

# Asphalt Technology News

## In This Issue

- Sold-out Test Track Cycle Focuses on Reducing Life-cycle Cost, Innovative Materials —page 1
- NCAT Offers Recommendations for Characterizing RAS —page 3
- Economical Mixes for Low-volume Roads —page 5
- Asphalt Forum —page 6
- Asphalt Forum Responses —page 7
- Specification Corner —page 8
- Selecting Virgin Binders for RAP Mixes Based on Regional RAP Binder Properties —page 10
- Market Analysis Shows Strengths, Needs of WMA —page 13
- Training/Education —page 15

## Sold-out Test Track Cycle Focuses on Reducing Life-cycle Cost, Innovative Materials

An unprecedented amount of real-world, accelerated pavement testing will take place during the current fifth cycle of NCAT's Pavement Test Track (2012-2015). The cycle sold out by early summer, with a total of 45 sections being sponsored by highway agencies and private industries.

Twenty-five of those sections remained in place from the fourth (2009) research cycle for further trafficking and evaluation, and 20 sections have been newly constructed. A track "sell-out"

technically occurs when the 26 tangent sections — those located on the straightaways—are sponsored, so that target was well exceeded for the fifth cycle.

"By the time track reconstruction began this summer, the tangents were sold out and sections were being located in the curves wherever practical," explains Test Track Manager Buzz Powell.

Fifteen of the traffic-continuation sections will be evaluated for mix performance, and 10 are structural sections. The new construction includes 11 mix performance and nine structural sections.

The warm-mix asphalt (WMA) and reclaimed asphalt pavement (RAP) sections remaining in place from the fourth cycle are part of the track's first Preservation Group (PG) experiment. Pavement preservation treatments (thin overlays and inlays, microsurfacing, chip seals and other surface treatments) will be applied when these sections reach a predetermined level of distress, and they will continue to be monitored.

Preservation treatments will also be applied to



Section S12 on the NCAT Pavement Test Track, sponsored by the Virginia DOT, was reconstructed in August 2012. The section was instrumented with strain gauges (left) before paving.

Lee County Road 159 (LR 159), which provides access to a quarry and an asphalt plant. The beginning pavement condition on this road varies from good to poor. Varying levels of pretreatment distresses mapped within 100-foot test cells on LR 159 will provide a starting point for monitoring the change in performance curves that occurs after the various preservation

treatments are applied. Test track sections will be used to define performance curves for interstate type pavements. At the end of the experiment, sponsors (state DOTs) will take away a quantified relationship between pretreatment pavement condition and the amount of time/traffic it takes for a pavement to return to its pretreatment condition. Unique performance curves will be defined for each preservation treatment.

"This (PG) approach will avoid any bias in the outcome that would have resulted from directly comparing preservation treatments on roads with different underlying support and traffic conditions," Powell says. "State DOTs will be able to take the results and use them in their preservation selection processes to objectively determine the most cost-effective treatments for their own roads."

Secondly, NCAT researchers involved in the PG study will quantify the life-extending benefit of

—Continued on Pg. 2

—Continued from Pg. 1



Section N11, a high reclaimed asphalt pavement (RAP) section produced with warm-mix asphalt (WMA), will remain in place on the 2012 Pavement Test Track as part of the Preservation Group experiment.

these preservation treatments by comparing each treatment's performance curve to that of an untreated control section. Powell says this will be a valuable tool for highway program managers who need to prioritize investments in pavement preservation.

Seven state DOT sponsors are funding the track PG study: Alabama, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina and Tennessee. Another sponsor, FP2 (formerly known as the Foundation for Pavement Preservation), is also funding the experiment as an equal partner with the DOTs.

The PG study goes hand-in-hand with the overall focus of the fifth research cycle, which Powell says is "minimizing the life-cycle cost of asphalt pavements through using innovative materials during construction and selecting the best preservation alternatives under traffic."

"State DOTs want to consider materials that will reduce the cost of pavement construction, but they need to implement changes in a way that does not negatively impact pavement life. The track is a tool that allows them to do that."

—Buzz Powell  
Test Track Manager

Four sponsors (Alabama, North Carolina, South Carolina and Tennessee DOTs) are supporting another group experiment known as the Green Group. This experiment will compare the performance and structural responses of test sections using recycled materials. The goal is to reduce initial pavement costs and extend pavement lives at the same time by combining high recycled content mixtures with perpetual pavement design principles. Four new test sections have been built for this experiment; each section will be composed of a surface layer, an intermediate layer and an asphalt base layer.

All the mixes used in the Green Group were produced using WMA technologies. A control section used RAP contents typical of current specifications—20 percent in the surface layer and 35 percent in the intermediate and base layers. The second section has a stone-matrix asphalt (SMA) surface layer containing 25 percent RAP, a high-modulus intermediate layer with 50 percent RAP, and a strain-tolerant base layer containing 35 percent RAP and a highly modified binder.

The third Green Group section has an SMA with 5 percent post-consumer shingles and no added fibers. The intermediate layer contains RAP and recycled shingles to have a 50 percent recycled binder content. The base layer for this section was also designed to be more strain tolerant than the control section base. It contains 25 percent RAP and a PG 76-22 binder. This section was designed to optimize the use of ground tire rubber (GTR), so the surface layer is an SMA with GTR and no added fibers. The high-modulus intermediate layer has 35 percent RAP and a GTR-modified binder. The base layer is a strain-tolerant gap-graded asphalt-rubber mix with 20 percent GTR by weight of asphalt.

Both the PG study and the Green Group are intended to help sponsors stretch transportation dollars—a need that garnered a great deal of interest in track sponsorship this cycle.

"State DOTs want to consider materials that will reduce the cost of pavement construction, but they need to implement changes in a way that does not negatively impact pavement life. The track is a tool that allows them to do that," Powell says. "Also, dwindling funding is forcing states to implement pavement preservation."

Four new sponsors came on board for the fifth research cycle. The Virginia Department of Transportation is the state DOT newcomer, sponsoring two surface performance sections and three structural performance sections built using a very green approach—all three sections' base layers were produced with 100 percent RAP using cold, central-plant recycling and foamed asphalt. The Alabama Department of Environmental Management was the first non-DOT state agency to join any cycle, funding a structural section to focus on using recycled tires in pavement construction.



Virginia DOT Section S12 was constructed using a very "green" approach: the base layer was produced with 100 percent RAP using cold, central-plant recycling and foamed asphalt. This process, shown above, is known as full-depth reclamation.

FP2 joined the cycle to partner in the PG study, and the private industry Modified Asphalt Solutions is helping fund the continued evaluation of a GTR-modified section built by the Missouri DOT for the fourth research cycle.

Trafficking for the 2012-2015 Pavement Test Track cycle began at the end of September.

# NCAT Offers Recommendations for Characterizing RAS

The use of recycled asphalt shingles (RAS) in asphalt mixes is on the rise. A recent survey conducted by the National Asphalt Pavement Association (NAPA) showed that RAS use increased by more than 50 percent from 2009 to 2010. Nationwide, 1.1 million tons of RAS were recycled into asphalt mixes in 2010, conserving more than 200,000 tons of virgin asphalt binder. Based on a composite of average asphalt price indices published by 11 state DOTs in 2010, this translates into savings of approximately \$100 million. While reducing material costs for asphalt mixes is a driving factor in the use of RAS, it also makes sense environmentally. In addition to conserving raw materials, using RAS in asphalt paving mixes resolves waste disposal issues and reduces the amount of shingles dumped in landfills.

