

OHIO ASPHALT

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ON THE COVER: BRADLEY ZWYER, WHO IS STUDYING CONSTRUCTION MANAGEMENT AT BOWLING GREEN STATE UNIVERSITY, IS ONE OF 15 OHIO COLLEGE STUDENTS RECEIVING AN ASPHALT PAVEMENT INDUSTRY SCHOLARSHIP AWARD THIS ACADEMIC YEAR. ZWYER WAS THE RECIPIENT OF THE 2012-2013 GERKEN PAVING INC. SCHOLARSHIP. PICTURED WITH HIS FATHER, MIKE ZWYER, A PROJECT MANAGER AT GERKEN PAVING, BRADLEY WORKED THIS SUMMER WITH THE COMPANY. FOR A LOOK AT ALL THE FPO SCHOLARSHIP RECIPIENTS, SEE PAGE 24.



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THE PRESIDENT'S PAGE



CLIFFORD URSICH, P.E.
PRESIDENT & EXECUTIVE DIRECTOR

“... Price Adjustment Clauses (PACs) lead to overall greater stability in the highway construction market. Sixty to 80 percent of responding DOTs perceive a moderate to large benefit from PACs to all stakeholders in the market: DOTs, prime contractors, subcontractors and suppliers ... The overwhelming response from DOTs indicate that contractor stability afforded by PAC programs provide a significant benefit.”

DEFLATING CONSTRUCTION INFLATION

Amazing isn't it? This past August, in the course of four days the price of gasoline in my hometown went from \$3.29 per gallon up 30 cents overnight to \$3.59, down to \$3.39 and finally topped out at \$3.89; today, it's posted at \$3.57. I don't ever recall such volatility.

Volatility has the potential to substantially increase the cost of a construction project. How? Volatility creates uncertainty, and uncertainty leads to high bids as contractors attempt to build in protection in the event a spike occurs in the price of a commodity (such as asphalt binder, fuel, steel, cement). Fortunately, there is a tool that has shown to be effective in mitigating cost increases. That tool is known as a price adjustment clause, and research indicates that it is effective.

The National Cooperative Highway Research Program (NCHRP) released a study in 2011 titled, “Price Indexing in Transportation Construction Projects.” This study researched the use of a contractual tool used by public agencies for infrastructure construction projects known as a price index or price adjustment clause (PAC). These measures mitigate the effects of price volatility of construction commodities by controlling the risk associated with the purchase of these materials over the duration of a construction project. The primary objectives of this research study were to:

- Describe the use of price adjustment clauses by state departments of transportation (DOT)
- Collect data on the experience with price adjustment clauses by state DOTs and contractors
- Analyze the effectiveness of price adjustment clauses using highway construction bid data
- Provide guidance and recommendations for state DOTs in utilizing price adjustment clauses

A LONG-STANDING ANTI-INFLATIONARY MEASURE

Ohio's use of price adjustment clauses dates back more than 31 years. The late 1970s saw the OPEC Oil Embargo result in a rapid rise in the price of crude oil. Products related to crude oil, such as asphalt, saw dramatic increases in prices due to this volatile market. In 1979, the Federal Highway Administration (FHWA) published guidance, “Combating Inflation in Highway Construction Costs.” Of the anti-inflation measures suggested, the FHWA guidance stated price adjustments for asphalt should be utilized to minimize the effects of supply and price uncertainties. Following that guidance, the Ohio Department of Transportation (ODOT) implemented an asphalt binder price adjustment in 1980. Since then, Ohio has continued to use what has become a best-practice of highway agencies for the purpose of fighting the inflationary effect brought on by volatility in the supply of petroleum. Throughout the United States such practices were adopted and have since expanded to include other commodities such as cement, steel and fuel.

MISCONCEPTIONS ABOUT PRICE ADJUSTMENT CLAUSES

Sometimes inappropriately referred to as “escalation clauses,” PACs do more than compensate a contractor when the price of a commodity increases; they are designed to return

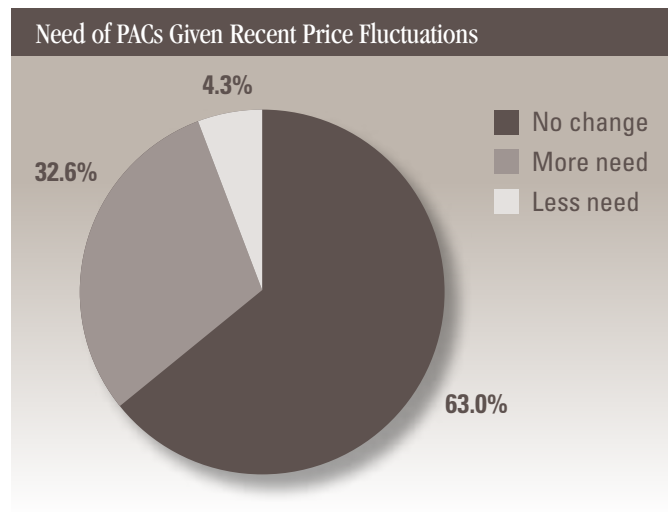


Exhibit 1-19 shows the percentage of DOTs that perceive there is more need, less need or no change in the need for PACs.

dollars to the agency when a commodity falls in price. In 2008, the increase of crude oil prices resulted in asphalt binder rising substantially in cost. The 2009 paving season saw the opposite, a tumbling of asphalt binder prices and a return of dollars to agencies utilizing PACs. The benefit realized by those agencies that utilized a price adjustment was more than the return of dollars; a further benefit was the anti-inflationary effect on bid prices.

Without the anti-inflationary benefits of PACs, contractors are faced with substantial risk when bidding work that incorporates volatile commodities, leading to the likelihood of bid inflation. The NCHRP findings state that when surveyed, “nearly all responding contractors (approximately 91 percent) claim they add contingencies to their bids in the absence of PACs. The problem of increased material price risk in contracts is largely mitigated by the inclusion of such clauses.”

To better understand the anti-inflationary benefits of price adjustments consider this example: As a proprietor of a gasoline station you are approached by a customer that desires to purchase your “commodity.” The customer adds this caveat — guarantee you will provide the fuel at the price agreed to at the signing of the contract and hold that price until the fuel is needed, which may be several years into the future. As the proprietor, what will you do given the fluctuating nature of fuel prices? Will you assume the risk and agree to provide the fuel at today’s posted price, all the while hoping that over the contract duration the price you pay to the wholesaler doesn’t increase? Will you simply say no? Or will you only agree to a deal if the price is sufficiently high to ensure you will not incur a substantial loss in revenue? If you choose the third scenario it is because you want to make the sale, but the risk associated with fuel pricing is so high that you must inflate the price to provide protection for your business.

Consider an asphalt paving project where the agency is requesting bids for paving work to be completed a year or two in the future. Similar to you, the gasoline station proprietor, the asphalt contractor too deals with a commodity that fluctuates in pricing. Without a price adjustment clause in the contract that compensates for rising

and falling prices throughout the duration of the project, he is left to speculate what his cost might be. He adjusts his bid to compensate for the possibility of future cost increases. Price adjustment clauses reduce the risk and the associated pressure that stimulates bid inflation thereby ensuring the asphalt contractor bids at his lowest and most competitive price.

It is true the possibility exists for a project cost increase when a PAC is included in a contract; conversely, it is true that a cost savings is possible. Such has been the experience in Ohio. What is certain is that PACs mitigate inflation and ensure the most competitive bidding environment.

USE OF TRIGGER VALUES IN PRICE ADJUSTMENT CLAUSES

The term “trigger value” is used to describe the percentage increase or decrease in commodity cost at which point a price adjustment is “triggered” (i.e. compensation or deduction made). NCHRP found lower trigger values decrease any risk premium (i.e. cost added to bid for purpose of covering risk) that may be included in the pricing. Conversely, higher trigger values may reduce the effectiveness of PAC programs, as contractors may still need to add a risk factor in pricing. NCHRP recommended trigger values are 0 percent to 10 percent (plus or minus). The report makes this important note: *“It is worth noting that the statistical model for Missouri showed that the price adjustment clause lowered average bid prices. Missouri was the only state tested that has a zero trigger value (0 percent) and the only state for which the statistical model provided consistently positive results for the price adjustment clause.”*

PRICE ADJUSTMENT CLAUSES RESULT IN LOWER BID PRICES

Among state DOT survey respondents, 78 percent reported a moderate or large benefit from PACs in terms of better pricing, while only 4 percent

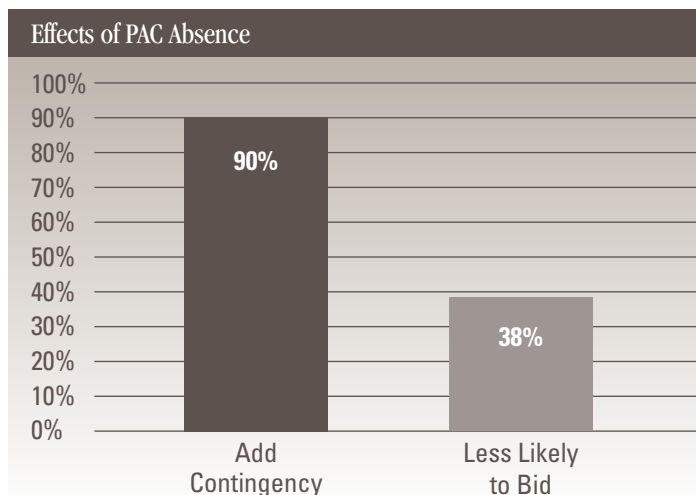


Exhibit 2-4 provides a compilation of responses on how bid prices and number of bids change without a PAC.

reported no benefits. Contractors agreed, with 58 percent responding that the presence of PACs led to moderately or significantly lower bid prices; while only 13 percent responded that they led to moderately or significantly higher bid prices. When PACs are not in place, almost all responding contractors claim they add contingencies to their bids to cover the material price risk.

PRICE ADJUSTMENT CLAUSES CREATE INCREASED MARKET STABILITY

The NCHRP report notes anecdotal evidence from both state DOTs and construction contractors that indicate PACs lead to overall greater stability in the highway construction market. Sixty to 80 percent of responding DOTs perceive a moderate to large benefit from PACs to all stakeholders in the market: DOTs, prime contractors, subcontractors and suppliers. Only 4 to 7 percent of DOTs perceive no benefit from PACs. The overwhelming response from DOTs indicate that contractor stability afforded by PAC programs provide a significant benefit.

If you would like more information on how your agency can deflate construction inflation by incorporating an asphalt binder price adjustment on your next asphalt project, contact FPO.

