How Do You Define Value in a Pavement?

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I wonder what comes to mind when you hear the saying, “It’s good enough for government work.” From those of you who know your history the phrase will elicit a very positive response.

**A Commendation**

Around the time of WWII, as I understand it, firearm manufacturers began using the expression “Good Enough for Government Work.” It was used as a means of communicating the high quality of their craftsmanship. You see, in those days the government had the most rigorous specifications for the manufacturing of these goods. To the citizenry, if a product was good enough for government work then it surely was good enough for “me!” What started as a marketing strategy soon became a commendation of products and services that were of superior quality.

With respect to government specifications, nothing has changed. Today, in the asphalt paving market, motorists enjoy the benefits that come from rigorous specifications on pavement quality. It is not a surprise that asphalt pavements last perpetually, even under today’s ever-increasing pounding from greater numbers and heavier truck traffic; it’s all because of good specifications. The legacy of performance wherein asphalt pavements on Ohio’s interstate system have never needed rebuilt is evidence that Ohio’s specs are among the best.

When the firearms manufacturers coined the slogan “Good Enough for Government Work,” clearly they were attempting to communicate the value of their product. You know what value is. Webster’s Dictionary defines “value” in several ways but one definition is . . . “something intrinsically valuable or desirable.”

As an engineer, when I think of “value” I’m drawn back to my college days and Dr. Nemeth’s CE576 Engineering Economics class. In those days we spoke of “value” in terms of benefits and costs (B/C). We learned that when making an economic decision an appropriate analysis always includes an evaluation of the benefits received from the project versus their associated cost. If the ratio of the benefits to costs was greater than 1.0 then the project made economic sense. In those instances where multiple project alternatives exist – such as asphalt versus brand X, the project returning the greater B:C ratio is the best selection. Notice that in all cases there must be an evaluation of the benefits received, as well as the costs. To leave one or the other out of the analysis can result in undesirable ramifications, sort of like buying a pig in a poke.

This whole matter of B/C evaluation is not exclusive to engineering. Everyone does this; they just think of it in everyday terms. Take for instance a major household purchase; it could be a room addition to the home, a new car, or perhaps an appliance. When making such purchases we all perform value judgments; that is, we determine if what are we getting (i.e.

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**The President’s Page**

Clifford Ursich, P.E.
President & Executive Director

When considering pavement or treatment types, asphalt has distinguished itself as having the attributes motorists prefer – long lasting, smooth, quiet, safe, sustainable and easily maintained. Unquestionably, asphalt has earned the commendation, “It’s Good Enough for Government Work!”
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Benefits) for the dollars we’re about to fork over (i.e. Costs) are worth the investment. Let’s take a look at purchasing a car. Here’s how it goes … I’ve got a particular car in mind; that’s what draws me to a particular dealership. I’m interested in that car because that brand is known for its long-term durability. The car is stylish, so it will impress my buddies; gas mileage isn’t the greatest but it’s probably worth it because the vehicle is heavier and safer. Last of all, the color matches my shoes. How much does it cost? I’ll buy it! It’s a VALUE!

Though as a purchaser you may not assign specific dollar (value) to particular benefits, you do have in your mind some rationale for weighing the benefits and the costs. If we as consumers make such value judgments when spending our own money, it makes sense that we should be equally guarded to ensure maximum value when making investments with public funds. When it comes to transportation projects, and more specifically selecting pavement or treatment type, we should be looking at more than just a price tag: to do so runs counter both to our intuition, our engineering training and the oath to which we all ascribed when we were entrusted with the title Professional Engineer.

**Something Intrinsically Valuable or Desirable**

As a motorist, what are the attributes that you find intrinsically valuable or desirable in a pavement as you ride along the highways and byways of Ohio? When it comes to pavement condition, in general, motorists desire the attributes of safety, smoothness, and in more recent years, pavement quietness. Long-term durability (i.e. not having to be stuck in a traffic jam while a pavement is rebuilt) and speed of construction also factor in when traffic flow is considered: as well, sustainable practices that conserve energy and natural resources are becoming increasingly important. Those are the pavement attributes that motorists desire; they are the “B” in the Benefit/Cost ratio. They are a necessary element in determining what pavement type or treatment delivers the highest “value” (B:C) to motorists — and they should be considered.