RAS contains asphalt binder, organic fibers or fiberglass, mineral aggregate and mineral filler. RAS is available from two distinct sources: manufacturing waste (MW) and post-consumer (PC) waste. PC, or tear-off shingles, are removed from houses or buildings during reroofing and typically contain higher asphalt contents due to weathering of the surface granules. Exposure to the sun over time also oxidizes the asphalt binder, which has a stiffening effect. The asphalt binder present in MW shingles has been aged due to the air-blown production process but is less stiff than PC RAS binder.

Many state agencies limit the amount of RAS in asphalt mixes—typically 5 percent or less by weight of the aggregate. Other states are beginning to move toward specifications that limit the percentage of recycled binder. In either case, successful RAS mixes depend on correct processing and handling of the RAS material. Mixes containing RAS must also be properly designed in order to be cost effective and to ensure good mix performance. An integral part of mix design is characterizing the RAS components.

## Processing and Handling RAS

Shingles must be processed, or ground, before being used in asphalt paving mixes. Deleterious materials such as nails, wood and other debris should be removed prior to grinding. These contaminants are more often present in PC than MW shingles. However, the grinding process is typically easier for PC shingles, since the asphalt has been further aged and is more brittle than in MW shingles. As heat accumulates during grinding, the asphalt in MW shingles becomes more plastic, making it difficult to achieve a uniformly ground product.

The current specification (AASHTO MP 15-09 Use of Reclaimed Asphalt Shingles as an Additive in Hot-Mix Asphalt) states that RAS should be ground such that 100 percent passes the 12.5-mm (½-inch) sieve. However, many contractors have found it

beneficial to have a finer grind of RAS such as a 3/8-inch top size. A finer grind ensures maximum economic benefit by increasing the amount of usable asphalt and also improves mat placement and quality. RAS particles should be ground to a uniform size to facilitate good blending during production.

MW and PC shingles should be stockpiled separately since the characteristics of each are very different. Other stockpile concerns include the following:

Adequate drainage of stockpiles is imperative because water is often added during the grinding process. Also consider covering RAS stockpiles to prevent precipitation from increasing the moisture content. Higher moisture contents mean higher temperatures during plant runs because the RAS must be dried completely before the binder can be heated sufficiently.

Prevent agglomeration of the shingle particles while stockpiled. This can be accomplished by blending RAS with an acceptable fine aggregate source or with RAP (at a ratio of 75/25 or 80/20 percent). When blending RAS with other materials, it is imperative that the blend be consistent throughout the stockpile. Otherwise, the variations in the stockpile will lead to variations in the produced asphalt mix.

If binder properties are being assessed, laboratory samples of RAS material should be dried with a fan. Otherwise, RAS samples may be oven dried at 110°C; however, this method may further stiffen RAS binder.



Coarse-ground (top) and fine-ground recycled asphalt shingles.

## RAS Asphalt

RAS binders are stiffer and have different rheological properties than virgin or modified binders since they are air-blown during shingle production. PC RAS binder is also stiffer than MW due to further aging on roofs.

## Asphalt Content

The current standard for RAS mix designs (AASHTO PP 53-09 Design Considerations When Using Reclaimed Asphalt Shingles in New Hot-Mix Asphalt) require that the asphalt content of RAS samples be determined using chemical extraction methods. However, both agencies and contractors desire to minimize the use of solvent extractions due to the hazardous chemicals involved.

The ignition oven method (AASHTO T 308) is a popular alternative for determining the asphalt content of recycled asphalt pavement (RAP), but some organizations are reluctant

—Continued on Pg. 4

# Characterizing RAS

—Continued from Pg. 3

to use this method with RAS. In addition to burning off asphalt, the excessive heat of the ignition oven can cause aggregate breakdown or the ignition of other RAS material components. Thus, a material-specific asphalt correction factor must be determined in order to account for this material loss. Developing an asphalt correction factor for RAS is difficult, however, due to the uncertain composition of RAS.

In the absence of an appropriate ignition oven correction factor, chemical extraction should be used to determine RAS asphalt content. With same-source RAS, comparisons should be made between the asphalt contents determined by chemical extraction and ignition oven to determine their relative closeness.

## PG Grading

PG grading for RAS binder is not required by most states. However, AASHTO PP 53-09 suggests that the virgin binder grade be based on a blending equation similar to that used for high RAP content mixes. This requires the RAS binder be extracted, recovered, and tested using standard asphalt binder Performance Grading procedures. However, this process is quite challenging for RAS binders. Further aging in the rolling thin-film oven (RTFO) and pressure-aging vessel (PAV) makes the material difficult to mold and characterize. Furthermore, since most RAS binders have a critical high temperature greater than the boiling point of water, standard dynamic shear rheometers (DSRs) cannot be used for RAS PG grading.

## RAS Aggregate

RAS contains aggregate granules that substitute for a portion of virgin aggregate in an asphalt mix. Thus, for accurate mix design, the aggregate portion of RAS should be characterized in terms of gradation, specific gravity, consensus aggregate properties and deleterious materials.

## Gradation

AASHTO T 30 is the test method used for determining the gradation of extracted aggregate. Again, there is the dilemma of whether to use solvent extraction or the ignition oven to extract RAS aggregate, as solvent extraction involves handling potentially hazardous chemicals. AASHTO PP 53-09 lists an assumed RAS aggregate gradation for use in mix design. However, a comparison of limited data from NCAT and other sources concluded that this assumed gradation could be inappropriate for RAS mix design. RAS aggregate gradation should be determined, not assumed, but strong conclusions could not be made from the limited data whether chemical extraction or ignition oven is the most appropriate means of recovering RAS aggregate for gradation testing.

## Bulk Specific Gravity

In order to compute volumetric mix design properties such as voids in mineral aggregate (VMA), bulk specific gravity of

the RAS aggregate must be determined. It is most practical, and fully acceptable per AASHTO PP 53-09, to use the effective specific gravity of RAS aggregate in place of its bulk specific gravity. Effective specific gravity can be calculated using standard theoretical maximum specific gravity testing (AASHTO T 209). To prevent RAS particles from floating to the top of the water during this test, alcohol can be misted onto the surface, or hot water (170°F) may be used to promote settling (in which case the sample must be cooled down to room temperature before applying vacuum pressure). Alternatively, the vacuum-sealing method (AASHTO T 331) may be used to backcalculate RAS aggregate effective specific gravity.

## Consensus Aggregate Properties

Since aggregate provides the skeletal framework of an asphalt mix, it is vital that all aggregate, including recycled materials, are of sufficient quality to ensure satisfactory mix performance. Although little has been written concerning the consensus aggregate properties of RAS fine aggregate, states should ensure that common fine-aggregate testing is conducted. This will help prevent any stability or workability problems with the mix.

## Deleterious Materials

While MW shingles are typically free of deleterious materials, PC shingles may contain such contaminants as wood, nails, plastics and other debris. These extraneous materials must be minimized. Limits are specified in AASHTO MP 15-09; however, several states such as Minnesota and Texas have developed more stringent specifications to limit the amount of deleterious materials in their RAS piles.

## Asbestos Concerns

All recycled materials used in roadway projects are required by federal regulations to contain less than 1 percent asbestos, since exposure to asbestos fibers is known to increase the risk of lung cancer. U.S. shingle producers have not used asbestos since the 1980s, but manufacturers should be required to ensure that MW RAS is asbestos-free.

Asbestos testing should be conducted on all PC RAS. A list of laboratories accredited for asbestos testing is maintained on the Web site for the National Institute of Standards and Technology at <http://ts.nist.gov/standards/scopes/programs.htm>. Two methods are available for asbestos testing: polarized light microscopy (PLM) and transmission electron microscopy (TEM). The most sophisticated means of identifying and quantifying asbestos fibers in RAS is TEM.

After sampling and testing a RAS stockpile for asbestos, it is critical not to add other RAS material to the stockpile. This will prevent possible contamination of a stockpile that has been certified asbestos-free.

