High-Friction Surface Treatments Reduce Crashes on Tight Curves

To reduce wet-weather crashes on curves, at intersections, and on bridge decks, Florida uses high-friction surface treatments (HFSTs) that consist of an epoxy layer and high-quality basalt aggregate. While highly effective at providing surface friction, some HFSTs have been prone to premature cracking, potholing, delamination, and raveling. Researchers wanted to identify alternative materials and aggregates for HFST that would prevent premature failure while also lowering installation costs.

Investigators analyzed the performance of Florida’s HFST projects in terms of distress, skid resistance, and crash reduction. Researchers then tested six projects in the field and conducted lab tests on HFST materials and construction methods with an eye toward improving durability and reducing costs.

HFSTs proved cost-effective for tight curves, where they reduced crashes significantly (32 percent overall, and 75 percent in wet conditions). The treatments were less cost-effective on wide curves without any history of crashes, and their cost-effectiveness for intersections and bridges was unclear.

Researchers developed new specifications and a guidebook for site selection, materials, and construction. HFSTs work best on well-cleaned, dense-graded pavement surfaces. In addition, builders should use automated application equipment to ensure well-mixed materials and should apply test sections and adjust application as needed before finishing a site. For now, researchers recommend the continued use of calcined basalt in HFSTs and the encourage the use of HFSTs on tight curves to reduce crash frequency. Final report.

Recycled Asphalt Contributes to Rutting Resistance

Asphalt pavements crack as they age, and cracking damage is a primary factor in the decision to replace a pavement. To reduce the expense of pavement materials and construction, agencies recycle some of the pavement they remove into new asphalt mixtures. Builders and designers test recycled materials at asphalt mixing sites and in laboratories to assess cracking potential in new pavement mixtures, but how well results in the lab and field correlate with one another has not been established, and the impact of recycled asphalt in new mixtures has historically been difficult to predict.

In New Hampshire, researchers compared asphalt binder and mixture parameters in recycled asphalt mixes and evaluated lab and plant test results for stiffness and cracking. The study compared lab and plant tests of 14 mixtures with various binder grades, binder sources, aggregate gradations, and recycled asphalt materials.

Results showed that binder and mixture stiffness parameters in the lab were good predictors of plant test results (though cracking parameters correlated less well between the lab and the plant). Using recycled asphalt remains an effective way to build stiff, rutting-resistant pavements. Final report.

New Method Improves Designs for Overlays of Composite Pavements

Ohio DOT designs overlays for older pavement based on AASHTO methods that work well but are conservative, especially when used with existing composite pavements—asphalt layers built over portland cement concrete. The AASHTO design procedure, based on simple field deflection data, is thought to significantly underestimate the structural capacity of existing asphalt-on-concrete structures. This results in new asphalt layers that are thicker and more expensive than necessary.

Researchers revised the procedure to more reasonably estimate the effective thickness of existing composite structures. The research team developed a method that applies the field deflection concept to a three-layer structural model, rather than a two-layer model, while still considering temperature effects as well.

The resulting design software based on the new method provides more accurate overlay design recommendations that are usually several inches thinner than overlays designed with the old method. New, more accurate designs of overlays for composite pavements will still provide structurally effective roads at substantially lower costs. Final report.

Software Helps States Strategize on Preservation Projects

WASHINGTON STATE

Most states select highway preservation projects based either on funding availability or on pavement condition. This may mean missed opportunities to maximize benefits to infrastructure, road users, and local economies over periods of several decades. Washington State DOT considers user and maintenance costs in selecting transportation investments with help from FHWA software best suited to new construction. Researchers wanted to join pavement management and economic impact analyses not just in new highway decisions, but in pavement preservation and maintenance planning as well.

Investigators surveyed state transportation agencies and found that only four states use FHWA’s Highway Economic Requirements System, State Version (HERS-ST) software in highway preservation decision-making, and none use it in precisely the same way. The research team developed an Excel-based benefit application tool as an add-on to the FHWA package.

The tool allows users to include reconstruction and overlay scenarios in asphalt and concrete pavement models, add user costs to compare improved and unimproved pavements over five-year periods, and input customizable values rather than national averages for data like fuel costs, taxes, and travel times. With the new tool, states can time maintenance and preservation projects to maximize long-term benefits to road users, regional economies, and the highway system—and make more strategic choices with current budgets. Final report.

Revised Method for Designing Pavement Overlays

OHIO

A new asphalt overlay design method helps prevent unnecessarily thick—and expensive—layers.

A new method improves designs for overlays of composite pavements. Access the electronic edition of this document with project links, as well as more high-value state DOT research projects, at AASHTO’s research website, research.transportation.org.

Recycled Asphalt contributes to rutting resistance in asphalt pavement mixtures.

Researchers used uniaxial fatigue testing to predict crack resistance in asphalt pavement mixtures.