OA

Asphalt ... Defining Value!
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By David Powers, P.E.
Contributing Author

Warm period

Ohio DOT in midst of latest asphalt movement

The use of warm-mix asphalt (WMA) has grown rapidly in the short time it has become a familiar acronym in the U.S. In fact, the Ohio Department of Transportation (ODOT) placed 2.8 million tons of water-injected WMA in 2011.

But, ODOT's WMA work has not advanced without concerns, questions and research.

The reality of WMA is that it just happens to be a promising improvement to an entire industry at an opportune time. However, numerous questions surround WMA: How does WMA perform given the variety of WMA techniques; what is the long-term performance of WMA; how will WMA affect construction approaches? In spite of these questions the potential benefits of WMA are more than sufficient to justify giving it a good, hard look. For most agencies, specification changes often occur in unpredictable ways: sometimes in very slow increments and sometimes in overnight chaos. Engineers, of course, prefer predictability as that is how they

are trained. Such is not always the world we live in though and reality has to be dealt with.

In Ohio, the asphalt-paving association, Flexible Pavements of Ohio (FPO), approached ODOT in early 2006 with a desire to evaluate WMA, at first for its potential worker-safety benefits, but certainly for its other potential benefits. A national Federal Highway Administration (FHWA) technical working group had recently established a very extensive list of data needed to give WMA a proper look. Very quickly a project was designed that included well-known WMA products at the time: Sasobit, Evotherm and Aspha-min. Additional research and data collection was incorporated into the project, and the project was successfully completed in September 2006.

From this project ODOT decided to look at a new approach to an old technology, foamed asphalt, which was quickly advancing nationally as a WMA alternative. Six foamed asphalt water-injection trial WMA projects were planned for 2008 with an eye to data collection for emissions, moisture-damage potential and quality-control issues. From these projects ODOT hoped to determine with more definition what

(Editor's note: A version of this article appeared in the February 2012 issue of Roads & Bridges magazine.)

durability issues might exist with WMA, as at first glance combining water and asphalt is not usually viewed as good.

Given the speed of trial work and potential benefits things at ODOT were about to heat up. In early 2008, FPO invited then ODOT Director James Beasley to a viewing of the plant operation for water-injected WMA. From that meeting a decision was made to move ahead with WMA implementation in all ODOT asphalt work. This implementation has progressed rapidly, and in 2011 56% of total ODOT asphalt tonnage was WMA by water injection.

Following the 2008 WMA trials, specifications were developed allowing WMA, but it was restricted from heavy-traffic surfaces. This was partly done to allow a learning period for producers and crews before using WMA on our most heavily traveled routes. The next season this restriction was lifted. Today ODOT specifications allow WMA as an alternative to HMA, provide plant requirements for water-injection units and stipulate how compaction testing is to be performed for quality control.

Heated activity

Some might say ODOT is out on a long limb with WMA, and there are valid arguments against rapid implementation of it. However, with all the data considered, trials evaluated and lack of project

failures ODOT appears to be on the right track. It must be admitted that no field fully answers all questions before implementing ideas.

ODOT's first WMA research project in 2006 was designed to learn as much as possible—quickly. In addition to the three trial sections and one control section, WMA was placed at Ohio University's indoor loaded-wheel facility. This work studied rutting of those mixes as well as collecting perpetual pavement data in the full-depth sections. The research produced some interesting conclusions:

- The four different sections of ODOT's first WMA project, GUE-541, showed no obvious differences in visual inspection after 20 months (now five years) of service;
- The laboratory measurements of indirect tensile strength indicated no significant difference between the WMA mixes and the HMA control mix;
- Emissions at the paving site of total particulate matter for all three warm mixes were 67-77% less than those for the HMA control mix. Emissions of benzene soluble matter were decreased by 72-81% relative to the HMA; and
- In the APLE, all three of the WMA surfaces experienced more consolidation than the HMA control surface during the initial stages of application of the wheel load. After the initial

consolidation, further consolidation of each pavement was about equal.

The report of research from this project can be found in the study Performance Assessment of Warm Mix Asphalt (WMA) Pavements on ODOT's website. In addition to ODOT's research, the National Center for Asphalt Technology (NCAT) conducted research on Ohio's first WMA project. NCAT had its test trailer on-site for the project and numerous samples were tested. NCAT published a report of this work, titled Ohio Field Trial of Warm Mix Asphalt Technologies: Construction Summary, which offers some useful and positive conclusions and is available on NCAT's website.

In 2008, ODOT set up six trial projects for WMA by water injection. These trial projects included control sections of HMA, one method of water injection, multiple mixture types and multiple contractors and plants. Data collection from these WMA trials produced the following conclusions:

- The projects were successfully placed with minimal disruption and are performing well today;
- Both polymer and nonpolymer mixes were successfully placed;
- WMA can act as a compaction aid;
- The WMA can be placed 30-40°F lower in temperature compared with HMA;



Above: Since the first WMA trial in 2006 nearly 4.9 million tons of WMA have been successfully placed in the state of Ohio.

Above right: In 2008, ODOT set up six trial projects for WMA by water injection.

Right: There have been very few placement problems attributable to WMA.



- The data showed a drop in tensile strength ratio but values passed minimum specification limits;
- Emissions values measured at the plant were nearly all lower but are heavily influenced by plant burner efficiency at the lower operating temperature; and
- For projects with much hand work higher placement temperatures may be needed.

Current ODOT research is taking a closer look at understanding the mechanisms and limitations of water injection for foaming asphalt. ODOT has completed a recent study looking at WMA by foaming in the laboratory. The goal of this work was to understand if WMA could be replicated in the laboratory for design and further research purposes.

In addition ODOT has recently started two studies looking at foaming. The first, The Use of Atomic Force Microscopy to Evaluate Warm Mix Asphalt, will consider a measurement technique that will on a nano scale better explain what exactly happens in an asphalt binder as water creates vapor pockets that in turn collapse upon cooling. Particularly of interest is the healing that takes place in binders and the effect of the vapor pocket process on the moisture-damage potential of WMA mixes. Secondly, a more extensive study involving two universities is looking at the limitations of WMA by water injection as it affects design, quality control and placement of mixes. This study also will look at the moisture-damage potential in WMA compared with HMA but will consider the amount of water injected to create foamed asphalt and the effect on production and placement. All of this research has a goal of understanding the degree of potential risks with WMA, particularly with regard to long-term asphalt-pavement performance.

Nothing unusual

Since the first WMA trial in 2006 nearly 4.9 million tons of WMA have been successfully placed in Ohio. In 2011, 2.8 million tons (56% of total production) of WMA were placed. There have been very few placement problems that are attributable to WMA. A few construction issues are noteworthy:

Figure 1. POR-224 summary of fuel emissions.

	T1 HMA	T1 WMA	Percent Reduction	T2 HMA	T2 WMA	Percent Reduction
Production tons/hr	430	330	-	452	478	-
Plant fuel usage (gal/ton)	2.08	1.71	17.8	1.77	1.57	11.3
Temp (°F)	290	261	-	296	260	-
NO _x (lb/hr)	31.97	19.10	40	30.46	27.33	10
CO ₂ (lb/hr)	16,599	11,378	31	17,258	15,253	12
VOC (lb/hr)	8.7	6.39	27	6.92	6.54	5

- Some crews like to increase the temperature above what water-injected WMA typically targets as they have found ease of compaction and lower emissions at the paver;
- In a couple of instances, projects have reported a minor “sheen” on the surface of newly placed WMA that is not as severe as a flushed pavement. The sheen quickly dissipated under traffic. While not fully understood it is believed the sheen is related to higher moistures in the mix and short haul distances. Avoiding over-compaction helps control the sheen appearance; and
- In a couple of instances, rough-looking hand work areas or smoothness issues have been noted. These are avoidable with proper contractor control of trucks and compaction temperature.

Although it is admittedly early, so far there are no projects exhibiting unusual damage, including unusual rutting, moisture damage or raveling, that are attributable to WMA.

According to specification

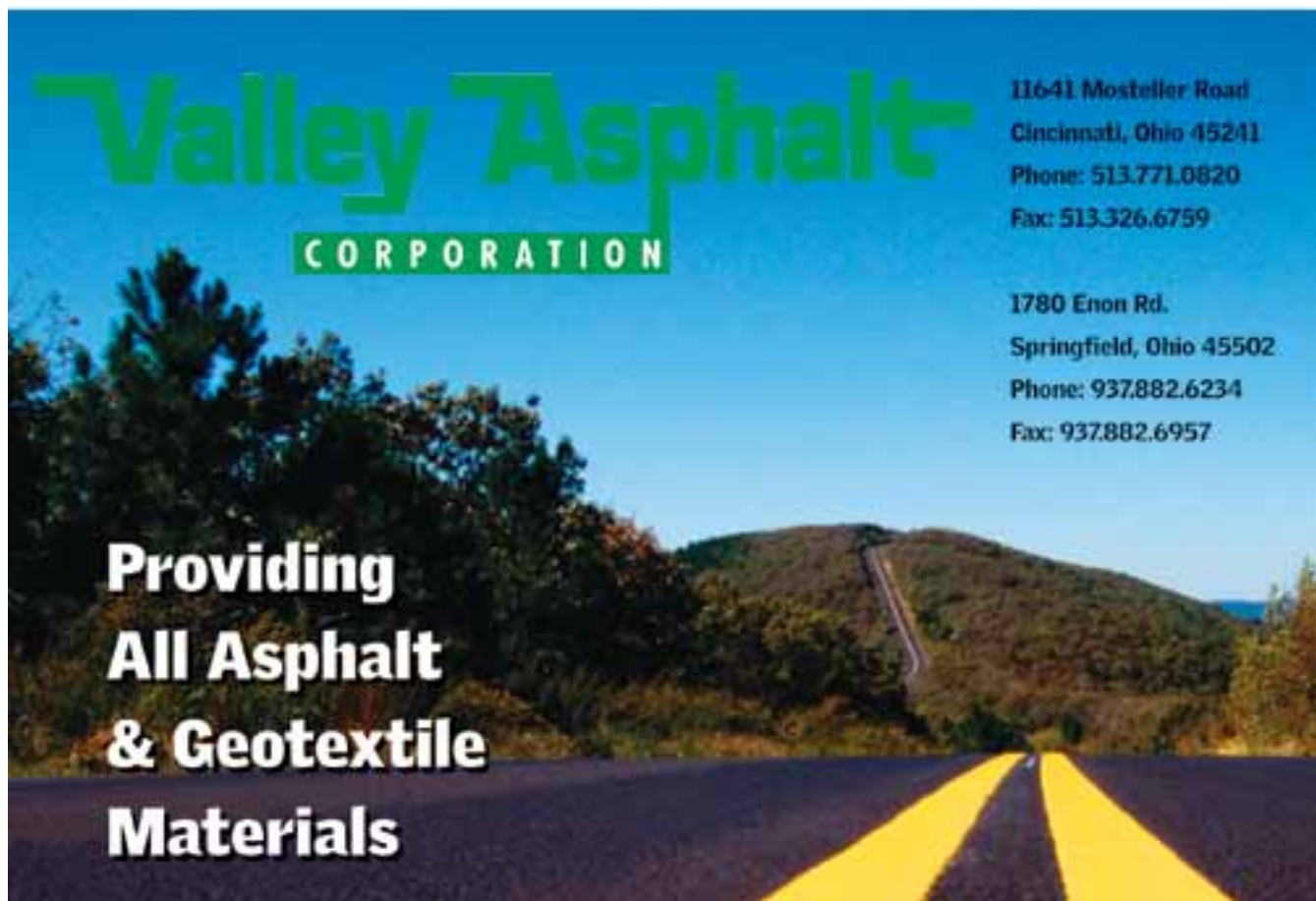
In section 401.05 of ODOT’s 2010 Construction and Material Specifications is this simple sentence: “Asphalt mixtures may be produced using warm mix asphalt method according to 402.09 except as restricted by specification.” Section 402.09 outlines requirements for water-injection equipment used at asphalt plants. (To date ODOT has seen seven different water-injection systems. Currently 83 of 141 asphalt plants have been outfitted with approved water-injection systems.) Per general specifications in ODOT Construction and Material Specifications, contractors can propose to ODOT for consideration WMA alternatives to these requirements.