Following these guidelines should promote the production of high-quality RAS asphalt mixes, which are a cost-effective and environmentally sound choice for both the asphalt industry and taxpayers.

# Economical Mixes for Low-Volume Roads

In recent years, transportation funding has dwindled, while the cost of maintaining roads has risen, creating a challenging situation for engineers responsible for keeping the nation's highway system in acceptable condition. The asphalt industry is responding to the challenge, providing ways to reduce construction and preservation costs as well as improving material performance to reduce life-cycle cost.

Although high-volume roads carry the majority of traffic, low-volume roads—defined as roads with less than 1,000 average annual daily traffic (AADT)—account for 82 percent of total U.S. lane mileage. Approximately two-thirds of low-volume roads are paved, so considerable savings can be realized nationwide when preservation costs are reduced.

Paved low-volume roads include both hot-mix asphalt (HMA) and chip seal surfacing, though the Federal Highway Administration (FHWA) statistics do not identify percentages of each. Asphalt mixes provide a smoother, safer riding surface and result in lower user costs than chip seals. Asphalt surfacing also offers a longer expected life span between maintenance treatments. Low-volume asphalt pavements should perform well for 10-20 years when properly designed and constructed, while chip seals typically require resealing every 5-10 years. Initial construction costs are higher for asphalt mixes, however.

When selecting pavement preservation treatments, engineers must carefully consider the life-cycle cost of available options. FHWA recently collected typical cost and performance data for many of the common preservation treatments, shown in Table 1. Costs and performance lives may vary by location and other factors. It is important to select the appropriate treatment for the existing pavement condition; otherwise performance life will be negatively affected.

Of these alternatives, the most commonly used preservation treatments are chip seals and thin asphalt overlays. Two options—crack treatment and fog seals—have a lower cost per year than chip seals or thin asphalt overlays but have limited benefits. While the reported cost of chip seals is approximately 25 percent less than asphalt overlays, there are additional benefits

**Table 1 Typical Unit Costs (2009) and Pavement Life for Specific Maintenance and Preservation Treatments (FHWA)**

Treatment	Unit price \$/sq.yd.	Expected Extended Life of Pavement, yrs.	Cost Per Year \$/sq.yd./yr.
Crack Treatment	0.32	2	0.16
Fog Seals	0.99	4	0.25
Chip Seals	1.85	6	0.31
Microsurfacing	3.79	6	0.63
Slurry Seals	4.11	5	0.82*
Thin Asphalt Overlay	5.37	13	0.41

\*Limited data was available for the slurry seals; the unit price may appear higher than expected.

associated with asphalt overlays, such as a smoother riding surface and lower user costs. Based on a typical cost per ton for HMA, the overlay thicknesses used to calculate the unit price for thin asphalt overlays were between 1 and 1-1/2 inches. Reducing the overlay thickness would lower the cost and make asphalt overlays a more competitive preservation choice.

## Reducing Layer Thickness by Using Smaller NMAS Mixes

For preservation of low-volume roads, layer thickness can be reduced by using a smaller nominal maximum aggregate size (NMAS) mix. Since layer thickness should be at least 3-4 times the NMAS for proper placement and compaction, a 4.75 mm NMAS mix can be placed at layer thicknesses between 3/4 and 1 inch. Care should be taken to ensure that a thin overlay is the appropriate preservation option based on existing pavement conditions.

Several states including Alabama and Georgia have reported good results for thin overlays using 4.75 mm mixes. Georgia DOT recommends minimum layer thicknesses of 7/8 inch and 1-1/8 inch for 4.75 mm and 9.5 mm mixes, respectively. This represents a 22 percent reduction in layer thickness. Assuming

—Continued on Pg. 11

**Table 2 AASHTO M 323 Recommended Material and Mix Requirements for 4.75 mm Mix**

Design ESALs 20 yr. design life (millions)	N <sub>design</sub>	FAA Depth from Surface		Dust-to-Binder Ratio	VMA	VFA	N <sub>initial</sub>
		< 100 mm	>100 mm				
< 0.3	50	40	-	1.0 - 2.0	16.0	67 - 79	≤ 91.5
0.3 - 3.0	75	45	40	1.0 - 2.0	16.0	66 - 77	≤ 90.5
3.0 - 10.0	75	45	40	1.5 - 2.0	16.0	75 - 78	≤ 89.0
<b>Sieve Size</b>	<b>Min.</b>	<b>Max.</b>	$V_a = 4.0 - 6.0 \%$				
12.5 mm	100	100					
9.5 mm	95	100					
4.75 mm	90	100					
1.18 mm	30	55					
0.075 mm	6	13					

NCAT invites your comments and questions, which may be submitted to Karen Hunley at [karen.hunley@auburn.edu](mailto:karen.hunley@auburn.edu). Questions and responses are published in each issue of *Asphalt Technology News* with editing for consistency and space limitations.

## Mark Woods, Tennessee DOT

When selecting candidates for re-surfacing projects, what does your state find the most useful (pavement management data, indices, tests, procedures, etc.) for a healthy resurfacing program?

## Ken Hobson, Oklahoma DOT

Have you allowed WMA to extend your paving season? If so, can you site a specific resource or research paper that the decision or limits were based on? If temperature or calendar limits were changed, what are they now?

We completed a project in Caddo County that used 7.5 percent styrene-butadiene-styrene (SBS) polymer in 8 inches of hot-mix asphalt (HMA). The Turner-Fairbank Highway Research Center (TFHRC) and Oklahoma University are performing dynamic modulus, fatigue, flow number and a few other tests on some of the materials.

## Bill King, Louisiana DOT

We would like information from other DOTs about tack coats you have used and resulting bond strengths.

## Don Watson, NCAT

Does your agency assign a factor less than 100 percent for reclaimed asphalt pavement (RAP) binder contribution to the mix? How was the factor determined? Are there research reports on your experience that can be referenced?

What are your highest priority research needs in the area of pavement preservation?

Has anyone used micro-milling to restore surface texture and friction and left it as the final riding surface? How was quality of the work measured? Describe your results.

Tack coat bond strength has been an item of national research for the last few years. What is your agency doing differently today to improve tack coat bond strength?

## 2012 Pavement Test Track Construction



Top: Graduate students help install a subgrade pressure plate for performance monitoring on a new test section. Top right: A team begins installing a strain gauge array. Bottom right: A new section is paved with the Safety Edge attachment, which rounds and softens the edges of the pavement for safer driving.



The following responses have been received to questions shared in the Fall 2011 Asphalt Forum.

1. **What lift thickness is optimal for SP-4.75 mixtures? What thickness would be considered too thin for good paving practices? Is there a maximum thickness where rutting becomes an issue? What binder grade is being used in this mix type? (Greg Sholar, Florida DOT)**

**Charlie Pan, Nevada DOT**

NDOT used 2 times nominal maximum size (NMS) as the minimum lift thickness.

**Mark Woods, Tennessee DOT**

Tennessee has gone as low as 45 lbs/yd<sup>2</sup> (~1/2") with its 4.75-mm equivalent, and we have found that is too low for placement. Rates of 65 and 85 lbs/yd<sup>2</sup> seem to be the most favorable according to our resurfacing coordinators. Considering the high stability and high rut resistance of these highly angular, screenings-based mixtures, we assume they could be placed at much higher thicknesses.

**Cliff Selkinghaus, South Carolina DOT**

We use a Surface Type E, which is composed of all crushed quarry screenings and reclaimed asphalt pavement/reclaimed asphalt shingles (RAP/RAS) in South Carolina. The rate is between 60-100#/SY. We have tested the rutting using the Asphalt Pavement Analyzer (APA) and get around 7-8 mm using PG 64-22, and tried some experimental designs in the lab using some PG 76-22 and got values around 5-6 mm. We only use the PG 64-22 for this mix, but do allow up to 30 percent aged binder from the fractionated RAP/RAS, which helps with rutting. We use this mix regularly to correct any cross-slope issues prior to paving the final surface.