New method improves designs for overlays of composite pavements.
Research Recommends New Approach to Moisture Sensitivity Testing

NORTH CAROLINA

State approval of asphalt pavement mixtures in North Carolina requires that mixes meet moisture sensitivity requirements to ensure adhesion of asphalt to aggregate. Some foam-based warm-mix asphalt (WMA) mixtures fail to pass the required tensile strength ratio (TSR) tests. However, these same WMA mixtures have performed well in North Carolina and around the country for years, suggesting the test may need to be modified or replaced with another examination method. Investigators considered whether trapped moisture and extended curing times might affect WMAs in standard testing. They studied stiffness, fatigue, and rutting potential of WMAs with TSR and comparable tension tests and explored modification of TSR tests and alternative protocols.

The research effort determined that TSR protocols, which are based on hot-mix asphalt (HMA) testing procedures, cannot be applied in the same way to WMA. Investigators recommended an alternative: a novel test for evaluating the adhesion compatibility of asphalt and aggregate for any asphalt mixture design (WMA or HMA). An old boil test method, now out of favor, was repurposed and adapted into a new asphalt-aggregate mix design procedure, which calls for evaluating moisture sensitivity at the beginning of the mix selection process rather than at the end. This is not only more accurate, but it also saves time and resources in asphalt mixture design acceptance. Final report.

Web-Based Tool Helps Plan Projects to Save Money, Minimize Impact

WASHINGTON STATE

For highway rehabilitation and reconstruction, pavement managers face challenges in maintaining public and road crew safety while minimizing traffic disruptions and economic impacts, particularly in metropolitan areas. The Pavement Reconstruction Scheduling Software pooled fund study led by Washington State DOT and supported by California, Minnesota, and Texas DOTs looked to improve a software-based decision support tool for scopeing and planning rehabilitation work.

Researchers and developers upgraded the original software into a web-based preconstruction scoping tool for selecting pavement designs and construction strategies. The new Rapid Road Rehabilitation (R3) tool compares road-building time frames, traffic, and costs in a three-phase process. Users vary construction schedules and pavement designs, weigh work zone traffic impacts and economic implications, assess road user delays and queues, and compare construction approaches. Program web page.

R3 helps create transportation management plans that minimize impact on the public, on road crews, and on state budgets. Caltrans used the R3 prototype with traffic simulation models in planning a 2.5-mile concrete construction project on Interstate 15 that would have taken 10 months with traditional nighttime closures. By using continuous one-roadbed closures and around-the-clock construction, Caltrans completed the project over two nine-day periods, saving $6 million in agency costs and $2 million in road user costs. Project web page.

Washington State DOT also used the prototype to determine construction duration and work zone closures for competing design alternatives in life-cycle cost analysis (LCCA). Most recently, it was used in the LCCA of a $40 million bridge rehabilitation project on northbound Interstate 5. The analysis helped determine the most efficient work zone closures for portland cement concrete reconstruction and crack and seat overlay with asphalt. The project was built in 2017-2018 based on the outcome of the LCCA. Project web page.

New Asphalt Layer Adhesive Shows Promise in Kansas

KANSAS

Crack resistance in asphalt pavement relies upon well-bonded layers of asphalt working as a single, thick layer of pavement that shares loading forces uniformly. To this end, a tack coat adhesive is commonly used between pavement layers. Kansas DOT examined two new alternative tack materials to see if they would outperform the state’s standard tack.

Investigators conducted lab tests of adhesive application rates, bond strength, and rutting resistance by applying the standard and alternative tack emulsions to the top surface of asphalt pavement cores, adding new asphalt, and testing them with several laboratory methods. All of the materials performed well in the lab environment.

Bonding, however, can be impacted by surface preparation in the field. The standard emulsion bonded better over milled and cleaned surfaces; the emulsion bonding liquid (EBL), one of the two alternative materials, bonded better with unmilled surfaces.

The other alternative material showed similar bonding with both surface types.

At the standard application rate, EBL offered the best bond and slightly better rutting resistance than the other materials. Kansas learned that the emulsion bonding liquid may be its best option in terms of performance and constructability for adhering new asphalt layers to newly built or older pavement. Final report.

Porous Concrete Sidewalks Handle Stormwater Without Puddling

NEW JERSEY

Porous concrete allows water to run through a sidewalk, reducing puddling; slowing stormwater flow on driving and walking surfaces, and capturing some pollutants as water filters down through an aggregate layer into the soil beneath. Potential benefits in watershed protection and pedestrian and driver safety, however, must be balanced against sidewalk cost and cost-effectiveness, as porous concrete may not be as strong or durable as regular concrete.

New Jersey researchers tested 11 porous concrete mix designs for strength, freeze-thaw properties, and water flow-through. Investigators conducted standard laboratory mechanical tests on concrete cores and beams made from each mixture and tested thermal properties of traditional and porous concrete mixtures in 4-foot-square slabs at a test site. The research also included life-cycle cost analysis of porous and standard concrete.

Porous slabs proved to resist freeze-thaw damage well, though they exhibited less compressive and flexural strength than standard concrete. While life-cycle costs for porous concrete may exceed those of traditional concrete, these pavements, when properly installed and maintained to be free of clogging debris, effectively resist puddling and manage stormwater. This makes them a strong option for New Jersey in areas where stormwater management is critical. Final report.