For WMA asphalt-mixture design, contractors submit for approval a WMA design per existing HMA design procedures. For quality control of WMA, specimens for air voids are to be compacted at 30°F less than the design-compaction temperature. ODOT has found this, in general, has worked well. There have been some occasional quality-control issues noted with regard to lower air voids. This can occur when a high absorptive aggregate is used. Simply put, absorption of binder is sometimes slightly less with WMA production than with the HMA design resulting in slightly lower air voids in quality-control testing. The extent of this issue is not known well enough to justify changing current specifications, but is being kept in mind as more knowledge is gained.

There is a tremendous amount of national and state research currently being conducted or planned to address numerous questions surrounding WMA production, design and performance. In addition, research is under way to provide understanding of WMA in more fundamental ways such as the mechanics of foaming and what is considered optimal for producing successful WMA pavements. All of these efforts will produce new approaches and requirements and enable WMA to be placed with greater confidence.

Given that the WMA market will continue to change as newer techniques are tried, and perhaps adopted, it appears ODOT may be in for many years of change in the asphalt industry. Of course, change is nothing new to asphalt users and producers. As agencies appropriately adopt newer approaches the changes expected will be for the best for the taxpayer. **AT**

Powers is an asphalt materials engineer for the Ohio DOT.

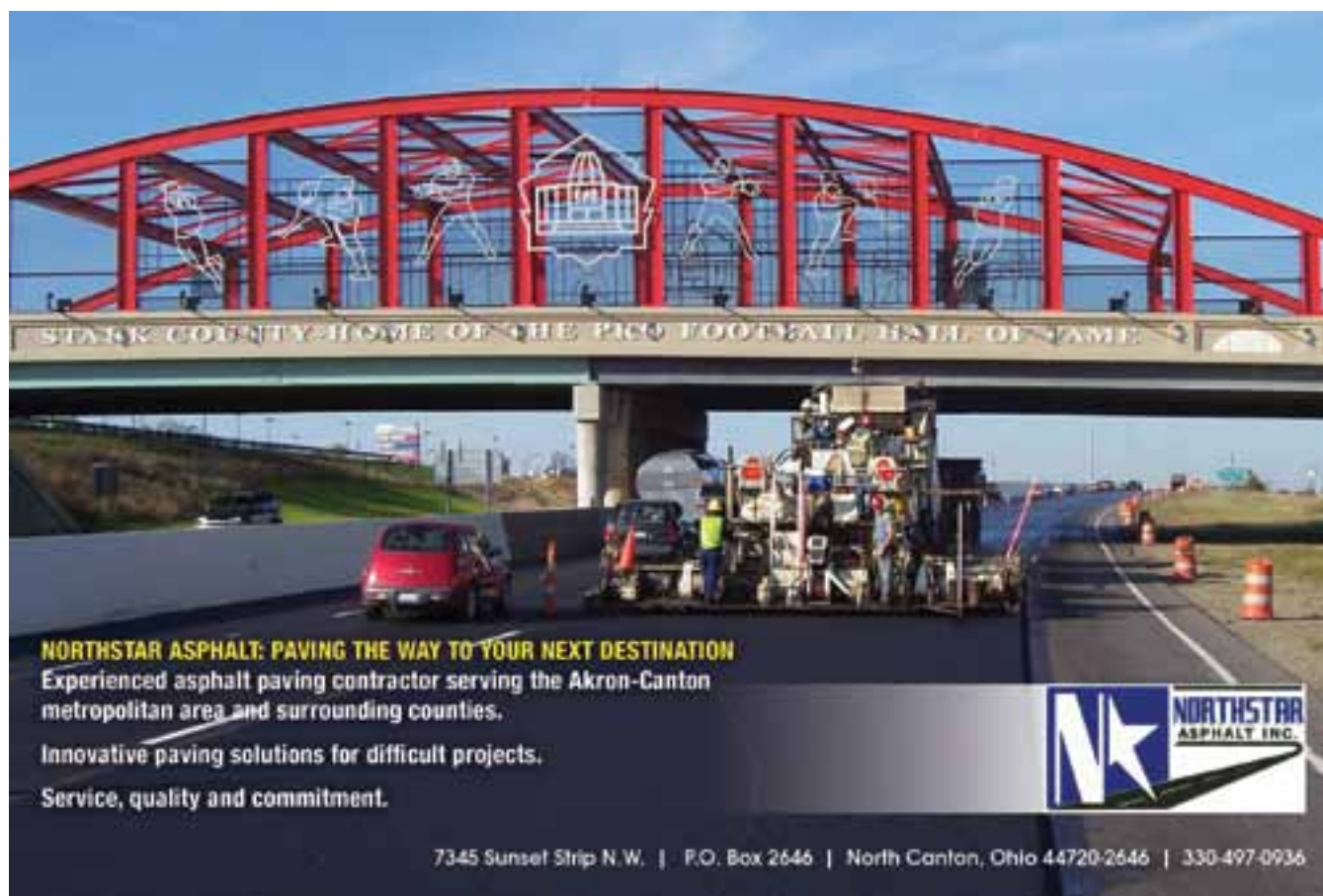


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CONVERSATION WITH NAPA'S PRESIDENT

A Bright Future for Warm Mix



View from the top:
NAPA President Mike Acott shares
his thoughts on warm mix asphalt.

(Editor's note: Mike Acott is president of the National Asphalt Pavement Association. He participated in an interview with the Wisconsin Asphalt Pavement Association, which is reprinted with WAPA's permission.)

WAPA: *Thanks for taking the time to speak with us today.*

Mike Acott: "You're very welcome."

WAPA: *Can you tell us a bit about the motivation for exploring warm mix asphalt in the first place?*

Mike Acott: "At the end of the 1990s and in the early 2000s, NAPA was keenly focused on investigating and promoting technologies that would improve working conditions for asphalt paving workers. The asphalt industry — manufacturers and contractors — had already worked in partnership with FHWA, the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and the labor unions to deploy engineering controls on paving machines, but we wanted to take it to the next level. Around that time, the National Center for Asphalt Technology had conducted research showing that temperature was the critical issue, so we were naturally interested in lower-temperature mixes."

WAPA: *Where did the idea of warm mix as we know it come from?*

Mike Acott: "I attended the Eurasphalt & Eurobitume conference in Spain in 2000 and saw a Norwegian contractor and Shell Bitumen demonstrating a foamed asphalt using a process called WAM Foam. At the same time, I learned that in Germany two other warm mix products were being marketed: Sasobit, a wax product, and zeolite, under the trade name aspha-min. I was very interested in how they were putting this approach into practice to drop temperature."

WAPA: *So foaming and warm mix were European ideas?*

Mike Acott: "Not originally, no. Foaming was actually a U.S.-developed process, pioneered by Ladis Csanyi at Iowa State University in 1956. Professor Csanyi used steam as a foaming agent, though we use water as the foaming agent today along with the various kinds of modifiers involved with warm mix asphalt."

WAPA: *But Europe was first out of the gates with warm mix?*

Mike Acott: "In the early 2000s, European countries were responding to meet the requirements of the Kyoto Protocol on climate change. The main concern there was how they could lower greenhouse gas emissions. That drove the initial interest overseas."

"NAPA became interested in those developments in Europe, and in 2002 we conducted a tour allowing NAPA leaders to observe firsthand the construction and performance of different warm mix products. The many advantages of warm mix were clear to us, and we were duly impressed with the improved working conditions associated with warm mix. We didn't even know at the time about all the construction benefits, such as extending the paving season, extending haul times, enhancing compaction, and the rest."

WAPA: *How did warm mix gain momentum here in the United States?*

Mike Acott: "Things started moving in the U.S. on multiple fronts. NAPA initiated partnerships on warm mix with FHWA and AASHTO, and we provided seed money for research at NCAT. We also partnered



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with technology providers and conducted various educational sessions.

“The first demonstration of warm mix in the U.S. was in 2004, at World of Asphalt in Nashville. Warm mix started to move along by then with various demonstration projects. There was a Warm Mix Technical Working Group meeting regularly that included representatives of industry, government and academia, and the National Cooperative Highway Research Program funded significant national research in this area.

“The use of warm mix really started to increase here in 2006. A big technical breakthrough in the warm mix foaming process simplified procedures from a multiple-step process to a simpler production technique that helped drive the interest. Significant developments with the chemical and non-foaming processes were also taking place, and field experiences with all the processes demonstrated major benefits. It became clear that warm mix was about more than improved working conditions. Warm mix showed excellent construction and compaction properties, and it offered a lower-energy alternative to hot mix.”

WAPA: And where are we today with warm mix?

Mike Acott: “Warm mix has really taken off, with significant jumps in use nationwide every year. In 2009, for example, 19 million tons of warm mix were laid in the United States. Just one year later, the figure had grown to more than 47 million tons, or 13 percent of total asphalt production.

“For the most recent construction season — 2011 — warm mix could easily be at 25 percent of the total asphalt market. We are conducting a study with FHWA to zero in on the growth figures.

As you know, warm mix is one of FHWA’s featured technologies in its Every Day Counts initiatives, and FHWA is actively promoting warm mix and encouraging state DOTs to consider using it.

“I give due credit to the industry as well. To a large extent, contractors led the effort once they saw the benefits of warm mix. This proved to be the direction in which the industry wanted to head.”

WAPA: Where do you see warm mix headed from here?