**Ken Hobson, Oklahoma DOT**

Using the rule of 3, 4, 5 times NMS: Optimal thickness would be 0.75 inches, minimum thickness would be 0.50 inches, and maximum thickness would be 1.00 inches.

The typical grade is PG 64-22. A few have used PG 76-28. This is usually a leveling course mixture. Passing the Hamburg rut test OHD L-55 can be difficult. Molding to 40 mm, though difficult, sometimes works better than molding and testing at the usual 60 mm.

**Bill King, Louisiana DOTD**

LADOTD does not have a 4.75 mm mixture. Our thin-lift mixes are designed for a minimum of 3/4-inch layer thickness. Binders used for those mixes include PG 70-22m, PG 76-22m, and PG 82-22 cm.

2. **What practices have agencies successfully used to prevent reflective cracking? (Don Watson, NCAT)**

**Charlie Pan, Nevada DOT**

Using softer asphalt/finer gradation mix in the bottom lift and cold-in-place recycling the existing pavement before overlay

**Joe Schroer, Missouri DOT**

Missouri used 5 3/4-inch overlays on interstate highways at one point, which all but eliminated reflective cracking. This was discontinued as budgets became tighter.

**Greg Sholar, Florida DOT**

FDOT has used an asphalt rubber membrane interlayer (ARMI) for many years, but results from field test sections and recent laboratory research have determined that it is not very effective at mitigating reflective cracking. FDOT has just initiated contracted research with the intent of identifying a new crack relief layer. One possibility is an open-graded crack relief layer.

**Mark Woods, Tennessee DOT**

TDOT will occasionally use chip seals to mitigate reflection of minor top-down cracks. We also have a specification for a concrete crack-mitigation mix, designated as an asphalt crack relief layer (ACRL).

**Ken Hobson, Oklahoma DOT**

Fabrics can retard cracks for maybe three years. Our NCAT test track section, N8, in the 2009 cycle used a high-polymer binder in the last repair that retarded cracks for longer than the fabric. Traffic will continue during the 2012 cycle to see how long.

**Bill King, Louisiana DOTD**

For existing surfaces, LADOTD uses the saw-and-seal joint method to prevent reflective cracking. New overlays with stone-matrix asphalt (SMA) and open-graded friction course (OGFC) were used successfully, too.

For new pavements, a crack relief layer, either with 4 in. stone-over-base or two shots of asphalt surface treatment (AST) over stabilized base, has been used. However, LADOTD did not have much success with fabrics or grids.

3. **There seems to be growing interest in recycled asphalt shingles (RAS), but are agencies actually seeing an increase in shingle recycling? Are there different handling procedures or mix design guidelines for tear-offs than for manufacturing rejects, since tear-offs are much stiffer? (Don Watson, NCAT)**

**Charlie Pan, Nevada DOT**

We have no experience with RAS.

—Continued on Pg. 8

—Continued from Pg. 7

**Joe Schroer, Missouri DOT**

Missouri sees contractors placing RAS in every mixture that they possibly can. Specifications are geared toward tear-offs since pre-consumer RAS is unavailable to most of the state. There is no distinction between the two; however, contractors pay attention due to handling differences during placement.

**Mark Woods, Tennessee DOT**

TDOT is interested in shingle use, but we are only at the trial projects stage.

**Cliff Selkinghaus, South Carolina DOT**

Yes, we have a renewed interest of RAS with several more contractors starting to use them in some of their low-volume mixtures. We predominantly see the tear offs being used in South Carolina. The tear-offs have a much higher binder content than the manufacturers' waste. We would like to see the shingles material grinded down further at times to eliminate "flakes" of fiber and paper, which we see in some mixtures that appear to be lacking enough virgin binder in the field.

**Ken Hobson, Oklahoma DOT**

We will be developing a special provision in late 2012. Since shingles are replaced often in Oklahoma, the difference in binder oxidation may not be that great, but it should be considered.

**Bill King, Louisiana DOTD**

Regulation does not exist on RAS. Numerous companies seem to show interest in RAS but still not a significant interest. LADOTD has not yet included anything about RAS in its specifications.

**4. There is renewed interest in the use of ground tire rubber (GTR). What mesh-size particles have worked best and in what proportions? (Don Watson, NCAT)**

**Charlie Pan, Nevada DOT**

No. 30 to No. 50 meshes

**Joe Schroer, Missouri DOT**

Missouri is in its seventh year of using GTR-modified mixtures cross-linked with TOR as placed on the recently completed cycle of the NCAT Pavement Test Track. These mixtures have performed well using minus No. 30 (30 mesh) GTR.

**Greg Sholar, Florida DOT**

FDOT uses a GTR meeting the following gradation requirements: 100 percent passing the No. 30 sieve, 40-60 percent passing the No. 50 sieve and no gradation requirements for sieves finer than the No. 50 sieve.

**Cliff Selkinghaus, South Carolina DOT**

We are experimenting with GTR as an alternate for SBS PG

76-22 in our state. We are using minus 30 mesh material, ambient grind, passenger tire material. We are only considering the wet process through terminal blending. We are seeing between 8-12 percent GTR when modifying a PG 64-22 base material. We are a little concerned about putting too much GTR in the binder, causing the true grade values to be too high and giving us constructability issues in the field.

**Ken Hobson, Oklahoma DOT**

We do not specify the mesh type or proportions. A GTR technology that meets AASHTO M 320 is something we will be trying soon. We have not considered other technologies other than what is used for our AC20-5TR that is used for chip seals.

**Bill King, Louisiana DOTD**

A minimum of No. 30 mesh-sized rubber particles at 10-12 percent by the weight of binder is the common practice in Louisiana. A wet process of blending rubber has been preferred.

**5. What are some of your agency's priority needs in the area of asphalt research? (Don Watson, NCAT)**

**Charlie Pan, Nevada DOT**

Asphalt materials characteristics for DARWin-ME and implement Asphalt Mixture Performance Tester (AMPT) requirements for HMA mix designs

**Greg Sholar, Florida DOT**

FDOT needs research to identify a reflective crack relief layer, research to mitigate top-down cracking and research to improve the durability of open-graded friction course mixtures.

**Mark Woods, Tennessee DOT**

We are interested in any topic that concerns increasing pavement fatigue life and the overall life cycle of our network.

**Ken Hobson, Oklahoma DOT**

We will research fatigue in 2013. We have two and possibly three fatigue research projects starting then. We may research multiple stress creep recovery (MSCR) in 2013.

**Bill King, Louisiana DOTD**

Our research needs include RAS and RAP, performance-related specifications/end-result specifications, a suitable cracking test for asphalt mixtures, and MSCR.

**6. What challenges do you foresee regarding workforce enlistment and development? (Don Watson, NCAT)**

**Charlie Pan, Nevada DOT**

I am not aware of any specific challenges.

—Continued on Pg. 12

## Missouri

Missouri is currently looking at over-compaction on the roadway of 75-gyraton stone-matrix asphalt (SMA) mixtures. Discussions with industry will focus on specification changes to limit compactive effort or possibly moving back to 100-gyraton mixtures.

## Florida

The biggest changes coming in the next year are related to asphalt binders. We are eliminating viscosity-graded binders for use with reclaimed asphalt pavement (RAP) mixtures and will use PG grades for all binders. Previously used blending charts for RAP mixes were based on viscosity, but we will now use a table approach for selecting the PG binder grade based on the percent of RAP. We will still sample production mix and test the recovered binder for PG grade.