Whether we call it “value” or B/C, as transportation professionals our primary objective is to serve the highway user efficiently and effectively; doing such demands consideration of pavement attributes that directly affect motorists’ costs, convenience and comfort. When considering pavement or treatment types, asphalt has distinguished itself as having the attributes motorists prefer — long lasting, smooth, quiet, safe, sustainable and easily maintained. Unquestionably, asphalt has earned the commendation, “It’s Good Enough for Government Work!”
Registration is underway for Flexible Pavements of Ohio’s (FPO) 49th Annual Meeting & Equipment Exposition, March 8 & 9, 2011. The annual meeting marks a new beginning with a change in venue to the newly constructed Hilton Hotel at Polaris in Columbus.

This luxurious hotel is a fully equipped convention facility and is within easy walking distance to the Polaris Fashion Place mall. The Hilton Polaris promises to provide a comfortable annual meeting experience and is conveniently located within five miles of more than 200 restaurants and less than a 15-minute drive to many central Ohio attractions.

Highlights of this 2011 Annual Meeting include:

- Membership Breakfast & Annual Business Meeting with FPO President & Executive Director Cliff Ursich reporting on the state of the association
- Award Luncheon with presentations of FPO’s prestigious Quality Asphalt Paving and Service Awards
- Annual Chairman’s Reception
- Public Agency Forum moderated by Hamilton County Engineer Bill Brayshaw, P.E., P.S.
- Annual Prayer Breakfast
- Technical sessions on new asphalt technologies and construction practices
- Large indoor exhibit area and outdoor equipment show with more than 30,000 square feet of exhibit space

For conference registration and additional information, go to www.flexiblepavements.org or visit us on Facebook.
This late summer and fall northeast Ohio saw the construction of three porous asphalt pavements: Nordion High School Parking Facility and Stadium Walking Path; Historic Cancasci House located in the U.S. National Park Service’s Cuyahoga Valley National Park; and the Tallmadge Meadows Area of the Monroe Falls Metro Park. These new installations mark a rising trend in interest of porous asphalt as a low-impact stormwater control technology.

Porous asphalt pavements were first developed in the late 1960s by the Franklin Institute while under a U.S. Environmental Protection Agency (USEPA) contract. The first porous pavements were constructed in the early 1970s in Pennsylvania. In recent years, however, porous pavements have captured the attention of Ohio specifiers for their potential as an effective technology for stormwater management.

Research conducted by the University of New Hampshire Stormwater Center (UNHSC) indicates management controls that utilize filtration are most effective in stormwater quantity control and quality control. Bioactivity occurring within the porous pavement system is the reason

Figure 1: Porous asphalt relies upon filtration as the means of stormwater control. Porous pavement can be used where low-permeability soils exist. This is accomplished by designing the pavement to detain stormwater rather than infiltrate. In such cases perforated pipe is utilized to ensure excess water is removed from the system.
for the effective performance. Figure 1 shows how a porous pavement functions. Stormwater passes through an asphalt layer specifically designed to an air void content that allows the free flow of moisture into the pavement layers below. Water accumulates at the bottom of a porous recharge bed during a rainstorm but eventually infiltrates the soil where bioactivity treats pollutants and moisture finds its way to an aquifer.

The Nordonia H.S. Parking Facility, Cancasci House and Tallmadge Meadows Area projects all utilized infiltration as the means of stormwater control. To accomplish this, each project specified a stone-filled reservoir, stabilization course and overlay with a porous asphalt mix. Failsafe controls were added in the Nordonia project in the event the pavement lost permeability. As well, the Cancasci House project installed a failsafe mechanism — in this case a 12-inch-by-36-inch French drain along the lower edge of the parking area; this was to keep the water out of the base and eliminated the use of underdrains. All projects utilized the Flexible Pavements of Ohio (FPO) mix specification for porous asphalt pavement surface mix (PAPS).

In all cases the projects were designed for use by light-duty vehicles; however, as with any project, things don’t always work out as planned.

The Nordonia H.S. project is seeing some school bus traffic on the porous pavement. This should provide an exceptional field experiment in how the porous pavement structures should be designed to stand up to heavy-load vehicles.

Some unique design features can be seen at the Tallmadge Meadows Area parking facility at Monroe Falls Metro Park, as both the parking facility and entrance roadway are porous asphalt. The entrance roadway includes a relatively steep grade (5-10 percent). Typically, porous pavements are used where the subsoil can be graded level; this maximizes infiltration surface area and ensures stormwater does not travel to a low point. Monroe Falls Metro Park creatively addressed this challenge using a simple solution — bleeder (French) drains. This provides some opportunity for stormwater infiltration but also accommodates heavier flows by diverting excess water to a (future) grassy swale. In doing this, the Metro Park was able to maintain the natural lay of the roadway and parking facility. Further challenging “conventional wisdom,” Monroe Falls Metro Park substituted a geogrid for the fabric typically used over the subsoil; fabric was still used at the sides of excavation. Park designers believe this reduces the risk of permeability loss to the porous system.