Mike Acott: “Right now, warm mix is being used extensively across the United States through the use of permissive specs. This is a good way of allowing their use and introducing warm mix in more and more states. The FHWA Technical Working

Group has a sample specification on its website that agencies can use.

“As the cost of energy continues to rise, interest in asphalt that requires less fuel to heat will be even higher. The combination of reclaimed asphalt pavement, recycled asphalt shingles, and warm mix technology is also a natural fit. In the long run, I see warm mix becoming

standard industry practice in the United States. It is definitely where we’re heading — it’s just a question of the rate of acceptance until we get there.

“In the end, an agency wants a quality asphalt pavement. And that’s what warm mix delivers.”

WAPA: Circling back to Europe, what’s been happening there? A lot of people think that Europe is still the leader in warm mix.

Mike Acott: “No, that is not the case. We have far exceeded Europe in this last decade — the percentage of production is



very small there, and European stakeholders I talk to tell me that they'd like use of warm mix to be much greater. When NAPA hosted the Second International Warm Mix Asphalt Conference in the fall of 2011, Europeans were there to try to figure out how we've implemented warm mix to such an extent and how they can do the same in their countries.

"It's a true reversal of roles from 10 years ago. The United States is leading the way."

WAPA: Thank you again for taking the time to talk to us today.

More information about warm mix is available at:

- FHWA's warm mix asphalt website (www.fhwa.dot.gov/pavement/asphalt/wma.cfm)
- NAPA's warm mix asphalt website (www.warmmixasphalt.com); NAPA's comprehensive publication, Warm-Mix Asphalt: Best Practices, Third Edition, 2012, is available from the NAPA online store (<http://store.asphaltpavement.org/index.php>)
- WAPA newsletter articles on warm mix (all in PDF format): Wisconsin specs, Winter 2012 (www.wispave.org/downloads/Winter2012WAPANews_WEB.pdf#page=1); Every Day Counts update, Summer 2011 (www.wispave.org/downloads/Summer2011WAPANews_WEB.pdf#page=5); what Wisconsin counties say about WMA, Summer 2011 (www.wispave.org/downloads/Summer2011WAPANews_WEB.pdf#page=6); warm mix technical overview (www.wispave.org/downloads/Fall2009pdf#page=4) by UW-Madison Professor Hussain Bahia (Fall 2009); and a county commissioner's experience, Fall 2009 (www.wispave.org/downloads/Fall2009WAPANews_WEB.pdf#page=5)

(Editor's note: For additional information on the use of Warm Mix Asphalt in Ohio go to FPO's webpage at www.flexiblepavements.org.)



NAPA just published a 2012 update to its most popular technical publication, Warm-Mix Asphalt: Best Practices. (Image courtesy of NAPA)

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YIELD - THICKNESS - DENSITY - SMOOTHNESS

By James A. Scherocman, P.E., Consulting Engineer & William H. Fair, P.E., Director of Engineering, FPO



The free-floating screed paver, given enough mix and left to its own devices, will substantially level a rough, uneven pavement. It has been that way since 1931.

Many contractors are faced with a very difficult question: How to achieve yield, thickness, density and smoothness at the same time?

Unfortunately, if sufficient quantities of mix and pavement layers are not provided for the existing pavement surface conditions, it generally cannot be done.

The way a typical asphalt paver works has not changed since 1931, when the free-floating screed principle was introduced by the Barber-Greene Company. As many know, a primary purpose of the paver is to level – to place more hot mix asphalt (HMA) in the low spots on the existing pavement surface and less on the high spots. For this reason, the amount of mix needed to resurface a state highway, county road, city street or parking lot depends, in part, on the smoothness of the existing pavement surface.

Yield: In most cases, the amount of mix needed to resurface a pavement is determined from a calculation of length multiplied by width and thickness, then converted to a tonnage value. If the pavement is “out of shape,” the designer may add 2 to 4 percent more mix to allow for the depressions in the surface to be filled in. Most pavements, however, require 5 to 15 percent more material so that proper smoothness can be obtained.

In order to place a minimum thickness of mix on the high spots in the existing pavement surface, it is necessary to increase the thickness of the mix in the low spots. This situation results in the need for additional mix beyond what is normally calculated based on length, width and thickness numbers. The contractor must be provided with enough mix to properly construct the pavement. In many instances, the amount of funds available to resurface the pavement is limited and thus the amount of mix included in the contract is also, inappropriately, minimized.

Under current ODOT specifications (see 401.15, 401.19 and 401.21); asphalt concrete is paid for based on the yield calculation. Contractors are required to maintain the spread rate (yield) within plus or minus 5 percent of the calculated plan quantity. On courses specified as uniform thickness, no payment is allowed for any material more than the plan quantity. So contractors must keep the yield to within minus 5 percent of the plan quantity or absorb the cost of the extra mix.

Thickness: Suppose the plans call for a surface course mix that is 1 1/2 inches thick. If the inspector on a paving project takes that to be a minimum thickness everywhere, there is going to be a problem with yield. Again, depending on the smoothness of the existing pavement surface, it is going to take “extra” mix to fill in the low spots. Thus, to achieve a minimum thickness on the high spots, the thickness of the mix in the low spots must, necessarily, be greater than the minimum.

The thickness shown on the plans must thus become an average thickness instead of a minimum thickness. If this is not done, the contractor will run out of mix before he runs out of roadway. Either that or his mix tonnage will significantly increase over the amount shown in the plans. This, of course, creates a problem with yield — and payment.

Placing the average thickness as the average yield is OK as long as the minimum thickness over the high spots doesn't become too thin. The “rule of thumb” in the industry is that this minimum must be at least twice the maximum aggregate size (three times the nominal maximum aggregate size) of the largest size aggregate in the mix. If the mat thickness is too thin, surface texture problems become evident and the ability to achieve density becomes very difficult, as discussed next.

Density: Density measurement for pay is generally required by the ODOT specifications (either 446 or 448) for courses specified as uniform thickness. For the specified level of density to be achieved, however, the course must be not only of uniform thickness but of sufficient thickness to allow for optimum compaction. Research conducted by the National Center for Asphalt Technology (NCAT) has indicated that to improve the chances to achieve the desired level of density, the minimum layer thickness should be three times the maximum aggregate size or four times the nominal maximum aggregate size in the mix. If the pavement layer thickness is not uniform and/or the minimum thickness is too thin, then the possibility of achieving the specified level of density is placed at risk.

Although vibratory rollers are very efficient for compacting asphalt concrete, their use is prohibited by ODOT specifications for HMA courses less than 1 1/2 inches in compacted thickness. Rubber tire rollers can be used successfully to compact variable thickness courses. Using a rubber tire roller, however, may compromise the smoothness obtained on the

pavement surface. In addition, use of a rubber tire roller is prohibited by ODOT specifications for use to compact polymer-modified asphalt surface course layers.

Smoothness: The amount of smoothness obtained depends on two major factors. The first is the condition or smoothness of the existing pavement surface. The second is the number of layers of HMA that are to be placed on top of that existing surface.

Based on the free-floating screed principle, each layer of HMA improves the smoothness of the underlying pavement layer by a significant amount. If the present pavement surface is relatively smooth, any new layer placed will be smoother than the original surface since the paver will add more HMA in the low spots and thus level that original surface. If the existing pavement surface is rough and uneven, however, the surface of the new layer will be smoother than the original surface, but will still be rough to some extent. This is due to differential compaction.

A layer of dense-graded HMA will typically compact approximately 1/4 inch per inch of compacted thickness. That means that a layer of mix that is 1 inch thick, when compacted, must be placed 1 1/4 inches thick by the paver screed in order to allow for the densification that is

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going to occur under the compactive effort applied by the rollers. An HMA layer that is compacted to a 2 inch thickness needs to be placed 2 1/2 inches thick in order to achieve the proper amount of density. When mix is placed along a roadway in variable thicknesses due to the condition of the existing pavement surface, the compacted new surface will still not be completely smooth since the thick areas of mix will compact more than the thinner areas and, thus, density will be compromised.

A second layer of mix will make the surface of that second layer smoother than the original pavement surface. This is because the amount of differential compaction between the thicker and thinner areas will be reduced. The placement of a third layer will make the new surface even smoother. The greater the number of layers constructed, the smoother the final pavement surface. The final smoothness is still dependent, however, on the initial smoothness (roughness) of the original pavement surface.

Pavement cold milling (planing) can substitute for a leveling course in order to achieve a greater smoothness. The typical tolerance required is 1/4 inch in 10 feet. Milling to a profile grade could obtain even greater smoothness. Unfortunately, milling to a profile grade is seldom specified and the specification simply calls for a depth of cut of a specified thickness that results only in smoothing the pavement surface to the specified tolerance.

Yield, Thickness, Density, and Smoothness: There are three basic rules in the asphalt paving industry in regard to the resurfacing of an existing pavement surface.

First, if yield is the primary consideration, the paver screed operator will have to continually adjust the angle of attack of the screed in order to reduce the amount of mix placed over the existing pavement surface. This, of course, will affect both the minimum thickness of the mix over the high spots in the existing surface and the smoothness of the new pavement layer. The amount of mix set up in the contract must be enough to allow the contractor to properly level the existing pavement surface.

Second, if a minimum thickness of mix over the high spots in the existing surface is required, then the amount of mix needed will increase more than the quantity shown on the plans. This will result in an increase in the cost to complete the project, but will result in a smoother pavement surface. A minimum layer thickness can result in a very rough ride. If the minimum level of density must also be achieved, and it is of critical importance for durability, then the pavement layers must be of a reasonably uniform thickness and of sufficient thickness to permit optimum compaction to be achieved.

Third, if smoothness is a primary consideration, several things must happen. First, the number of layers of mix placed must be increased – only one layer will not do the job, and even a leveling course or “scratch course” of mix may not be sufficient if the existing surface is very rough. Second, enough quantity of mix must be available to properly level the surface – to fill in the low spots and “shave off” the high spots, while at the same time keeping a minimum thickness of HMA over the high spots in the existing pavement surface. Third, the paver screed operator must allow the paver to do its job without continually adjusting the angle of attack of the screed.

The minimum layer thicknesses recommended by ODOT in its Pavement Design Manual are sufficient and prudent for best economy for new construction projects where the base, intermediate, and surface courses can be constructed and controlled to uniform thicknesses. Where an existing irregular road surface is to be resurfaced, however, considerable analysis or engineering judgment must be applied in specifying the number of courses and the minimum thicknesses of those courses in order to obtain the best results.