We will be implementing the multiple stress creep recovery (MSCR) test within the next year for all binders. We also plan to implement a new PG 76-22 rubber-modified binder type at the same time. The PG 76-22R binder must have a minimum 7 percent ground-tire rubber (GTR) and must pass PG 76-22 requirements, including MSCR *Jnr* for traffic level "V" and percent recovery. A separation requirement of a maximum 7°F will be implemented. The dynamic shear rheometer (DSR) testing will be accomplished using a 2-mm gap instead of the standard 1-mm gap. The solubility requirement will be waived for the PG 76-22R binders. The binder supplier may add polymer to the rubber-modified binder if necessary to meet the specification requirements.

We are conducting pilot projects using an incentive/disincentive specification for smoothness.

## Tennessee

We recently modified our design guidelines and specifications to target tack coat rates of 0.07 and 0.10 gal/yd<sup>2</sup> for standard and milled surfaces, respectively. Specifications will soon be updated to permit the use of trackless tack.

## Oklahoma

Specification 708-22 now allows hot-mix asphalt (HMA) designs to be used as foaming technology warm-mix asphalt (WMA) designs if Pba =/ $<$  1.00 percent. This will increase the use of foaming technology WMA. Past policy required an HMA design converted to a foaming WMA design to have plant-produced material to pass AASHTO T 283 and Hamburg rut test OHD L-55, which added an extra two weeks before mainline production. For more information:

- [http://www.okladot.state.ok.us/c\\_manuals/specprov2009/oe\\_sp\\_2009-708-22.pdf](http://www.okladot.state.ok.us/c_manuals/specprov2009/oe_sp_2009-708-22.pdf)
- <http://www.okladot.state.ok.us/materials/pdfs-ohdl/ohdl55.pdf>
- [http://www.okladot.state.ok.us/c\\_manuals/specprov2009/oe\\_sp\\_2009-708-23.pdf](http://www.okladot.state.ok.us/c_manuals/specprov2009/oe_sp_2009-708-23.pdf)

We also changed our WMA acceptance policy to allow

consideration of some nationally accepted WMA technologies. For more information:

[http://www.okladot.state.ok.us/c\\_manuals/specprov2009/oe\\_sp\\_2009-708-26.pdf](http://www.okladot.state.ok.us/c_manuals/specprov2009/oe_sp_2009-708-26.pdf)

Specification 708-26 increased binder content by approximately 0.3 percent to make pavements last longer. Full implementation started with the July 2012 lettings. For more information:

[http://www.okladot.state.ok.us/c\\_manuals/specprov2009/oe\\_sp\\_2009-708-26.pdf](http://www.okladot.state.ok.us/c_manuals/specprov2009/oe_sp_2009-708-26.pdf)

1. Reduced Superpave gyratory compactor (SGC) gyrations to three levels by binder type.
2. Increased voids in mineral aggregate (VMA) limit by 0.5 percent for Superpave mixtures. Voids filled with aggregate (VFA) values changed accordingly.
3. Increased minimum binder content for Superpave mixtures by 0.2%.
4. Removed  $N_{max}$  requirements.
5. Removed equivalent single-axle load (ESAL) references to design by binder type.
6. Fractured face limits were increased and decreased.
7. Removed Asphalt Pavement Analyzer (APA) option and test method OHD L-43.
8. Added Hamburg rut test method OHD L-55 and specifications.
9. Removed FAA requirement and test method. It can still be used as a tool for the designer.
10. Removed option to use RAP in low-volume roadways for the surface course. This was needed to remove the last ESAL specification.
11. ESALs may still be shown on the mix design, but it is for information only.

A new special provision will require hydrated lime to be used in Beaver, Cimarron and Texas counties in Oklahoma. It requires hydrated lime as the anti-stripping agent if one is needed to meet specification requirements.

We are also working on a RAS/RAP special provision for late 2012.

## Louisiana

The Louisiana Department of Transportation and Development (LADOTD) has just completed new specifications, pending Federal Highway Administration (FHWA) approval, that are scheduled for implementation in spring 2013. The  $N_{design}$  gyratory level has been changed from 100 gyrations to 75 gyrations for high-level mixes and from 75 to 65 for low-level mixes. The design voids in mineral aggregate specification (VMA) has been raised 0.5 percent, and the voids filled with asphalt (VFA) guideline for design will be a minimum of 72 percent. In addition, 25 percent RAP will be allowed in binder course mix if the plant screens RAP to a maximum 1-in. diameter.

—Continued on Pg. 12

# Selecting Virgin Binders for RAP Mixes Based on Regional RAP Binder Properties

Contractors and agencies are gaining confidence with the use of higher RAP contents. Field performance studies, including studies that compared long-term performance of overlays with virgin and 30 percent RAP mixes as well as test sections on the NCAT Pavement Test Track with up to 50 percent RAP, have shown that higher RAP content mixes can perform well if they meet standard mix design and quality assurance criteria. Contractors are learning how to manage RAP to minimize dust content, contamination and variability within their stockpiles. Across the US, average RAP contents continue to increase.

One hurdle that sometimes limits the use of higher RAP contents is the selection of the binder grade for the virgin asphalt. For years, conventional wisdom has been to use a softer grade of virgin binder to blend with the aged RAP binder so that the combined binder would have appropriate properties for the climate and traffic conditions. Currently, AASHTO M 323 recommends changing the binder grade at RAP contents greater than 15 percent, as shown in Table 1.

**Table 1 Current binder selection guidelines for RAP mixes according to AASHTO M 323**

Recommended Virgin Asphalt Binder Grade	RAP Percentage
No change in binder selection	<15
Select virgin binder one grade softer than normal (e.g., PG 58-28 if PG 64-22 is normally used)	15-25
Use a blending equation	>25

As seen in Table 1, it is necessary to use a blending equation to estimate the grade of the blended RAP and virgin binders when RAP contents exceed 25 percent by weight of aggregate. Blending equations require determining the critical temperatures of the recovered RAP binder, which involves binder extraction and recovery, an expensive and time-consuming process using potentially hazardous chemicals. Most contractors do not have the equipment necessary to perform these tests, and some highway agencies are hesitant to specify percentages of RAP that require this extra testing.

A new variation of this approach for selecting the virgin binder grade for high RAP content mixes now being reviewed by FHWA's Mix Expert Task Group (ETG) is to determine the properties of RAP binders on a regional basis. In this method, an evaluation is performed on numerous RAP stockpiles within a region/state. The draft procedure is summarized as follows:

- RAP samples are obtained from stockpiles throughout a geographic area, which should be defined based on similarity of climate and materials.

- Solvent extractions are used to recover the RAP binders, which are then performance graded on a continuous scale (true grade).
- Determine the continuous low temperature grade for each virgin binder grade supplied within the region.
- After testing all of the RAP and virgin binders, determine the average low temperature grade plus two standard deviations for the RAP stockpiles and virgin binders in the region.
- Calculate the maximum allowable RAP binder ratio as follows:

$$RBR = \frac{T_{crit}(need) - T_{crit}(virgin)}{T_{crit}(RAP\ Binder) - T_{crit}(virgin)}$$

Where:

*RBR* = RAP Binder Ratio - the ratio of the RAP binder divided by the mixture's total binder content. The mixture's total binder content is an unknown prior to mix design but can be estimated based on historical data for the aggregate types and nominal maximum aggregate sizes.

$T_{crit}(need)$  = low critical temperature needed for the climate and pavement layer based on LTPP Bind version 3.1.

$T_{crit}(virgin)$  = average low critical temperature of the virgin asphalt binder plus two standard deviations.

$T_{crit}(RAP\ Binder)$  = average low critical temperature of the RAP binders plus two standard deviations.

This approach is based on the premise that the low temperature properties should control the amount of RAP that can be used with a particular virgin binder.

