



▲ **In Michigan in 2005**, thin lift hot-mix asphalt pavement awaits compaction on U.S. Route 127.

Photo courtesy of Asphalt Pavement Association of Michigan

Thin is in

Thin lift hot-mix asphalt overlays are securing their place in the 'pavement preservation toolbox' touted by the Federal Highway Administration, the Foundation for Pavement Preservation, and other groups.

And while they are more expensive in initial costs than other proven pavement preservation surface treatments, such as micro surfacing or chip seals, proponents argue that they provide increased smoothness and a quieter ride than other surface treatments in the short term, and more durability due to slight structural enhancement to the pavement in the long term.

"Most thin treatments only address surface distress [and] do not improve ride quality," said Jim Huddleston, P.E., executive director, Asphalt Pavement Association of Oregon, at the Northwest Pavement Management Conference in October 2009.

Thin HMA overlays are preferable to other preventive surface treatments because they do everything traditional seals do, Huddleston said, including sealing and preserving the pavement, and restoring skid resistance while improving ride and effectively eliminating rutting. He added they have low [but not the lowest] initial costs, and low life-cycle costs, have

low-performance risk, provide minimal road user delays, and add structural strength to the road.

As surveys indicate that ride quality is what is most important to drivers, Huddleston said, thin HMA lifts will please road patrons more because they significantly improve ride quality, while chip and slurry seals only slightly improve ride quality.

While thin HMA overlays have the highest initial cost, however moderate compared to conventional lifts, the lowest-cost alternate is the old-fashioned chip seal.

"The popularity of chip seals is a direct

result of their low initial costs in comparison with thin asphalt overlays and other factors influencing treatment selection where the structural capacity of the existing pavement is sufficient to sustain its existing loads," says Douglas D. Gransberg, P.E., University of Oklahoma, in his 2005 Transportation Research Board paper, *Chip Seal Program Excellence in the United States*.

"Thin and ultra-thin asphalt overlays have performance advantages compared to other preventive maintenance treatments," Huddleston said. "Initial costs are only slightly higher, and life-cycle costs will clearly save agencies money and extend limited budgets."

Long-lasting driving surfaces

Thin (3/4- to 1-1/2-inch thickness) overlays of hot-mix asphalt usually are intended to address problems of surface roughness, rutting, and surface cracking.

Typically, a thin asphalt overlay will be a 3/8-inch NMAS mix, using performance-grade binder, placed 1- to 1.5-inch thick. An ultra-thin asphalt overlay will be a slightly finer-graded mix placed 0.6- to 1-inch in depth.

"People are looking for a way to keep their road system in as good a shape as possible, for as little money as possible," says David E. Newcomb, P.E., vice president, research and technology, National Asphalt Pavement Association. "Thin lift overlays are less expensive than thicker overlays, while lasting longer than other surface treatments."

Thin asphalt overlays have been studied intensively, and their design has become accepted in recent years. Some agencies, like Maryland and Ohio, have been using them for decades.

"Other agencies have adopted them more recently as a pavement preservation technique," Newcomb tells *Better Roads*. "Some were skeptical about using such fine, or small aggregate size mix on the surface, for fear it would rut, but research at the National Center for Asphalt Technology (NCAT) has shown that fine mixes are no more prone to rutting than coarse mixes."

Like their thicker "big brothers," thin asphalt overlays can be dense-graded, open-graded or stone matrix asphalt. Open-graded overlays allow surface



▲ **Ultra-thin asphalt lift** above tack coat is compacted to 3/4-inch in Michigan.

Photo courtesy of Asphalt Pavement Association of Michigan

water to drain away quickly, preventing hydroplaning and improving visibility in wet weather.

For thin lifts, polymer modification can help bring neat asphalt up to performance grade, adding durability, and resistance to rutting at high temperatures, and to cracking at low temperatures. Elastomeric polymers in the binder will result in a thin overlay that will be more elastic under traffic, and less sensitive to temperature fluctuations. Polymer-added asphalts also will fight raveling on conventional and open-graded mixes.