In its Pavement Design Manual, ODOT recommends consideration of milling (504.02) for all projects. Where milling is not feasible or desirable, the designer must attempt to determine the volume of extra material needed to fill areas below a level plane in both profile and cross slope and add that quantity to the minimum thickness of the leveling course. For an excellent case study in doing this type of analysis, see the presentation, “Designing for Smoothness,” given by Eric Heckert, ODOT District 2, at the 2011 Ohio Asphalt Paving Conference, archived at www.flexiblepavements.org/sites/www.flexiblepavements.org/files/events/conferences/4Heckert.pdf, and the article about the same project in the Spring/Summer 2010 issue of *Ohio Asphalt* at www.flexiblepavements.org/sites/www.flexiblepavements.org/files/ohio-asphalt-pdf/newsletter_68.pdf.

Yield, minimum thickness, density and smoothness cannot be obtained at the same time unless enough mix tonnage and pavement layers are set up for the project in order to permit the contractor to allow the paver screed do its job – fill in the low spots and improve the smoothness of the pavement surface, one layer at a time. Also, remember that a uniform pavement layer thickness is necessary in order to achieve optimum compaction in the HMA layers.

FPO Updates Tack Coat Technical Bulletin

Based on Recently Completed NCHRP Research



Research on tack coat placement conducted by the National Cooperative Highway Research Program (NCHRP) was recently published (NCHRP Report 712, Optimization of Tack Coat for HMA Placement, Mohammad, et. al. TRB, 2012). FPO has updated its Technical Bulletin on Tack Coat to incorporate the findings of the NCHRP research. The revised FPO Technical Bulletin can also be found on the FPO website at www.flexiblepavements.org.

The research has confirmed that the proper application of tack coat material is a key component of a quality asphalt paving project. Tack coat promotes bond to underlying layers, facilitating achievement of maximum strength of the pavement structure. It prevents delamination and

sliding-type failures and ensures long-term performance and lasting ride quality to the highway user.

The research has not contradicted previously understood practices with respect to tack coat application, but has demonstrated the importance of proper application, the variation in bond strength provided by different tack coat materials and surface textures and established test methods for evaluating the effectiveness of the bond between layers.

The NCHRP report also contains a training manual for operators, Appendix F, in the proper application of tack coat. The report can be found at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_712.pdf.





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Technical Bulletin: Proper Tack Coat Application

General

Research published in 2012 (Reference A) has confirmed that the proper application of tack coat material is a key component of a quality asphalt paving project. Tack coat promotes bond to underlying layers, facilitating achievement of maximum strength of the pavement structure. It prevents delamination and sliding type failures and ensures long-term performance and lasting ride quality to the highway user. This technical bulletin examines the necessary procedures for ensuring proper tack coat application.

As in the placement of Hot Mix Asphalt, uniformity is a very important consideration when placing tack coat materials. Since the purpose of tack coat is to promote bond between an existing pavement surface and an overlay, it is very important that the tack coat be applied in a uniform manner, with full coverage of the surface and pick up by haul vehicle tires minimized. Attention to detail is necessary for all aspects of tack coat application: the surface condition of the existing pavement, the consistency and temperature of the bituminous liquid, and the capability of the placement equipment.



Figure 1 –Uniform tack coat application (Photo courtesy of the Ohio Department of Transportation (ODOT))

A good tack coat application will exhibit a uniform layer of bituminous material at the desired rate (gallons per square yard). Streaking and puddling, the two extremes of any tack coat application, are considered unacceptable.

The application of tack coat on vertical surfaces must also be uniform, just as application on horizontal surfaces. Here, tack

coat promotes bond and mitigates cracking and subsequent deterioration at construction joints. ODOT specifications, 401.17, require that the entire face of a cold longitudinal joint be sealed with either PG binder or rubberized asphalt emulsion, 702.13, overlapping the edges of the joint 1/2 inch prior to placing the adjacent mat.

Equipment

Proper functioning equipment will help ensure that the tack coat application meets the desired uniformity and rate requirements. The distributor must be calibrated to ensure the placement of the required application rate. If there is any question as to the distributor's capability to uniformly place the required application rate, its calibration should be verified using the method in ASTM D 2995.

Tack distributors must be capable of maintaining temperature of the bituminous material to ensure the material will adequately flow. A spraying temperature between 75° F and 130° F is suggested for slow-setting asphalt emulsions such as SS-1h. Excessive heating should be avoided. This may cause the emulsion to break while still in the distributor.

Distributors must have the capability to develop pressure sufficient to force the bituminous material through the spray bar nozzles, creating a fan shape as the material leaves the nozzle. For slow-setting emulsified asphalt tack coat materials, dilution will facilitate this operation by reducing the material's viscosity. An adjustment to the rate of application must be made, however, to ensure sufficient bituminous material is deposited on the pavement surface.

The elevation of the distributor spray bar should be set at a height sufficient to allow the fan of bituminous material to fully develop. A fully developed fan will provide overlap of the material placed by the adjacent nozzles. This double lap, or in some cases triple lap, ensures the desired uniform application with approximately full coverage of the pavement surface.

As tack coat material is placed, the reduction in its quantity will cause the distributor to lighten. Consequently, the spray bar will tend to rise. Should this occur it would result in a non-uniform layer of bituminous material across the pavement width. As such,

the distributor should be equipped to maintain the spray bar at a constant height.

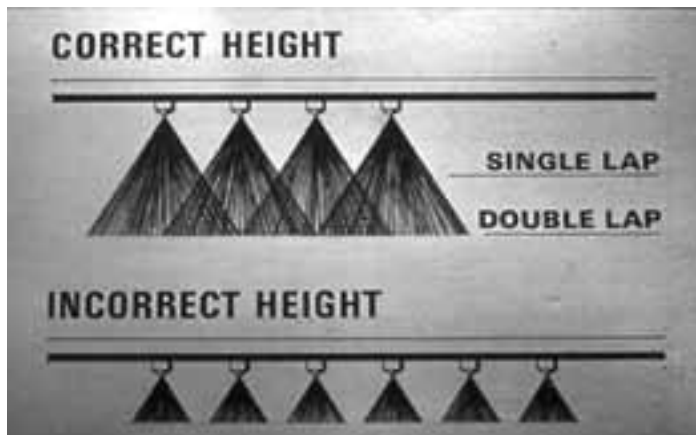


Figure 2 – Spray bar height to obtain desired coverage (Figure courtesy of the Asphalt Institute, *Pavement Maintenance with Asphalt* (AIPMA))

To assure a uniform coating of material on the pavement, ALL spray bar nozzles should be open and set at the same angle. The angle is measured from the axis of the spray bar and is typically 15° to 30°.

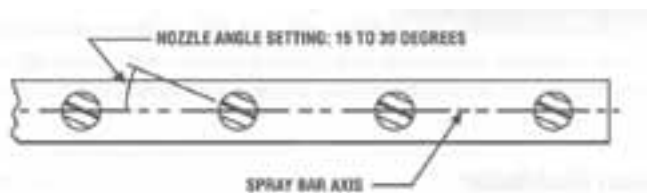


Figure 3 – Proper Nozzle Angle Setting (Figure courtesy of the Asphalt Institute, *A Basic Asphalt Emulsion Manual*)

Lack of a uniform angle will result in some areas of the pavement having thicker coverage, and possible interference between nozzles.

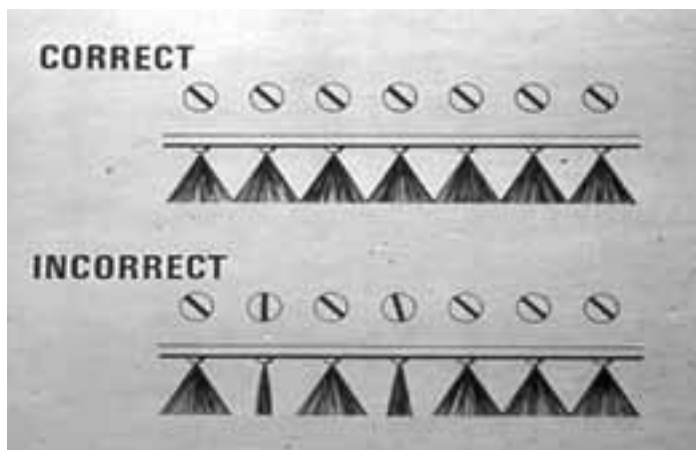


Figure 4 – Spray bar nozzle adjustment (Figure courtesy of AIPMA)

Application

Tack coat material should be placed on clean, dry pavement. Where cold and/or damp weather conditions exist, an adjustment to the type of material used may be necessary. Emulsified tack coat materials may be applied to cool and/or damp pavement, however, the length of time needed for the set to occur may increase. Guidance on the types of tack coat materials can be found in the Asphalt Institute's publication number MS-19, *A Basic Asphalt Emulsion Manual*.

The pavement surface receiving tack coat material should be free of any substance that might inhibit bond. The tack coat operation is never a substitute for cleaning a pavement prior to overlay. A dirty or overly dusty surface will inhibit the ability of the tack coat to bond, resulting in a potential slippage plane between the existing surface and the asphalt overlay. Slippage cracking, or tearing, and delamination are distresses typically seen when cleanliness is lacking.

Application rate should vary depending on the condition of the pavement being overlaid. The objective is to apply a sufficient quantity of tack coat, resulting in a thin, uniform coating of asphalt covering the entire pavement surface. Matching the application rate with the condition of the existing surface is key to success.

Pavements having a fine surface texture require less tack coat material than those with coarse textures. This is due to the lesser amount of exposed surface area. Conversely, milled surfaces will typically require amounts of tack coat material similar to that of existing weathered surfaces.



Figure 5 – Non-uniform tack coat application (Photo courtesy of ODOT)

In some instances it is desirable to dilute slow-setting emulsified asphalt tack coat materials. This is done to facilitate obtaining uniform coverage without placing too much asphalt on the surface. However, ODOT specifications require the engineer's approval for dilution and have a minimum viscosity specification for the diluted emulsion. Dilution will increase the break and set times. Only slow-setting emulsion should be diluted in the field – and then only carefully, by adding water to the emulsion instead of the opposite. Adding the emulsion to water may cause the tack to break. The dilution rate should not exceed 1:1.

In lieu of dilution, alterations to equipment or operational methods, such as reducing nozzle opening size or increasing pressure, can provide the desired fan shape without placing excessive amounts of tack coat.

Excessive tack coat is detrimental. In these instances the tack coat acts as a lubricant, creating a slippage plane. Additionally, using too much material can cause it to be drawn into an overlay, negatively affecting mix properties and even creating potential for bleeding in thin overlays. ODOT specifications require the actual rate to be within plus or minus 10% of the required rate.

When using diluted emulsified asphalt tack coat material, an adjustment to the application rate will be necessary to ensure the desired residual asphalt is achieved. Failure to do so will result in too thin of a coating of bituminous material and inadequate bonding between the layers.

Typical application rates for various pavement conditions are provided in Table 1.