A few states are using statewide RAP binder evaluations to revise RAP specifications. Indiana tested 33 RAP stockpiles across the state and found the average RAP binder to be PG 90-11. Virgin binders, both PG 64-22 and PG 58-28, were also tested. Using the critical low temperatures and the blending equation found in section X1.4 of AASHTO M 323, maximum allowable RAP percentages were calculated to be approximately 23 percent for -22 virgin binders and 38 percent for -28 binders. Based on these calculations, the recommended new specification is no change in binder grade (PG 64-22) for less than 25 percent RAP, and one grade lower (PG 58-28) for 25 to 40 percent RAP.

A similar study in Florida involved testing a total of 21 RAP stockpiles throughout the state's seven districts. The results of the study were used to validate Florida's proposed limits, which include no change in binder grade (PG 67-22) for less than 15 percent RAP, PG 58-22 for 16 to 30 percent RAP, and PG 52-28 for more than 30 percent RAP.

An analysis of 36 RAP stockpiles across Alabama indicates

—Continued on Pg. 12

# Low-volume roads

—Continued from Pg. 5

that 70 percent of in-place asphalt mix costs are for materials, this layer thickness reduction translates into a 15 percent savings in asphalt mix cost.

## Mix Requirements

High voids in mineral aggregate (VMA) is often present in 4.75 mm mixes, often resulting in higher asphalt contents and increasing the mix cost. VMA and optimum asphalt content can be reduced by increasing the amount of material passing the 0.075 mm sieve, which also serves to stiffen the binder and add stability to the mix. To further reduce the optimum asphalt content, 4.75 mm mixes should be designed at a higher air void content (4 to 6 percent). These adjustments should provide adequate mix stability and durability, only slightly increasing the binder content relative to typical 9.5 or 12.5 mm NMAS mixes.

In the past, rutting was a concern for 4.75 mm mixes. However, this was primarily due to excessive use of rounded natural sand rather than the gradation. To avoid rutting problems, natural sand should be limited to 15 percent of the total aggregate, and fine aggregate angularity (FAA) requirements should be met.

Although many state agencies use their own specifications for 4.75 mm mixes, AASHTO M 323 provides detailed specification requirements, shown in Table 2. This table reflects revisions published in the 2012 AASHTO standards.

Because 4.75 mm mixes are placed at thicknesses of one inch or less, many states do not specify in-place density requirements. However, these finer mixes should be compacted to at least 90 percent of theoretical maximum density. Fine-graded 4.75 mm mixes do not have an interconnected void structure and are not permeable at this void content.

## 4.75 mm Mix Performance at the Test Track

Mississippi DOT placed a 4.75 mm mix at a layer thickness of 3/4 inch on the NCAT Pavement Test Track in 2003. The mix contained a blend of limestone, gravel and sand, and was produced using PG 76-22 binder. All AASHTO mix requirements were met, and an average density of 92.2 percent was achieved.

This mix has shown excellent performance throughout three traffic cycles at the track. Even after the application of 30 million ESALs, no cracking has been observed in the section, and rutting is minor (approximately 7 mm). Roughness measurements have remained steady throughout trafficking, at an IRI of approximately 50 inches/mile. While surface friction has been cited as a potential concern for 4.75 mm mixes, this mix has been shown to provide acceptable friction. Traffic is scheduled to continue on this section (W6) during the 2012 Pavement Test Track cycle. Complete production and performance data is available at [www.pavetrack.com](http://www.pavetrack.com).

## Reducing Costs with 4.75 mm Mixes

The 4.75 mm mix placed on Section W6 contains polymer-modified binder at a higher percentage than is typical for 12.5 mm mixes, which translates into a higher cost per ton. However, since the mix was placed in a thinner lift, the cost is more reasonable when figured as cost per square yard. Still,



A 4.75 mm mix with a layer thickness of 3/4 inch was placed on Section W6 on the test track in 2003 and has performed well throughout all three cycles.

methods for reducing binder cost would make smaller NMAS mixes even more appealing.

A recent laboratory rutting study investigated the use of PG 67-22 binder with several binder replacement technologies in a 4.75 mm mix similar to that used on Section W6. Three options—50 percent fine fractionated RAP, Thiopave (a warm-mix sulfur replacement package) and 5 percent RAS—exhibited Asphalt Pavement Analyzer (APA) rut depths similar to or better than the control PG 76-22 mix.

As part of the 2012 NCAT Pavement Test Track Preservation Group experiment, several variations of a 4.75 mm will be placed on Lee Road 159, which provides access to a quarry and an asphalt plant. The control mix will incorporate polymer-modified PG 76-22 binder, while experimental sections will use PG 67-22 alone, with 50 percent fine fractionated RAP, and with 5 percent RAS. Existing pavement conditions near an intersection warrant the use of an additional experimental 4.75 mm mix containing highly polymer-modified (HPM) binder.

## Using RAP, RAS and WMA to Reduce Mix Cost

Whether or not reducing layer thickness is an option, the most economical asphalt mixes use RAP and/or RAS to replace a substantial portion of the virgin binder. Typical percentages are 15 to 20 percent for RAP and 5 percent for RAS. Increasing these amounts results in even greater cost savings, and evidence suggests that properly designed mixes with higher recycled contents can provide good performance.

A common practice in many areas is fractionating RAP so that it is divided into a coarse maximum-size material and a fine maximum-size material. Fine fractionated RAP typically contains higher asphalt contents and greater percentages of material passing the 0.075 mm sieve, making it especially suitable for 4.75 mm mixes. Likewise, coarse RAP fractions are well-suited for other asphalt mixes, making it possible to incorporate greater RAP percentages, since the amount of material passing the 0.075 mm sieve is lower.

Another means of reducing mix cost is the use of warm-mix asphalt (WMA). When used alone, WMA can reduce fuel costs, but it typically does not significantly reduce mix cost. Depending on the warm-mix technology used, mix cost might even increase slightly. However, when WMA is combined with the use of recycled materials, maximum cost-effectiveness is achieved. WMA serves as a mixing and compaction aid for RAP and/or RAS mixes, and some state DOTs allow greater percentages of RAP and/or RAS when WMA is used.

## Asphalt Forum Responses —Continued from Pg. 7

### Ken Hobson, Oklahoma DOT

With regard to asphalt engineers, not many engineer interns in Oklahoma are interested in asphalt. The Professional Engineer's exam seldom asks any questions about asphalt, which can make it difficult for those that do choose the field. At least half of our current engineers can retire in five years. Asphalt technicians, like engineers, throughout Oklahoma DOT probably mirror national trends. Obviously, the economy in the next few years will either help the problem, or it will exacerbate the problem. The most likely scenario is the latter.

Development will not be a problem for technicians, as we have a robust training program. All current Oklahoma DOT asphalt binder technicians are Asphalt Institute certified as well.

### Bill King, Louisiana DOTD

LADOTD has been losing experienced technicians at a faster rate than we can replace them. Getting experienced technicians is a tremendous challenge. However, LADOTD has been working with the local community college to introduce a technician certification program to meet this challenge.

## Specification Corner —Continued from Pg. 8

LADOTD is also changing its methods for quality assurance. In lieu of paying on plant voids as measured by a LADOTD technician at the plant, LADOTD will monitor all plant mix using contractor-provided data—one sample every 1,000 tons. However, no pay will be associated to plant-provided data. All pay will be based on roadway cores sampled randomly once every 2,500 ft. for acceptance. The pay will be based on PWL, with no incentives. For  $n=15$ , 80 PWL equals 100 percent pay, and 34 PWL equals 50 percent pay. A new section has been added to the LADOTD specifications for "thin asphaltic concrete applications" for mixtures with less than 1.5-inch thickness. Mixes specified under this

category are (1) dense mix for low and medium traffic; (2) coarse mix for low, medium, and high traffic; and (3) open-graded friction course (OGFC) for all traffic but especially required on interstates.