Micro surfacing vs. thin lifts

While surface treatments for pavement preservation include chip seals, slurry seals and enhanced chip seals, micro surfacing is the biggest rival to thin lift HMA overlays, due to its durability and ability to repair surface ills like rutting.

Some states specs such as Missouri's describe micro surfacing and call it a thin lift asphalt overlay, but there's actually a big difference.

Micro surfacing – which is defined by the Foundation for Pavement Preservation (FP2) as a mixture of polymer modified asphalt emulsion, mineral aggregate, mineral filler, water, and other additives, properly proportioned, mixed, and spread on a paved surface

– must be applied by a truck modified with proprietary equipment. A conventional asphalt paver places thin lift asphalt overlays, just in a thinner section.

"Thin lift overlays offer a better opportunity, in my opinion, to provide a smooth surface, as opposed to micro surfacing," Newcomb says. "Micro surfacing can be relatively noisy, while thin lift overlays generally have a dense surface – one that's not quite so open – so tire noise is not quite so pronounced in most cases, research has shown. They provide a quieter riding surface. And thin lifts do provide a small, but measureable, amount of structural benefit."

Unlike slurry seals, micro surfacing usually is placed at more than a single stone thickness. But like thin lift asphalt overlays, micro surfacing can be used on high-volume roadways, to correct wheel path rutting, and provide a skid-resistant pavement surface.

Ohio sold on thin asphalt lifts

Ohio took a close look at thin asphalt lifts, and in 2008 released an important study that justifies them cost-wise.

"Thin [HMA] overlays protect the pavement structure, reduce the rate of pavement deterioration, correct surface

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deficiencies, reduce permeability, and improve the ride quality," say Eddie Y. Chou, D. Datta and H. Pulugurta, University of Toledo, in their 2008 paper *Effectiveness of Thin Hot-Mix Asphalt Overlay on Pavement Ride and Condition Performance*, produced in conjunction with the Ohio Department of Transportation and FHWA. "A thin HMA overlay is generally a cost-effective maintenance treatment. Employed properly, thin overlays provide a relatively low-cost alternative in preserving and extending the service life of the existing pavement."

Chou, Datta and Pulugurta based their cost-effectiveness conclusions on performance data for thin overlays constructed by Ohio DOT since 1990. "The average thin overlay project cost is about 40 percent of the average minor rehabilitation project cost for [Ohio's] Priority System [of high-level and National Highway System pavements], and approximately 60 percent for the General System pavements [all other pavements]," they said in 2008. "In contrast,

the average service life of a thin overlay is generally more than 70 percent of that of a minor rehabilitation."

Thin overlay projects that are not cost effective tend to be those performed on very poor pavements, and those of insufficient thickness. Thin overlays are most likely to be cost effective if the existing pavement's pavement condition rating (PCR) score is between 70 and 90 for Ohio's Priority System, and between 65 and 80 for its General System pavements.

Properties, materials of thin lifts

For the standard-size 1-1/2-inch thin lift overlay, the top size of aggregate is restricted. "You won't want to use a nominal aggregate size larger than 12.5 mm," Newcomb says. "Ideally you

would use a 9.5-mm mix. If you are going down to a 1-inch overlay, you might want to something along the lines of a 4.75-mm mix."

Agencies can be confident that their thin lift asphalt overlays containing a lot of fines will perform well for a long time, Newcomb says. "Research at NCAT dispelled the notion that asphalt mix made with finer aggregate ruts more than others," he tells *Better Roads*.

For a successful thin lift overlay, New-

The new data allow the DOT to place thinner asphalt pavements with the same load-carrying performance as its existing design, allowing more square yards of asphalt pavement to be placed within the same budget, beginning in 2010. The effect will be more lane miles of asphalt overlay in the state placed with the same budget, and the benefits will apply to other states, counties and cities as well.