Table 1 – Typical Application Rates

Existing Pavement Condition	Application Rate* (gallons/sy)		
	Residual	Undiluted	Diluted (1:1)
New Asphalt	.03 to .04	.05 to .06	.10 to .12
Oxidized Asphalt	.05 to .06	.08 to .09	.15 to .18
Milled Surface (asphalt)	.05 to .06	.08 to .09	.15 to .18
Milled Surface (PCC)	.04 to .05	.06 to .08	.12 to .15
Portland Cement Concrete	.04 to .05	.06 to .08	.12 to .15
Vertical Face	**	**	**

* Rates shown are for slow-setting asphalt emulsions (SS1, SS1H) containing approximately 60% bituminous material.

** Longitudinal construction joints should be treated using a rate that will thoroughly coat the vertical face without running off. Rates listed are in accordance with the recommendations from NCHRP Research project 09-40 (Reference A)

Allowing the emulsified asphalt tack coat material to set prior to placing the asphalt overlay will enhance opportunity for bond to occur. Whenever practicable, equipment should stay off the tack coat until the set has occurred.

During the break, dispersed droplets of asphalt cement in the emulsified asphalt begin to coalesce. This starts when the emulsified asphalt comes in contact with the pavement surface, and is complete after all moisture has evaporated. A change in the color of the emulsified asphalt tack coat material, from brown to black, is a visual indicator of when the emulsion has broken. The ability of the tack coat to bond is best once the material has set.

Tracking

Tracking, the pick-up of bituminous material by vehicle tires, can occur as a result of the tack coat operation. The critical consequence of tracking is the removal of the needed tack coat from the pavement surface, which may prevent adequate bond. Areas where the tack coat has been excessively picked up must be corrected by reapplying tack coat material to the areas where the tack has been lost. Care must be exercised to avoid over-tacking areas already sufficiently tacked.

An undesirable consequence of tracking is the depositing of bituminous material on adjacent pavement and at intersections. Though aesthetically not pleasing, the effect on adjacent pavement is typically minimal, and wears off in a short time period. Intersections, on the other hand, can receive deposits of material significant enough to distort the pavement surface and hinder a driver's ability to navigate. As such, steps should be taken to eliminate the occurrence of tracking.

The magnitude of tracking is largely dependent upon two issues. They are: the type of bituminous material being used, and whether sufficient time has been allotted to allow emulsified asphalt tack coat materials to set prior to haul vehicles having access.

Tack coat material having enhanced elastomeric properties (rubberized tack) has a high propensity to adhere to vehicle tires. Because of the tenacity of rubberized tack material, it is more readily carried off the project site than conventional tack coat material. Exacerbating this is the failure of allowing emulsified asphalt tack coat materials to set. Haul vehicle tires will pick up material that has not had sufficient time to set. During transport, the tack coat material will gather on the haul vehicle tires, from which deposits will be made on the road surface. Intersections experience the greatest distress due to the haul vehicle being at rest, allowing the greatest amount of material to be deposited on the road surface.

In order to reduce tracking, the emulsified asphalt tack coat material must have sufficient time to set prior to exposure to haul vehicles. To accomplish this, the delivery of material must be balanced with the speed of the paving operation, the length needed for access by haul vehicles, all in consideration of weather conditions.

Preventing tracking by haul vehicles is particularly challenging during night work, where cooler weather and the lack of sunlight

tend to increase the time needed for the set to occur and on traffic maintained maintenance projects, where sufficient time and space may not permit allowing the tack coat to set before paving. The NCHRP research suggests two alternatives for these situations. Trackless tack, a proprietary emulsion, can provide short set times and track free residual coating on the pavement. This material was also shown to provide a superior bond.

Based on experience in Europe and limited trials in the U.S., it is suggested that paving over the un-broken tack coat may prevent pick-up on haul vehicle tires without consequence to the paving. In Europe, the use of “spray pavers” that apply the tack coat just ahead of the paving have been used effectively. The only problem with this equipment is verifying that the tack coat application is uniform.

Maintenance of Traffic Considerations

Ensuring the driving public is provided a safe driving surface is a primary consideration. For safety reasons, traffic should be kept off the tacked road surface at all times. When a tacked road surface is exposed to traffic, the potential exists for reduced skid resistance, especially during wet weather. To address this, good practice is to tack just far enough in front of the paving operation to provide reasonable access to the paver by haul vehicles and sufficient time for the tack coat material to set. It is prudent to use a sand cover to provide friction and prevent pick-up when the paving operation requires that the tacked road surface be open to traffic. A typical rate for applying sand cover aggregate is 4 to 8 lbs/sy.

The Effect of Texture on Bond

The NCHRP research indicates that the texture of the surface to be overlaid has a significant effect on the bond strength that is developed. Milled and tacked surfaces generally showed greater bond strengths than overlays placed on smooth surfaces. Thus, milling an existing asphalt or concrete surface can result in better bond and should be considered in high-stress applications where bond will be critical.

In a similar manner, one could expect that a fine-graded surface course placed over a coarse textured intermediate or base course would produce stronger bond. On new construction this is typically the case. For example a 12.5 mm surface course is placed on a 19 mm intermediate course. However, some maintenance, resurfacing projects consist of leveling and surface courses using the same fine-graded material for both courses. For example, a Type 1 surface on a Type 1 leveling. For most applications this has not been a problem. However, in a high-stress application the bond that can be achieved between these similar materials may not be adequate to resist the shear stress applied by heavy loads stopping or starting on the pavement. Alternatives include placing the material as a single, thicker course over a milled surface or making the leveling a thicker, coarser-graded material.

The Effect of Tack Material Type on Bond

The NCHRP research indicates that harder grades of residual asphalt and polymer modified materials provided higher bond strength than softer asphalt grades. The use of PG binder, SS1H, and trackless tack provided higher bond strengths in the tests. Ohio has specified a rubberized tack material for use on concrete or brick for many years.

This material, 702.13, Rubberized Asphalt Emulsion, is produced by blending SBR rubber compound into a tack coat emulsion. It has been shown to provide a very strong bond, but is very difficult to haul and pave over.

Conclusions

- Uniformity is a major consideration in the proper application of tack coat material. A good tack coat application will exhibit a uniform layer of bituminous material adequate for the condition of the existing pavement.
- To ensure a uniform application of tack coat material, equipment must be capable of delivering the material at the required temperature and pressure. Dilution may facilitate uniform application by assisting the flow of material, however, a delay in the set time will result. Modification to equipment or operational methods such as reducing spray bar nozzle size or increasing pressure will help ensure uniform application. The spray bar and angle of the nozzles must be verified for proper height and alignment.
- Tack coat application should be made on clean, dry pavements at a rate reflecting the condition of the pavement being overlaid.
- Allowing the emulsified asphalt tack coat material to set prior to placing the asphalt overlay will enhance opportunity for bond to occur.
- To mitigate tracking, the emulsified asphalt tack coat material must set prior to access by haul vehicles.
- Maintenance of traffic should ensure that any road surface that has been tacked is covered prior to access by traffic, either by a Hot Mix Asphalt overlay or a cover aggregate.
- For high-stress applications, ensure that sufficient pavement texture exists between courses, in addition to proper tack coat application, and use high-strength tack coat materials to develop high-bond strength between layers.
- For more information on the proper application of tack coat, consult the Training Manual included in NCHRP Report 712 (reference A)

All reasonable care has been taken in preparation of this Bulletin. However, Flexible Pavements of Ohio can accept no responsibility for the consequence of any inaccuracy that it may contain.

References:

- A. NCHRP Report 712, Optimization of Tack Coat for HMA Placement, Mohammad, et. al. TRB, 2012 and in the same publication, Appendix F, Tack Coat Training Manual
- B. A Basic Asphalt Emulsion Manual, Manual Series No. 19, Third Edition, Asphalt Institute
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- D. Construction of Hot Mix Asphalt Pavements, Manual Series No. 22, Second Edition, Asphalt Institute
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ASPHALT PAVEMENT INDUSTRY SCHOLARSHIP AWARDS

FPO PROGRAM SURPASSES \$430,000 IN SCHOLARSHIPS

Since the scholarship program began in 1995, FPO has awarded a total of 355 scholarships worth \$432,000. Former recipients of the asphalt scholarships are now working in responsible positions throughout the transportation industry with contractors, public agencies and consultants, helping to advance the public interest and improve the quality of asphalt pavement construction.

For the past 16 years, FPO has recognized and showcased the traits and accomplishments of 355 college undergraduate and graduate students through the Asphalt Pavement Industry Scholarship Awards program. For the 2012-2013 academic year, FPO recognized an additional 15 accomplished students by awarding 12, \$1,200 scholarships for undergraduate students; three, \$1,400 scholarships for graduate students; and one Dine Comply, Inc. Asphalt Scholarship for Environmental Studies for \$1000.

Undergraduate awards are based on academic performance; potential leadership; participation in school, community and extracurricular activities; work experience; career and educational aspirations; and personal

circumstances. The graduate scholarship is awarded to a post-graduate student whose major field of study is related to asphalt pavement technology and who has been recommended by his/her faculty advisor. The Dine Comply, Inc. Asphalt Scholarship for Environmental Studies is awarded to an outstanding student studying environmental science or health with an interest in working in environmental compliance or regulation.

This academic year, scholarship recipients represent Akron, Bowling Green State, Cincinnati, Ohio Northern, Ohio State, Ohio University and the University of Toledo. FPO's scholarship program is open to universities in Ohio offering degrees in Civil Engineering or Construction Management and coursework in asphalt pavement technology. Of this year's 15 recipients, Benjamin Darkow of Toledo, Benjamin Jordan of Ohio and John Slone of Ohio State are repeat recipients.

The 2012-13 scholarship recipients were recognized and honored during the Ohio Asphalt Expo this past March.

For more information on the Asphalt Pavement Industry Scholarship Awards, perhaps insight on a future job candidate, or an application and information regarding the 2013-14 program, visit www.flexiblepavements.org/scholarships/hma-scholarships-program.



Perpetual Since 1995 ...

The goals of the Asphalt Pavement Industry Scholarship Awards have remained unchanged since the FPO program began 17 years ago. The program's four initial objectives include:

- Provide an incentive for students to gain knowledge in HMA by requiring each student receiving a scholarship to take at least one course in HMA
- Provide an incentive for colleges/universities to offer training in HMA by creating a student demand for the course
- Establish close ties between the asphalt industry and universities to raise the awareness of HMA in the academic community and foster HMA-related research
- Provide a workforce trained in asphalt technology

The Asphalt Pavement Industry Scholarship Awards Program is administered through the National Asphalt Pavement Association's National Research and Education Foundation.