Figure 2: Historic Cancasci House located in the Cuyahoga Valley National Park accommodates 12 vehicles on its recently placed porous asphalt pavement.

Figure 3: Historic Cancasci House located in the Cuyahoga Valley National Park accommodates 12 vehicles on its recently placed porous asphalt pavement.

Figure 3: Nordonia High School’s new pavement features a porous asphalt surface mix furnished by The Shelly Company, Twinsburg Division, and placed on a blended stone recharge bed.
Lessons Being Learned

As porous pavements have gained popularity across the nation it has become increasingly clear that the success of these pavements requires a paradigm shift by designers, contractors and maintenance personnel. Designers are coming to understand that porous pavements require much more engineering than simply placing a porous asphalt mixture on a few inches of dense-graded aggregate. Soil preparation specifications need to be re-thought, ensuring permeability is retained through the construction phase. As well, there is a growing understanding that porous pavements are indeed feasible solutions where soils lack substantial permeability. The need for a geotextile fabric at the stone recharge bed/soil interface is being questioned. Continuing evaluation is occurring here; the issues being long-term permeability and economy. The fact that these pavements are typically constructed with a deep-strength stone reservoir having larger structural capacity than traffic demands raises the question whether soil migration into the stone recharge bed will indeed occur should fabric be eliminated.

Contractors constructing porous pavements are learning new techniques for site preparation, construction sequencing and placement of the various courses of porous materials. Construction sequencing plays a large role in ensuring soil permeability is retained. Porous asphalt mixtures must be produced under very controlled conditions to ensure the asphalt binder coating of the mix is sufficiently thick. Gradation variability must be restrained to ensure a consistent asphalt binder coating and pavement permeability. Mix temperature must be closely monitored so as to prevent the binder from draining off the stone. Mixing temperature at the asphalt plant plays an important role in ensuring uniform coating and pavement permeability. Contractors fearful of using 10-ton rollers to compact porous asphalt mixtures shouldn’t be, because the fully fractured aggregate can, and must, be completely seated to ensure against excessive voids and potential for aggregate loss.

Pavement maintenance techniques are also being rethought. To ensure full utilization of permeability afforded by porous pavements, maintenance practices must be adopted that minimize debris from getting into the pavement pores. This can be as simple as seasonal sweeping, vacuuming or leaf blowing. Education is needed here. Placing a sign at the entrance of a porous pavement is a very simple way to
communicate to landscapers, snow and ice removal personnel and others that some of these practices can clog the pavement and must be avoided. That means no more dumping topsoil or mulch on the pavement for convenience; no more sand used in deicing materials. At first these may appear to be an extra expense, but observations by the UNHSC indicate that maintaining porous pavements is more about instituting different procedures rather than additional maintenance.

**Ensuring Future Success**

Evidence is mounting that porous pavements are an effective stormwater management technology. UNHSC has noted that porous pavements are one of the most effective stormwater technologies for reducing stormwater quantity and improving quality; this due to the fact that it relies upon filtration.

The asphalt industry is learning from each of the porous projects placed. In February 2010, materials specifications for PAPS were updated to include the most current porous asphalt technology for ensuring durable surface mix performance; the three projects discussed in this article included these specification enhancements. To advance the technology and provide greater economy, FPO will continue to evaluate new materials and methods and make specification refinements. Specifiers are encouraged to visit the FPO website www.flexiblepavements.org and click on the “Sustainable Pavements” link to obtain specification updates.

You can follow FPO on Facebook; there you’ll find the most current information and status of the various projects FPO is working on to ensure specifiers’ satisfaction and success using asphalt.
Ground Penetrating Radar (GPR) is an effective tool for pavement rehabilitation design and roadway network condition assessment. In a recent project, Resource International Inc. (Rii) used GPR in salvaging the existing asphalt pavement of a section of Hamilton-Mason Road located in Butler County. The use of GPR allowed the engineers to determine the precise locations of pavement sections that needed different maintenance and/or rehabilitation strategies.

Unlike the current coring methods, which would have required too much data to achieve the same results, GPR enabled Butler County to identify only the necessary reconstruction segments of the road, thereby saving an estimated $600,000 over a traditional reconstruction approach. In addition, GPR caused less inconvenience to highway users during data collection and presented an economical repair approach resulting in significant savings.