The new research from NCAT, *Re-*

calibration of the Asphalt Layer Coefficient, by Kendra Peters-Davis and Dr. David H. Timm, P.E., was published in August of last year and establishes that in the age of Superpave and other advanced pavement designs, today's asphalt layers are stronger structurally than layers used during the AASHTO Road Tests of 1958-1960. But that new research is not immediately applicable to thin lift asphalt overlays, Newcomb says.

"The revised structural coefficient for asphalt won't impact thin overlays at all," Newcomb says.

"While thin lifts provide some structural strengthening, they generally aren't put on as a structural layer, and they're not designed to behave in a structural manner. They're put on as a functional treatment, that is, to improve ride quality, to keep pavement distresses from developing into more severe problems.

"The structural coefficient work done by NCAT was intended for overall pavement design, for building full-depth or deep-strength pavements," Newcomb continues. "When a thin lift overlay is planned, normally a structural design is not made; they are there for a different reason. The pavement structure has to be adequate in the first place, and if it's not, you will have to go with a thicker overlay to get that kind of improvement."



▲ **Micro surfacing poses a strong competitor** to thin hot-mix asphalt overlays, but must be placed using modified spreader trucks.

Photo courtesy of Intermountain Slurry Seal, Inc.

comb says, agencies should specify a binder that is a little stiffer to accommodate higher traffic loads. "You definitely want manufactured sand to be in a higher proportion than natural sand, to accommodate higher loads," he says.

New structural coefficient, no impact

The revelation in late 2009 that new research refining or "recalibrating" the structural coefficient of asphalt layers will let the Alabama DOT decrease its hot-mix asphalt overlay thicknesses by nearly 19 percent is generating excitement in the HMA community (see *Top 5 Trends of 2010 in Better Roads*' December 2009 "Road Science" section on pg. 22).

Warm mix, RAP enhance thin lifts

Both reclaimed asphalt pavement (RAP) and today's warm mix asphalts easily fit into the thin lift asphalt overlay. There is a role for RAP fines in thin lift asphalt overlays, although it will require the material be sized, crushed and screened, that is, treated in a plant as a conventional virgin aggregate.

"You will want to size the RAP," Newcomb says. "The RAP should be sand-sized material. Its use is a great idea because sand-sized RAP will have higher asphalt content. As there will be a higher asphalt demand for a finer mix anyway, the residual asphalt will help mitigate the added costs that will result from the required higher asphalt content."

The reduction due to fine RAP in percent liquid asphalt of a thin lift overlay can be quantitatively calculated. "The range will depend on the residual asphalt of the RAP," Newcomb says. "We like to see the amount of binder replaced – be it from RAP or

roofing shingles – at about 40 percent, with 60 percent virgin liquid asphalt in the mix."

Also, the lesser depth of thin lift overlays – and subsequent potential cooling of the mat prior to attaining density – makes thin lift overlays a good match with today's warm mix asphalt technology.

"Whenever you have temperature conditions – particularly with thin overlays – where you may not have as long to compact, warm mix can provide an edge in extending that window for compaction," Newcomb says.

This is even more important as warm-mix asphalt goes mainstream, and prices decline for the value-added material. "Increased interest has done a lot to put the 'heat' on warm-mix additive and equipment suppliers to be more competitive," Newcomb notes. "A lot of suppliers are looking at ways to improve their product and lower their costs."

A one-two punch

Further, new research shows that both WMA and RAP can be successfully combined in thin lift asphalt pavements.

In their 2009 TRB paper, *Incorporating High Percentages of Recycled Asphalt Pavement (RAP) and Warm Mix Asphalt (WMA) Technology into Thin Hot Mix Asphalt Overlays*, Dr. Walaa S. Mogawer, P.E., Mr. Alexander J. Austerman and Bryan Engstrom, of the Pavement Research Institute of Southeastern Massachusetts, University of Massachusetts-Dartmouth, and Dr. Ramon Bonaquist, P.E., Advanced Asphalt Technologies, LLC, Sterling, Va., experimented with different permutations of such mixes, containing up to 50 percent RAP with different sieve sizes.