LADOTD will also implement a separate payment-by-the-gallon for tack coat material. Tack coat application rate has been increased by 0.10 gal/sq. yd., 0.03 gal/sq. yd., 0.02 gal/sq. yd., and 0.02 gal/sq. yd. for existing surface treatment, new hot mix, existing hot mix, and Portland cement concrete surfaces, respectively.

## Regional RAP Binders

—Continued from Pg. 10

that a maximum 35 percent RAP could be used with PG 67-22 binder and 33 percent RAP with PG 76-22, based on critical low temperatures. This represents 96 percent reliability that a target climate grade of  $-16^{\circ}\text{C}$  will be met. Current Alabama specifications allow a maximum of 20 percent RAP for surface mixes and 25 percent for underlying layers. ALDOT also considers contractor-proposed mix designs with up to 35 percent recycled content for binder and base layers using PG 67-22; such mixes require additional testing, including binder extraction and recovery.

In Wisconsin, samples from six RAP stockpiles and six fractionated RAP (FRAP) stockpiles were characterized. The stockpiles were evenly divided between northern and southern areas of the state. The continuous binder grading properties were similar for all of the RAP stockpiles tested, with an average RAP binder grade of PG 82.8-21.8. A reliability analysis was conducted to evaluate Wisconsin's current binder replacement criteria, and revisions were recommended in order to improve

the reliability of meeting design low-temperature grades. As a result, a decrease in the percentage of allowable RAP binder was suggested for surface courses (from 25 to 20 percent), while an increase was recommended for underlying layers (from 40 to 45 percent RAP binder replacement).

### Need RAS Testing?

The NCAT laboratory can meet all your needs for recycled asphalt shingles (RAS) testing:

- Gradation of RAS
- Asphalt Binder Content of RAS
- Performance Grading of RAS Binder
- Deleterious Materials
- Asbestos Testing Using Polarized Light Microscopy

Call Jason Moore at 334.844.7336 for more information.

# Market Analysis Identifies Strengths, Needs of WMA

The National Center for Asphalt Technology (NCAT) recently conducted a nationwide market analysis of the use of warm-mix asphalt (WMA) to assess the current state of practice. This analysis was conducted mainly through a series of surveys NCAT disseminated to four stakeholder groups: state departments of transportation, asphalt paving associations (APAs), contractors, and WMA suppliers. The information was gathered to identify the primary drivers and obstacles encountered in the deployment of WMA.

## Current WMA Usage and Specifications

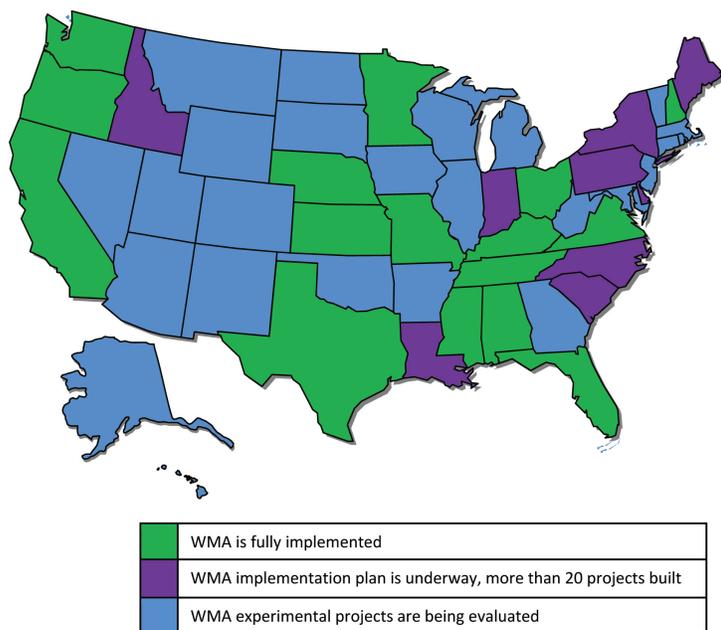


Figure 1 Current status of U.S. warm-mix asphalt implementation.

Although a clear definition of warm-mix asphalt is important to accurately assess current usage, the NCAT surveys found that definitions for WMA differed significantly among the state highway agencies. While about one-third of the definitions mentioned using both a WMA technology and a specific maximum temperature or temperature range to create WMA, the remaining two-thirds defined the term by mentioning only one or the other (temperature or WMA technology). It is helpful to note that most contractors indicated a target temperature of about 270°F to produce WMA.

Survey results also showed that WMA usage has increased significantly in the last few years—between 20 and 30 percent of all plant mix produced in 2011 was WMA. In comparison, NAPA surveys indicated that in 2010, just 13.2 percent of plant mix was WMA, and in 2009, 5.4 percent. However, WMA implementation is not uniform among either contractors or state DOTs, with some reporting a much higher WMA production than others.

Overall, WMA implementation continues to be headed in a positive direction. According to the DOTs who responded to the NCAT

surveys, 26 states have either fully implemented WMA or have a WMA implementation plan underway, as shown in Figure 1. In the remaining states, experimental WMA projects are still being evaluated. About 80 percent of DOTs said in the 2010 NAPA survey that they had a specification for WMA in place.

Additionally, both the NCAT and NAPA surveys indicated that WMA use seems to be growing among all segments of road/highway owners, including state agencies, local agencies, and non-government clients (e.g., commercial developers).

## WMA Technologies

More than 30 WMA technologies are marketed in the U.S., generally categorized into four groups: 1) chemical additives, 2) organic additives, 3) foaming additives and 4) water-injection foaming systems. Some technologies also combine these categories.

NCAT surveys found that water-injection foaming systems are the most popular WMA technology, with state asphalt associations reporting that 78 percent of WMA was produced through water-injection foaming in 2011. Chemical additives were the second most common, accounting for about 19 percent of WMA.

Table 1 summarizes the comparison of WMA usage for years 2009, 2010 and 2011 by road/highway owner segment and by technology used.

Table 1 Summary of WMA Usage for 2009-2011

Year	2009 <sup>1</sup>	2010 <sup>1</sup>	2011 <sup>2</sup>
DOT (%)	6.3	15.0	31.9
Other Govt.	4.4	11.7	25.8
Commercial	4.5	11.6	27.1
Chemical additive	15.0	6.0	19.6
Additive foaming	2.0	1.0	2.3
Plant foaming	83.0	92.0	77.9
Organic additive	0.3	1.0	0.2

<sup>1</sup> NAPA survey; <sup>2</sup> NCAT survey

## WMA Economics

While some WMA technologies cost more to use, the benefits related to plant energy reductions and eliminating anti-stripping additives in some WMA additives can outweigh these costs. In the NCAT survey, most contractors noted about a 10 percent energy savings when using WMA via a water-injection foaming system. Based on energy savings estimated from testing conducted in NCHRP 9-47A, the cost of water-injection foaming systems can typically be offset just by the energy savings it provides through a five-year period. However, for WMA additive technologies, there must be savings beyond energy reduction to break even. Many contractors who routinely use WMA have found that meeting

—Continued on Pg. 14

—Continued from Pg. 13

in-place density specification criteria is easier with WMA. For contractors working in states with bonuses and penalties tied to in-place density, a small improvement in density can result in a substantial financial reward that helps cover a large portion of the WMA technology cost.

Some of the chemical additive WMA technologies also provide antistripping benefits. If the mix design otherwise requires an antistripping additive, some states allow the WMA technology to serve a dual role provided the mix is able to meet either tensile-strength ratio (TSR) or Hamburg test criteria.