A Discussion of Pavement Management Systems

Historically, Pavement Management Systems (PMS) are used to provide a network-level assessment of surface conditions and to determine maintenance needs and rehabilitation strategies to restore roadways in the network. Distress type, severity and extent serve as the basis for identifying and selecting roadways of the network for each type of maintenance. Associated costs for budgeting purposes are also based on this distress assessment.

An effective PMS must provide the necessary information for an accurate estimate of pavement life expectancy. Pavement life can be estimated by performing a Pavement Life Expectancy Analysis. Upon performing that analysis, a strategy can be developed and overlay thickness determined that ensures the pavement is sufficiently strengthened. Cost estimates are then calculated.

Getting an accurate assessment of pavement life expectancy is key to determining a rehabilitation strategy and associated costs. Methods for doing this fall largely on strength estimates as determined by examination of pavement cores or non-destructive tests such as Falling Weight Deflectometer (FWD) testing. In the case of coring, getting an accurate estimate requires a substantial amount of sampling (i.e. coring), thickness measurements and good observational skills as the technician examines the quality and strength of the materials cored.

For those seeking “Greenroads” certification, it is important to note that coring does not meet the sustainability guidelines. FWD testing is more “friendly” but it too requires a substantial amount of sampling (i.e. deflection tests) of the pavement to obtain a representative value for a pavement’s strength. Confounding the situation is the fact that most roads are quite variable in strength due to factors such as soil strength, moisture content and pavement thickness variation.
Project development costs are always a concern and the cost associated with securing the necessary pavement information is no exception. Besides the costs associated with physically procuring samples and testing them, traffic-control costs are substantially greater for testing that creates a large traffic disruption. Data capturing systems that provide a comprehensive assessment of pavement condition and are non-destructive and non-intrusive to traffic are more efficient. GPR can provide such efficiency, simultaneously accomplishing the goals of network level maintenance planning and project level rehabilitation design analysis, and is done so within the frameworks of environmental and economical sustainability guidelines.

**Addressing Strength Variation on Hamilton-Mason Road**

Hamilton-Mason Road is an approximately two-mile-long asphalt pavement section located in the south edge of Liberty Township in Hamilton County. It was designated for improvement as part of the expansion of the I-75/Liberty Way Interchange. The pavement of the existing road had two lanes with residential development on both sides. The project involved widening the pavement to five lanes by salvaging and overlaying the existing pavement. Project development included the design of the roadway, drainage, bikeways, sidewalks, lighting, traffic controls, right of way plans and deed preparation.

Early in the project development, concerns were expressed over potential variation in the existing pavement thickness and pavement strength. To resolve that issue, and to determine the feasibility of salvaging the existing pavement, an assessment of pavement thickness throughout the entire project was necessary.

The pavement assessment was performed by Rii staff, which used a non-destructive and sustainable solution referred to as GPR.PAVE®. The method combines network-level pavement condition survey data, Pavement Condition Rating (PCR) and GPR data to arrive at a project-level rehabilitation strategy and cost. It utilizes the American Association of State Highway and Transportation Officials’ (AASHTO) pavement thickness design guidelines to calculate the Structural Number (SN), a measure of an asphalt pavement’s strength, for various traffic and soil conditions. This method is also capable of assessing the effective thickness of rigid pavement. The GPR.PAVE® analysis yields an adjusted SN (i.e. effective pavement strength) of the roadway, a projected life expectancy of roadway and the overlay thickness necessary to increase pavement strength to levels sufficient to carry the anticipated future traffic.

Pavement condition surveys, as described in AASHTO D 6433-09 or the Ohio Department of Transportation (ODOT) PCR System, can be used. In either case, an assessment of pavement condition is made by inspecting the pavement surface to determine the various types of distresses, their severity and extent. The survey used in the Hamilton-Mason Road Project was based on ODOT’s PCR method.

PCR can range from “good” to “failed,” and accordingly, with PCR=0–100. A “good” to “excellent” pavement condition is indicated by values from 85 to 100. Such pavements require little to no maintenance; typically, crack sealing or other very minor maintenance is recommended. A pavement rating of 75 to 85 represents “satisfactory” condition, and the recommended maintenance includes crack sealing, patching, and/or preventive maintenance treatment such as a thin asphalt overlay. Pavements exhibiting a PCR of less than 75 are candidates for minor or major rehabilitation or reconstruction and thus may require a Life Cycle Cost Analysis. Noteworthy is the fact that in Ohio only minor rehabilitation in the form of asphalt overlays has been necessary for maintaining ODOT’s deep-strength asphalt pavements.