The researchers concluded that the voids-to-mineral aggregate (VMA) decreased as the amount of RAP increased, regardless of the asphalt binder used. "This could be attributed

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to the degree of blending between the aged RAP binder and the virgin binder or the corresponding increased amount of fine aggregates in the mixtures," they said in their report.

Also, the stiffness of the mixtures increased as the amount of RAP increased. "However, the increase in stiffness was not as significant between the control mixtures and the 15 percent RAP as it was between the control mixture and the 30 and 50 percent RAP mixtures," the researchers said.

"This increase in stiffness confirms that a degree of blending exists between the virgin and aged RAP binder."

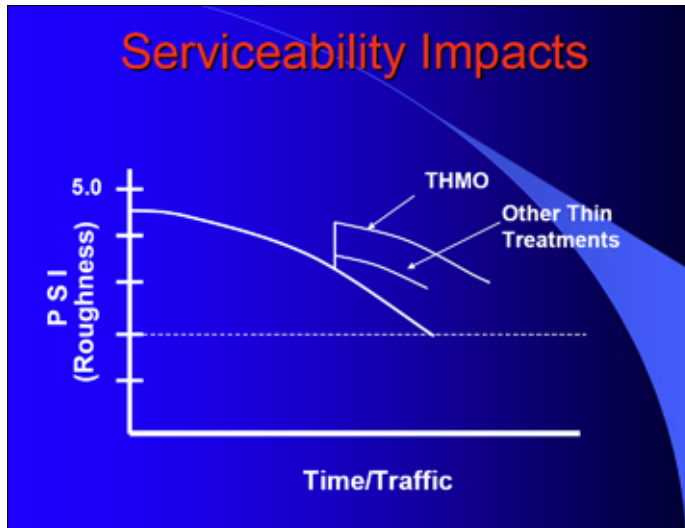
The workability data indicated that the addition of the RAP used in this study caused a reduction in each mixture's workability, they added.

The proof was in the field, as during the research, a contractor took interest in the idea of using high percentage RAP in thin lift mixtures, and offered to place one of the RAP mixtures on a trial project.

The contractor, Saugus, Mass.-based Aggregate Industries Northeast Region, placed a 4.75-mm Superpave mixture with 30 percent RAP using PG 52-33 binder and 1.5 percent Sasobit warm-mix additive from Sasol Wax North America Corporation. The mix was similar to the Superpave 30 percent RAP mixture developed under the Massachusetts study, with differences being the source of aggregates and RAP, and the addition of 1.5 percent latex to increase the elasticity of the binder and preclude potential cracking. The pavement has performed well, the researchers said.

Getting it right the first time

Thin lifts are a simple concept, but they are very dependent on the condition of the surface on which they are placed, and on best-practice construc-



▲ **Proponents of thin hot-mix asphalt overlays** maintain they provide a better pavement, longer, than other pavement preservation treatments.

Photo courtesy of Asphalt Pavement Association of Oregon

tion procedures.

"The thing about thin overlays is that you don't get a second chance to correct whatever happens in that layer," Newcomb says. "So whatever you do for that layer has to be done right the first time."

First and most important is surface preparation, he says. "The smoother the surface being paving on, the smoother the final product will be. Milling to take off surface defects will benefit a lot. Otherwise, the normal paving best practices, such as maintaining a good balance of production at the plant with paving speed at the site, so you have continuous paver operation, will help eliminate paver starts and stops.

"Make sure you are checking screed wear every day," Newcomb says. "Make sure you have the right cross profile on the pavement. Make sure your compactors are in the right intervals in back of the paver, so they are not either shoving mix out in front of the rollers, or not getting on the mat too late. It's all a matter of balance in the chain of events that begin with taking the aggregate out of the stockpile, to operation of the finish roller. All contribute towards a smooth pavement."

Thin HMA lifts can be used to improve pavements afflicted by raveling,

longitudinal cracking, transverse cracking, alligator cracking and rutting, and milling can substantially eliminate the root causes of the distress. While thin surfacings can be placed directly over existing rough or rutted surfaces, experts strongly suggest that the candidate surface be milled, some say to the depth of the overlay prior to placement.