Many contractors also use WMA to achieve smoother pavements, though the potential savings are harder to estimate due to the variation among highway agencies regarding incentive specifications for smoothness.

### SWOT Analysis

One objective of the NCAT surveys was to identify the strengths, weaknesses, opportunities and threats (SWOT) for WMA implementation as perceived by the asphalt community. This information plays a critical part in developing recommendations on marketing strategies and training needs for continued WMA implementation.

Strengths, or benefits, of using WMA seemed to vary among the different stakeholder groups. Overall, however, energy savings, reduced plant emissions, improved work environment for paving crews and better workability were identified as the most important benefits of using warm-mix asphalt. All contractors noted a reduction in energy consumption of 5 to 15 percent, and some asphalt paving associations noted a reduction of more than 20 percent.

The most common weaknesses identified through the NCAT surveys were the higher cost of WMA, the difficult of working with WMA by hand and incomplete drying of the aggregate. These problems were ranked differently among the stakeholder groups. Thirteen DOTs also said they consider factors such as pavement layer, traffic volume or mix type when deciding to use WMA, which may inhibit the growth of WMA.

Additionally, although the majority of DOTs and state asphalt paving associations said that no changes are needed in WMA mix design, some said that modifications to the criteria used to evaluate WMA moisture susceptibility, compaction, coating and/or rutting are needed.

Opportunities to increase WMA implementation were identified in the surveys as 1) specifications and/or special provisions, 2) education/training for contractors and local agencies, 3) documentation of field performance to prove effectiveness and 4) capability of the technology to be used in all mix types.

Finally, the NCAT surveys helped identify potential threats to

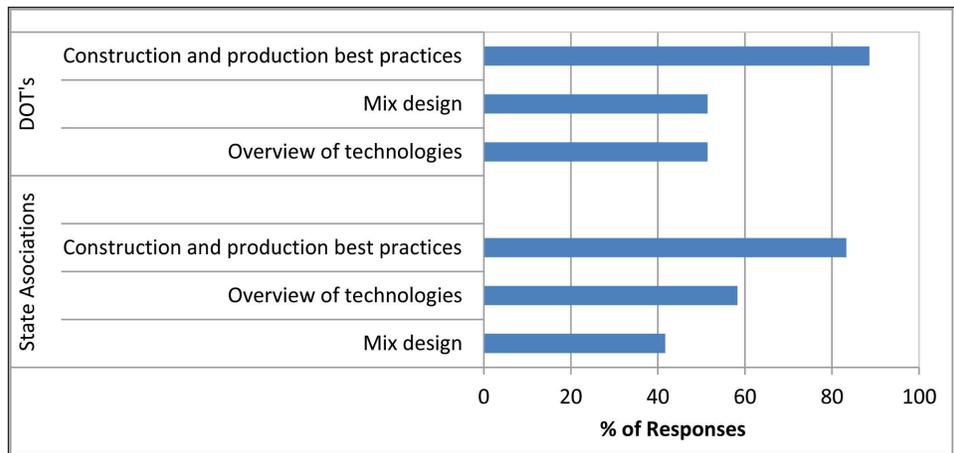


Figure 2 WMA training needs .

WMA implementation, which include 1) concerns about long-term durability, 2) laboratory testing that is inconsistent with field performance, 3) lack of industry buy-in to use WMA technology in some locations, 4) contractors' lack of understanding about benefits, 5) lack of understanding of the different WMA technologies, 5) uncertainty about future acceptance of WMA technologies, and 6) third-party customers' concerns about mix quality/workability.

Despite increased use of WMA nationally, this trend is not consistent for every state. Implementation strategies and WMA training should be tailored to fit each state's individual needs.

### WMA Training Needs

In the NCAT surveys, DOTs and state APAs identified construction and WMA production best practices as the areas in which training is most needed (see Figure 2). They also said an overview of WMA technologies and mix design would be helpful.

Responses regarding the preferred method of instruction were mixed. While most DOTs seemed to prefer live webinars, most state paving association representatives said classroom/instructor-led training was their top choice. This is likely because it is difficult for many DOT employees to travel outside their respective states, so webinars are more convenient. As a result, it is best to have both a classroom training course and webinars on necessary WMA topics.

NCAT took this approach this fall, holding a two-day "Implementing WMA" workshop in two different locations (Denver and Atlanta), as well as a series of four webinars covering the same topics.

NCAT offers a variety of training opportunities to fit your needs. To register for a class or for more information, please visit our website at [www.ncat.us](http://www.ncat.us) or call Don Watson at 334.844.7306.

## FHWA, NCAT Host Workshop on AMPT

Participants in the TPF-5(178) pooled-fund study—Implementation of the Asphalt Mixture Performance Tester (AMPT) for Superpave Validation—and other users of the performance testing device gathered in Atlanta Sept. 11-12 for the National Pooled-Fund Workshop on AMPT.

The workshop was hosted by the Federal Highway Administration (FHWA) and coordinated through the National Center for Asphalt Technology (NCAT). Seventy people from the FHWA, state transportation agencies, consulting companies and academia attended the workshop, including 36 from states participating in the pooled-fund study.

The workshop was an effort to present up-to-date information and identify key issues with the implementation of AMPT for evaluating the performance of asphalt mixtures and for providing key inputs for the mechanistic-empirical pavement design method (DARWin-ME). On the first day, presentations focused on the development and importance of the AMPT for asphalt mixture testing and DARWin-ME implementation. Participants also held round-table discussions to share their own experiences with AMPT testing and to address issues with the equipment, test procedures and acceptance criteria. The second day included more round-table discussions on the top five issues identified the previous day as well as presentations on an inter-laboratory study plan and the future fatigue testing capability of the AMPT.

NCAT Assistant Director Michael Heitzman and Director Emeritus Ray Brown served as workshop moderators. Presenters included Ramon Bonaquist of Advanced Asphalt Technology (AAT) and representatives from state DOTs, FHWA, NCAT and academia.



Judie Ryan from the Wisconsin DOT gives a presentation during the AMPT workshop.

“The workshop was very well received by the participants,” Heitzman said. “There was a general agreement that additional workshops should be held in each region of the country.”

After the workshop, about 30 participants traveled to the NCAT Pavement Test Track in Opelika, Ala., for an optional tour of the 1.7-mile track and its laboratory facilities.



AMPT workshop attendees participate in round-table discussions.

### 2012-2013 NCAT Training Course Schedule

Advanced Mix Design	January 29-31, 2013
Asphalt Technology Course	Feb. 25-March 1, 2013
Superpave Mix Design	March 25-28, 2013
Binder Technician Training and Certification	April 22-25, 2013

All courses are held at NCAT in Auburn, Alabama.

For more information and registration, visit [www.ncat.us/education/training](http://www.ncat.us/education/training).



at AUBURN UNIVERSITY

735 Extension Loop, Auburn, AL 36849-7350

Nonprofit Org.  
U.S. Postage  
PAID  
Permit #9  
Auburn, AL 36849

**National Center for Asphalt Technology,**  
277 Technology Parkway, Auburn, Alabama 36830-0550  
Phone: 334.844.NCAT (6228) Fax: 334.844.6248

Randy West, Director, NCAT  
Karen Hunley, Editor, NCAT  
Courtney Jones, Writer, NCAT

ASPHALT TECHNOLOGY NEWS (Library of Congress Catalog No. ISSN 1083-687X) is published by the National Center for Asphalt Technology (NCAT) of Auburn University. Its purpose is to facilitate the exchange and dissemination of information about hot mix asphalt technology, trends, developments and concerns. Opinions expressed in this publication by contributors and editors, the mention of brand names, the inclusion of research results, and the interpretation of those results do not imply endorsement or reflect the official positions or policies of NCAT or Auburn University.