In the case of the Hamilton-Mason Road Project, the pavement surface of the entire length of the project was in “poor” condition with PCR ranging in the low 50s, therefore, a layer coefficient of 0.23 was assumed for the entire length of the project.

**Determination of In-Situ Structural Number (SN)**

Published data indicates that some highway agencies may recommend a specific layer coefficient for cracked surfaces; For example, ODOT
Ohio Asphalt

recommends a layer coefficient of 0.23 for existing asphalt concrete that is old, oxidized and weathered. ODOT also recommends a layer coefficient of 0.43 for new surface and intermediate layers and 0.36 for a new asphalt base.

The GPR pavement surveys of Hamilton-Mason Road were conducted with an automated survey vehicle and the data was analyzed to determine the thickness of the pavement layers.

In general, the layer coefficients of the asphalt layers can be proportionately decreased from its original value by the current pavement condition Index (PCR or PCI). For example, if the PCR of the existing pavement surface is 80, the layer coefficient would be determined by 0.80 x initial layer coefficient. AASHTO recommends a value of 0.44 for new/initial asphalt layers; other highway agencies may use a different value. Formulae for determining the SN (i.e. strength) of the existing pavement are shown below.

\[
\text{ai (adjusted)} = (\text{PCI}/100) \times \text{ai (AASHTO)} \\
\text{SN (in-situ)} = \text{ai (adjusted)} \times \text{hi GPR}
\]

Using the appropriate layer coefficient of 0.23 and the GPR layer thickness (hi GPR), the SN of the existing pavement for Hamilton-Mason Road was determined to be in the range from 4.5 to 5.0 for various sections.

**Developing a Rehabilitation Strategy**

In the Hamilton-Mason Road rehabilitation design project, the primary concern was the determination of pavement sections with adequate remaining life such that a cost-effective rehabilitation and reconstruction plan could be developed. Accomplishing this task would ensure future maintenance is minor and costs are kept to a minimum.

The remaining life of the existing pavement can be used to determine an appropriate maintenance strategy. Dependent upon PCR data, a range of repairs may be needed to successfully rehabilitate a road and bring up the desired strength. The appropriate maintenance action can be found by determining the remaining life of the existing pavement:

1. When remaining life is 15 years or more, routine maintenance is needed
2. When remaining life is 10-15 years, minor rehabilitation is needed
3. When remaining life is less than 10 years, major rehabilitation is needed

To determine the remaining life of the existing pavement of Hamilton-Mason Road, Rii staff used GPR.PAVE in a three-step process:

**Step 1:** Use of current and projected future traffic data to determine the future ESAL per year on the existing pavement

**Step 2:** Use of the layer coefficient for the existing asphalt pavement [ai (adjusted)] and the thickness of the existing pavement layers - as determined from the GPR measurements - to determine the In-Situ SN of the existing pavement (as noted, the In-Situ SN ranged from 4.5 to 5.0)

**Step 3:** Use the In-Situ SN to calculate the total number of ESAL the pavement will service using either AASHTO or ODOT method of pavement design. Divide this ESAL number by the yearly ESAL calculated in Step 1 to determine the remaining life of the pavement.

**Hamilton-Mason Road Rehabilitation Results**

After implementing these various traditional and non-traditional processes, Rii presented two alternatives in the project report. Alternative No.1 was a strategy wherein the entire pavement section would be reconstructed for a design life of 20 years. However, Rii staff was able to develop a second, more economical alternative using the results from GPR. This alternative also utilized a 20-year design life. The rehabilitation strategy called for a 7-to-9-inch-thick overlay and full-depth pavement repair in those sections identified by GPR. The cost analyses of these two alternatives indicated that Alternative No.1 would cost $1,319,276 and Alternative No.2 would cost $675,921. Rii concluded that the use of GPR data, which avoided unnecessary reconstruction of salvageable asphalt pavement sections, saved approximately $600,000 (49 percent) with Alternative No.2.
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SEGREGATION: CAUSES & CURES, PART 2

(Editor’s note: This is an update of the second part of a three-part series of articles that originally appeared in the winter, spring and summer 2005 issues of Ohio Asphalt. Eradicating segregation is a primary goal of Ohio’s asphalt pavement industry. It is for this purpose “Segregation: Causes & Cures” is being reprinted. In this second part, Jim Scherocman continues his discussion of preventing the most prevalent problem of truckload-to-truckload type segregation. Specifically, the unloading of the haul truck and the operation of the paver will be presented. The winter, spring and summer 2005 issues of Ohio Asphalt, in which this series originally appeared, are archived for viewing at www.flexiblepavements.org/ohio_mag.cfm.)