"If a crack is there, eventually it will propagate through to the surface," Newcomb says. "I encourage users to mill a moderate amount off the surface, just enough to remove the surface defects prior to overlay. One of the big advantages is that it gets rid of cracks that are right on the surface that might reflect upwards more quickly than cracks a little further down."

Fine milling for thin lifts

While milling adds to the cost, fine milling in advance of a thin lift enhances adhesion, removes any significant poor ride quality, and if done right, can provide a very level surface that will provide the super-smooth riding experience that drivers demand.

"We've found that for super-smooth thin lift HMA surfacings, cold-milling of the existing, worn surface with a fine-tooth drum is a must," says Jeff Wiley, senior vice president, sales and marketing, for Wirtgen America, Inc.

"With a conventional drum, and relative to ground speed, your 'peaks-and-valleys' patterns will be relatively high and deep, and if you are not placing a lift that's thicker than 1 to 1 1/4 inches, the rough surface can reflect through to the paved surface," Wiley tells *Better Roads*. "But with 5/16-inch bit spacing (or less) an owner or contractor can minimize the potential reflection of the peaks and valleys through the thin lift surface."

For an even smoother surface, full-lane milling with a full-lane fine texture drum will help attain an even smoother surface. These 12.5-foot-wide drums remove a full lane at one pass. When the full-lane-width milling head



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is combined with a fine-tooth or fine-texture drum, the result is very smooth substrates for overlays, and bonuses for meeting stringent smoothness goals, Wiley said.

"In addition to the fine texture from the drum," he adds, "the full-lane width drum permits extraordinary control over the outfall of the milled surface, which also contributes heavily to a project's exceeding smoothness specs, and perhaps a bonus."

While NAPA's Newcomb recommends milling ahead of a thin lift overlay, unlike Wiley, he doesn't necessarily recommend fine milling. "A drum with tight bit spacing is not necessarily required, Newcomb says. "Any milling is a good idea, more from the standpoint of being able to provide a good platform on which to compact," Newcomb says. "If you have that kind of rough texture on the surface on which you are paving, the mix won't shove out from under the rollers so easily, and compaction will be more effective."

Fine milling can be used in this application if the owning agency is concerned about pavement roughness, Newcomb says, adding because of their thinness, thin lifts are vulnerable to significant existing poor ride quality, which can reflect through to the new surface.

Sweep and tack coat first

Experts recommend that the existing surface be broomed or swept prior to placement. The surface should be clean and dry, FHWA suggests, and if required, a tack coat be applied uniformly at the right rate, and cured prior to the placement of the overlay.

For breakdown and intermediate rolling of a thin asphalt overlay, steel-wheeled vibratory, steel-wheeled static or rubber-tired rollers can be used, FHWA says.

For vibration of the thin lift, high frequency and low amplitude are usually used, at a maximum frequency and at a speed that provides a minimum of one impact per inch for thin lifts over an inch in depth, FHWA says. Rollers should be operated in the static mode when lift thickness is 1 inch or less, as with ultra thin HMA overlays.

For finish rolling, steel-wheeled static rollers or vibratory rollers in the static mode should be used, FHWA says.

If density can't be achieved, it may be the result of the problems of conventional-depth mats, such as aggregate gradation being outside of the target gradation, binder content being too low, or the mix being too cool, FHWA says.

But there are reasons unique to thin lifts that may complicate getting density. "Check the density of the underlying mat, which will influence nuclear gauge readings on thin overlays," FHWA says in its *Pavement Preservation Checklist: Thin Hot-Mix Asphalt Overlay*. "If this is the case, a control strip can determine the maximum achievable density." Also, the mix nominal maximum aggregate size may be too large for the thinness of the lift. In that case, a different mix or lift depth may be indicated, FHWA says. ♦



▲ **Full-lane fine milling** in advance of a thin asphalt overlay can result in a super-smooth product and resulting bonuses.

Photo courtesy of Wirtgen America, Inc.

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