that county and district builders and maintenance crews can apply natural channel design practices reliably. One piloted approach—installation of concrete vane structures to reduce sedimentation under bridges—was completed with local crews at a cost 75 percent less than projected by using concrete blocks and irregular quarried rock blocks. Further work will be needed to allow quick and economical permitting of these techniques for local crews, but natural channel practices show promise for both bridge maintenance and reconstruction. [Final report.](#)

Weirs, vanes, and other techniques used in stream restoration can also be used near bridges.

Research Assesses and Improves Asphalt Pavement Performance

MISSISSIPPI

A multiphase Mississippi DOT research study that addressed aspects of asphalt pavement design, rehabilitation, and maintenance has helped confirm the effectiveness of the agency's current practices and identify possible improvements.

The first part of the study examined field performance of asphalt reconstructed using full-depth reclamation (FDR). Researchers studied a high-traffic application of FDR over a 53-month period. Laboratory and field data helped assess the performance and structural integrity of the FDR layers, with measured density, strength, and distress characteristics all pointing to FDR performing well over the long term under heavy traffic conditions. **Final report.**



Source: Mississippi DOT

Cold in-place recycling involves pulverizing old pavement and constructing new pavement in series.

The second part of the study focused on cold in-place recycling (CIR) of asphalt pavement. Researchers developed a new laboratory design procedure for CIR mixes stabilized with portland cement, asphalt emulsions, and both in combination. The testing matrix balanced both economic and performance factors, and Mississippi plans to adopt the new mix design procedure when using CIR in the future. **Final report.**

The third part of the study addressed ways to assess moisture intrusion into the longitudinal construction joints of thin lift asphalt pavements. Researchers developed permeability (or infiltration) tests that helped show thin lift longitudinal joint cracking was largely influenced by underlying layers rather than joint quality or sealer treatment. The infiltration test protocols were very promising and are scheduled for use to assess a wider range of Mississippi DOT asphalt pavement surface treatments. **Final report.**

Thin Polymer Overlays Improve Skid Resistance, Reduce Corrosion on Bridge Decks

WISCONSIN

In the Snow Belt, road salt and other deicers damage concrete bridge decks. Many northern states use sealers and overlays to protect decks from chloride damage and to increase friction for better skid resistance. Because of their thinness, polymer overlays add less weight to the bridge deck than other types of overlays, and they take less time to apply.

Researchers evaluated the performance of several thin polymer overlay designs in Wisconsin using lab tests. The overlays were effective at resisting chloride penetration and at maintaining increased friction on the driving surface over time. An epoxy resin overlay with flint rock aggregate performed best overall. The tests also confirmed that thin polymer overlays cannot halt corrosion activity if the underlying concrete has already experienced chloride contamination.

The study gave Wisconsin DOT valuable guidance on how to make the most cost-effective use of thin polymer overlays, which can extend bridge deck life seven to 15 years. For new construction, applying sealers every three to five years may be a more economical choice. However, thin polymer overlays may be warranted on bridges with high traffic volumes where frequent sealer application is impractical, or on structures where additional skid resistance is important. **Final report.**



Source: Wisconsin DOT

Thin polymer overlays provide skid and corrosion resistance to new bridge decks.

New Decision Tool Helps Extend Bridge Life and Save Money

VERMONT

Maintenance of distressed concrete bridges is costly and time-consuming. However, properly timed, low-cost preventive maintenance activities can reduce the rate of concrete degradation, delaying or preventing the need for costly repairs.

To identify the best approaches for concrete repair, researchers assessed current practices within Vermont Agency of Transportation. These practices include applying sealers to critical components, such as curbs, fascia, and piers; maintaining proper drainage and gutters on expansion joints; and maintaining bearings to allow for proper movement of the bridge.

Investigators used the results of this research to develop a software program to assist in decision making for concrete bridge maintenance and repairs. The tool provides guidance based on the structural characteristics of the bridge, the available repair techniques, and economic and public safety considerations. Users navigate the software's decision tree to find the best repair procedures for a particular structural element.

The results of this research are helping Vermont reduce the lifetime costs of bridge ownership and make well-informed decisions about maintenance planning. **Final report.**



Source: Vermont Agency of Transportation

Repairs studied include those made to bearing seats and piers on an Interstate 89 bridge in Richmond, Vermont.

Aqueous Wastes Are Effective Supplements in Deicing and Dust Control

SOUTH DAKOTA

Aqueous wastes from commercial and industrial activities have been used in various roadway applications, most notably deicing and dust control, for over a decade. Deicing solutions, already well established as improving salt and sand performance, have been supplemented with liquid waste from oil fields and from processes like corn wet-milling, cheese making, and brewing. Sources for dust-suppressant liquids have included vegetable oils, molasses, mulches, and other byproducts. Liquids rescued from the waste stream can be effective road treatments, and they can also be more sustainable and less expensive than conventional road brines.

South Dakota DOT studied the reuse of aqueous waste streams in transportation. University researchers identified potential transportation applications for aqueous wastes in South Dakota and developed comprehensive guidelines for evaluating and approving the reuse of such wastes on roadways. Next, they demonstrated the use of these new guidelines for the Watertown municipal water treatment plant. They found that the brine wastewater from Watertown's magnetic ion exchange system can be enriched and used effectively in road deicing and dust control. The guidelines developed through this research have been adopted by the South Dakota Department of Environment and Natural Resources. **Final report.**



Source: South Dakota State University

Liquid waste from a local water treatment plant can be reused in road deicing and dust control applications.

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