2012-2013 ASPHALT PAVEMENT INDUSTRY SCHOLARSHIP RECIPIENTS

**Repeat Scholarship Recipient*

Barrett Paving Materials Inc.
and the Dine Comply, Inc.
Asphalt Scholarship for
Environmental Studies

Fred & Teresa Frecker

Gerken Paving Inc.

Gerken Paving Inc.



Eric Hahn
U. of Cincinnati



Brian Harlow
Ohio State U.



Benjamin Darkow*
U. of Toledo



Bradley Zwyer
Bowling Green St. U.

Northstar Asphalt/Kenmore
Construction Co.

Northstar Asphalt/Kenmore
Construction Co.

John R. Jurgensen Co./
Valley Asphalt

Ohio CAT/Caterpillar Inc.



Kevin Carper
Ohio Northern U.



Michael Rehfus Jr.
U. of Akron



Anthony Wehr
U. of Cincinnati



Emily Steva
Ohio State U.

Burgett Family/Kokosing
Construction Co.



Robert Drsek
U. of Akron

Burgett Family/Kokosing
Construction Co.



Christine Copeland
U. of Akron

The Shelly Co.



John Slone*
Ohio State U.

Shelly & Sands Inc.



Anthony Colella
U. of Akron

Martin Marietta Aggregates
Graduate Student Scholarship



Jamal Tahat
U. of Akron

Shelly & Sands Inc.
Graduate Student Scholarship



Benjamin Jordan*
Ohio U.

Shelly & Sands Inc.
Graduate Student Scholarship



Matthew Scheer
Ohio U.

Scholarship Fund Contributors

The following companies and individuals have contributed to endow the Ohio Asphalt Pavement Industry Scholarship Fund through the National Asphalt Pavement Association Research & Education Foundation (NAPAREF):

Osama Abdulshafi, Ph.D.
Barrett Paving Materials Inc.*
Bowers Asphalt & Paving Inc.
Burgett Family/Kokosing Construction Co. Inc.*
Columbus Bituminous Concrete Corp.
Columbus Equipment Co.
Cunningham Asphalt Paving Inc.
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Erie Blacktop, Inc.
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Fred & Teresa Frecker
General Insurance Co.
Gerken Paving Inc.*

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Northeastern Road Improvement
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Northstar Asphalt, Inc.*
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Schloss Paving
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In addition, Shelly & Sands Inc. made a supplemental contribution to enable additional scholarships.



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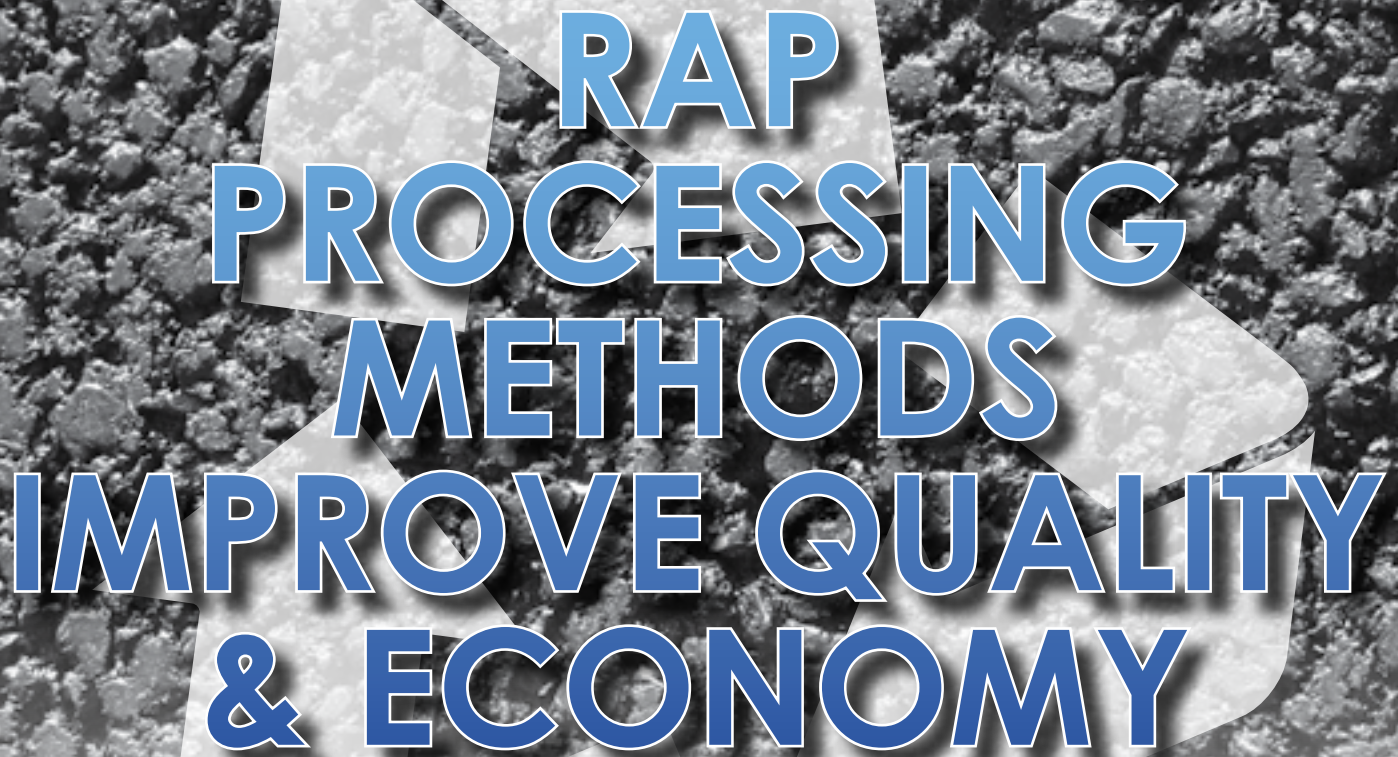
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RAP PROCESSING METHODS IMPROVE QUALITY & ECONOMY

When ODOT instituted the option of allowing higher RAP (Reclaimed Asphalt Pavement) amounts in asphalt mixtures it was necessary to develop a specification that ensured RAP was sufficiently processed for this purpose. ODOT and FPO worked jointly to create a dual-method specification that retained traditional RAP processing requirements and created more stringent requirements for asphalt mixtures incorporating high RAP amounts.

RAP requirements are specified under 401.04 of Supplemental Specification 800 (current version dated 4-20-2012). The specification cites two methods from which a contractor may choose based on the desired RAP usage. Though the specification cites two “methods,” there are four allowable processes – two for each method.

Method 1 Standard RAP

Method 1 Standard RAP defines two processes for RAP processing depending on the nature of the project.

Method 1 – Process 1

The first requires a processed and tested stockpile of RAP. The purpose of the processing during the stockpile construction is to ensure the RAP composition (i.e. aggregate gradation and asphalt binder content) is reasonably uniform. Processing methods are determined by the asphalt mixture manufacturer and may involve crushing and screening. Testing provisions are in the specification to ensure uniformity throughout the stockpile. Once stockpile uniformity is determined acceptable, the RAP is further processed in-line during asphalt mixture production. The in-line process sieves the RAP to ensure correct particle size for incorporating RAP into the new asphalt mixtures.

For mixtures used in surface courses, in-line processing ensures RAP particle size is less than 0.75 inch. For this purpose, a screen having mesh openings of 0.75 inch is placed in-line to the RAP conveyance used to feed the asphalt mixing plant. For intermediate and base course mixtures maximum RAP particle size is 2 inches and an in-line screen having

mesh openings of 2 inches is used. The specification does include this caveat: *Ensure that the RAP is the proper size to allow for complete breakdown in the plant.*

Though not specifically related to RAP processing, it is noteworthy that mixes that incorporate polymer binders have limitations on the amount of RAP that can be used. Discussion of those limitations is beyond the scope of this article; however, more information can be obtained by contacting the FPO office.

Method 1 – Process 2

The second process allowed under Method 1 consists of the introduction of RAP directly into the asphalt plant through a “stream process.” That process requires RAP acquisition be from a specific project to ensure the RAP composition is uniform. Separately tested stockpiles are not required. Using the stream-process presumes the uniformity of the material stream is consistent since in general, asphalt reclaimed from within a specific project is typically consistent in composition. This is true so long as the cold-milling process used in reclaiming the asphalt runs at a consistent depth. This is an

important factor in that surface, intermediate and base course mixes differ in asphalt binder content and gradation; to vary the depth of milling will compromise RAP uniformity.

Procuring RAP in a stream process as described above is often referred to as “concurrent RAP.” This name came about by the nature of the asphalt construction process; that is, the asphalt mixture manufacturing runs “concurrent” to the acquiring of RAP from the roadway being paved. Think of it as a loop where the existing asphalt pavement is reclaimed (by cold-milling), the reclaimed material (RAP) is then hauled to the asphalt plant and reincorporated into new asphalt mix.

The Method 1 – Process 2 specifications state that concurrent project RAP must be taken from one existing mix type on the concurrent project, or two existing mix types if both mix types are taken at the same time in

one pass of the milling machine. Screening requirements are the same as described for Method 1 – Process 1.

The limitation of the processes described in Method 1 is that the variability in RAP composition restricts use to lower RAP content. The method, however, is well suited for asphalt manufacturers incorporating modest amounts of RAP since in such cases final mix properties are not easily compromised. The concurrent RAP process, although not very common, has the advantages of reducing stockpiling and providing RAP with lower moisture content.

Method 2 Extended RAP

Method 2 Extended RAP also allows two methods of processing RAP. Processing is more substantial and results in better uniformity. What is significant about Method 2 is that added processing allows higher percentages of RAP, and as a result better economy.

Method 2 – Process 1

The first process under Method 2 requires fractionated and tested

stockpiles. Fractionation is the breaking down of RAP into two or more sizes by utilizing a sieving process, typically resulting in a fine fraction and a coarse fraction. Asphalt mixture manufacturers have found that fractionation provides high levels of uniformity that allows them to consistently meet mix proportioning requirements such as air voids and voids in the mineral aggregate, all the while running higher quantities of RAP. By ODOT specification, RAP that

has been fractionated and stockpiled in its various fractions can be directly introduced into the asphalt mixing plant’s raw material feed without additional screening.

Method 2 – Process 2

The second process allowed under Method 2 is similar to Method 1 – Process 1, in that stockpile uniformity must first be assured. Once assured, the RAP receives additional in-line processing as it is directed



The double-deck screen and associated conveyors between the RAP cold-feed bins and the drum.

into the asphalt mixing plant's raw material feed. The additional processing consists of processing by passing the RAP over a double-deck screen placed in-line between the RAP cold-feed bin and the mixing drum, using a 9/16 inch (14.3mm) screen for surface and intermediate mixes and a 1.5 inch screen for base mixes.

Binder Grade Change

An important consideration when using higher RAP contents in an asphalt mixture is the necessity to ensure sufficient mixture flexibility to avoid cracking. Asphalt binder reclaimed from RAP has high stiffness. There are different ways of accommodating for this stiffness. One method is to use a low enough RAP content that the new mix stiffness is not detrimentally affected. The other option is to use a softer virgin binder to accommodate for the stiffness of the much harder RAP binder. Blending charts are used for this purpose. The downside of blending in a soft virgin asphalt binder with the harder RAP binder is cost. Soft virgin binders are more expensive.

The need for softer virgin binder can be avoided for mixtures having RAP percentages between 26 and 40 percent if the mix is produced as foamed warm mix at 275 degrees F or less. When the mix is produced below this temperature, aging and oxidation are reduced and the virgin binder is not hardened or stiffened to the extent normal for hot mix production at higher temperatures. It then becomes unnecessary to substitute a softer grade of virgin binder to blend with the aged binder in the RAP. ODOT will be enforcing this temperature limitation in production, and will require a mixture to be redesigned if mix is produced at a higher temperature.

Stockpiling Requirements

Stockpiling requirements are similar under all methods and processes. At a minimum, a facility will need one or more receiving stockpiles for untested material being received from milling or other projects, and one or more processed and tested stockpiles for further processing into ODOT mix. There is a testing advantage for keeping RAP from ODOT projects separate from other sources; but, that requires separate receiving

stockpiles. Creating fractionated stockpiles will also add to the number of stockpiles to be created and tested.

Common Specification Requirements

Other specification requirements common to both methods 1 and 2 are:

- The producer must provide enough space for meeting all RAP and Recycled Asphalt Shingles (RAS) handling requirements at their asphalt manufacturing facility
- A clean, graded base for stockpiles must be provided to ensure water does not collect
- Blended stockpiles of RAP and RAS, dubbed SHRAP (Shingles & RAP), must be tested to assure uniform gradation and asphalt binder content
- Assurance must be made that stockpile properties match the RAP properties stated in the mixture formulation (i.e. JMF)
- All stockpiles on the grounds of the asphalt manufacturing plant are to be mapped; labeled according to material type and quantity; signature provided by the responsible manufacturer's employee; kept current; and posted in the asphalt manufacturing plant control room
- Tested stockpiles must not be co-mingled
- The asphalt manufacturer Quality Control Plan must document methods that will be employed to ensure the aforesaid specification requirements are met
- ODOT personnel monitoring asphalt manufacturing operations are instructed to note deficiencies in RAP housekeeping

Summary Comments

The four RAP processing options are:

Method 1 – Process 1

A simplified RAP process utilizing basic in-line screening for plants not desiring to use higher RAP amounts (for lower RAP amounts)

Method 1 – Process 2

A stream process for concurrent project RAP (for lower RAP amounts)

Method 2 – Process 1

A process ensuring a higher level of RAP uniformity through fractionation of RAP stockpiles (for higher RAP amounts)

Method 2 – Process 2

A process ensuring a higher level of RAP uniformity through introduction of in-line, double-deck RAP screening as a component of the raw material feed to the asphalt manufacturing process (for higher RAP amounts)

The four different processing methods described in the ODOT specifications (and above) are not all appropriate for higher levels of RAP usage. However, ODOT has structured the specification to allow and encourage asphalt manufacturers



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to use higher amounts of RAP. ODOT hopes contractors will weigh (as many have) the cost of additional processing against the savings attained through using higher amounts of RAP, and begin moving toward more RAP usage. ODOT expects that someday the specification with higher RAP allowances will become standard practice. In fact, ODOT notes that most contractors have already adopted the higher RAP standards.

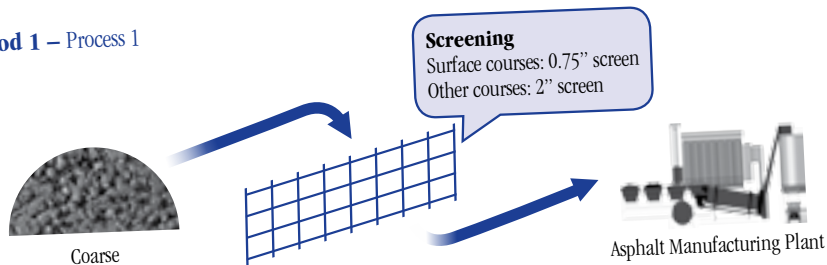
Significant progress has been made over the years to capitalize on the benefits of using reclaimed asphalt pavement. It is estimated that in Ohio

the amount of RAP re-used into new asphalt mixtures produced in 2011 was 3.5 million tons. That is enough reclaimed asphalt to pave four lanes of pavement from Columbus to Los Angeles. The approximate value of that material is \$168 million. The use of recycling, and the associated cost savings, was essential in mitigating cost increases to asphalt customers during the crude oil fluctuations recently impacting the asphalt industry. The new ODOT RAP standards give promise to those benefits continuing and marking asphalt as a sustainable pavement construction material.

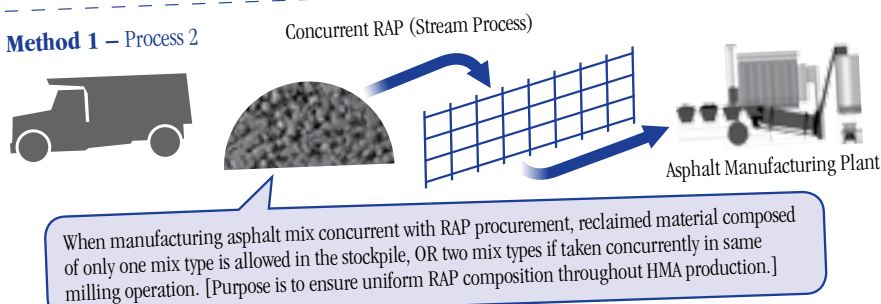
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THE FOUR RAP PROCESSING OPTIONS

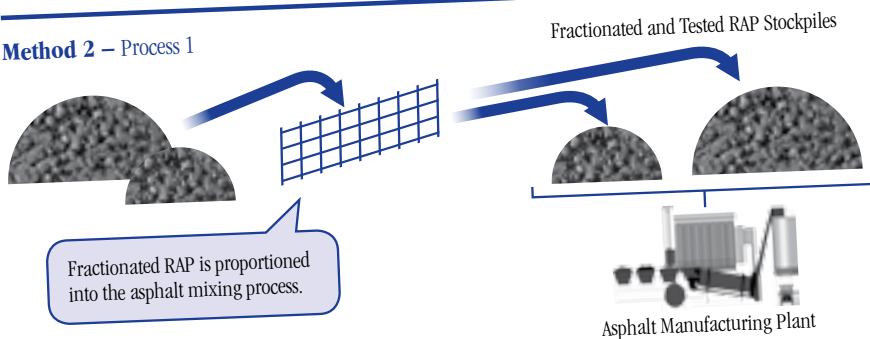
Method 1 – Process 1



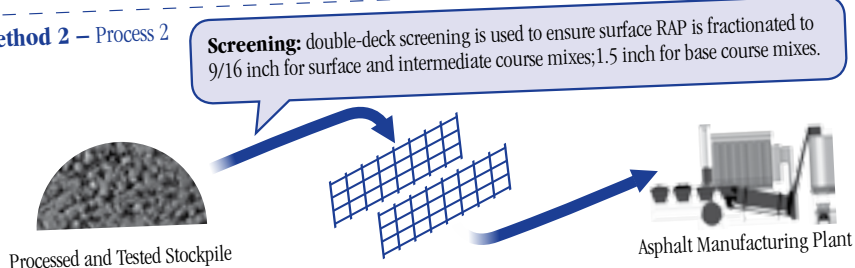
Method 1 – Process 2



Method 2 – Process 1



Method 2 – Process 2



Mark Your Calendars

Principles of Quality Hot Mix Asphalt Pavement Construction, October 22

Colas/NACTECH Training Facility
7374 Main Street • Cincinnati, OH 45244



The Asphalt Institute (AI) is presenting “Construction of Quality Hot Mix Asphalt Pavements” in the Cincinnati area on October 22. The course is recommended to anyone needing additional training in asphalt pavement construction practices, and especially to those individuals who serve as Field Quality Control Supervisors under ODOT specifications. The event will be held at the Colas/NACTECH training facility.

For more information and registration visit the AI website at www.asphaltinstitute.org/public/asphalt_academy/construction-of-quality-hot-mix-asphalt-pavements-seminar.dot.



Ohio Asphalt Paving Conference, February 6, 2013

The Fawcett Center
The Ohio State University
2400 Olentangy River Road
Columbus, Ohio 43210

The 2013 Ohio Asphalt Paving Conference (OAPC) is scheduled for February 6, at the Fawcett Center located on the campus of The Ohio State University. The OAPC is a collaborative effort of state and local government, academia and the asphalt industry to present practical, usable technologies and strategies for the design and construction of asphalt pavements. For conference registration and additional information, go to <http://www.flexiblepavements.org/calendar/oapc/oapc>.



Ohio Transportation Engineering Conference, October 30-31

Columbus Convention Center
400 North High Street
Columbus, Ohio 43215

The 2012 Ohio Transportation Engineering Conference (OTEC) is scheduled for October 30-31 at the Columbus Convention Center. This year's theme: “Transportation- Revising the Blueprint” will focus on innovative funding solutions, enhanced delivery of products and services and a strategy for economic development.

FPO is organizing an Asphalt Technology session at 1 p.m. on Tuesday, October 30. This session will include technical presentations by nationally recognized industry experts on innovations and best practices to ensure the long-life and perpetual performance of asphalt pavements. These presentations are:

- Best Practices for Constructing and Specifying HMA Longitudinal Joints, Wayne Jones, Asphalt Institute
- Highly Modified Asphalt: An Innovative Approach to Polymer Modification for Perpetual Performance, Bob Kluttz, Kraton Polymers
- New Jersey DOT Uses Innovative Asphalt Mix to Reconstruct Interstate 295 Into a Perpetual Pavement, Bob Sauber, Advanced Infrastructure Design

Please stop by booth 101 in the main exhibit hall during the conference and meet the FPO staff. Visit the OTEC website at <http://www.dot.state.oh.us/engineering/OTEC/Pages/default.aspx> for up-to-date registration and conference information as well as archived material from previous conferences.



2013 Ohio Asphalt Expo, March 5-6

Columbus/Polaris Hilton Hotel
8700 Lyra Dr.
Columbus, Ohio 43240

The 2013 Ohio Asphalt Expo is scheduled for March 5-6, at the Columbus/Polaris Hilton Hotel located in Columbus. Planning is currently underway for this must-attend event. For conference registration and additional information go to www.ohioasphaltexpo.org or visit FPO on Facebook.

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