INTRODUCTION

Segregation in a Hot Mix Asphalt (HMA) mixture can be defined as the separation of the coarse aggregate particles in the mix from the rest of the mix. The segregation can take one of three forms — random, side to side or longitudinal, and truckload to truckload. Each type of segregation is caused by a different problem(s). Each type of segregation, however, affects the long-term durability of the asphalt concrete pavement structure.

Segregated areas in the surface of the pavement have a rougher texture than the surrounding pavement area. In addition, the density of the mix is much lower in the segregated locations compared to the density of the HMA mix in non-segregated areas. Pavement deterioration of the segregated areas in the form of raveling typically occurs quickly under traffic. With more time and with traffic loading, the raveled areas can increase in both size and depth, with a pothole forming in the pavement surface. With additional time and traffic, it is possible for the raveling to progress completely through the pavement layer.

UNLOADING THE HAUL TRUCK

If the haul truck is loaded properly — using multiple drops of mix into the length of the truck bed with mix against both the front bulkhead and against the rear tailgate — unloading the truck should not create any segregation problems. When the tailgate on the truck is opened, a mass of mix will flow from the truck bed into the paver hopper. As the truck bed is raised, the mix in the truck bed continues to move in a mass. In this case, by loading the truck bed correctly, the largest aggregate particles in the mix will not separate from the rest of the mix. Segregation of the mix will not occur.

If the haul truck is loaded improperly and the large aggregate particles in the mix have rolled both to the tailgate and the front bulkhead on the truck, the segregation problem has already occurred. The problem can be minimized, but probably not completely eliminated, by using a different procedure to unload the haul truck. In this procedure, the tailgate on the truck bed should remain closed and the truck bed should be raised into the air, as seen in Figure 1.

The bed should be raised far enough for the mix to shift in the bed and move toward the tailgate. This process will add more mix on top of the segregated material at the tailgate. After the mix has shifted, the tailgate can be opened. With the bed up in the air and with the additional mix moved against the tailgate, the combined mix will be moved in a mass into the paver hopper. Some or all of the segregated material will be blended into the rest of the mix and the amount of segregation that will occur behind the paver screed will be significantly reduced.

While it is important to unload the haul truck correctly, it is much more important to load the truck bed properly so that the segregation of the mix does not occur in the first place.

Figure 1: Truck bed in the air with the tailgate closed.
Condition of the Paver Hopper between Truckloads of Mix

If one is an optimist, the paver hopper should remain half full between truckloads of mix. If one is a pessimist, the paver hopper can remain half empty between truckloads of mix. In either case, the amount of mix which remains in the hopper of the asphalt paver when the truck bed of a haul truck is empty should be above the bottom of the flow gates at the back of the paver hopper (or above the opening for the slat conveyors at the back of the hopper, if the paver is not equipped with flow gates). Figure 2 shows the correct condition of the paver hopper — half full.

As shown in Figure 3, the paver hopper is essentially empty between truckloads of mix. If segregated material has collected at the tailgate of the haul truck, and the tailgate is opened before the bed is raised into the air and the mix in the truck has shifted back toward the tailgate, the first mix that will be dribbled into the empty hopper will be all of the segregated, large aggregate particles that had collected at the tailgate of the truck. With the hopper empty, the segregated material will be pulled through the paver on the slat conveyors and dumped on the augers in front of the screed. This will result in two segregated mix spots behind the screed when the paver moves forward.

If the paver hopper is half full, and if there is segregated mix at the tailgate of the haul truck, there is an excellent chance that the segregated material will blend into the mass of mix already in the hopper if there indeed is a mass of mix there. The more mix in the hopper, the greater the chance to “lose” a major portion of the segregated material.

Keeping the hopper half full between truckloads of mix can be easily accomplished by stopping the paver quickly once the haul truck bed is emptied — rapid stop. The haul trucks then should be exchanged with the empty truck pulling out of the hopper and the loaded truck backing into the hopper. Ideally, the bed of the new truck should be partially up into the air and the mix should be made to shift against the closed tailgate. (This is a good practice, even if the haul truck has been loaded properly; it increases the efficiency of the truck exchange and speeds up the unloading process). When the newly arrived truck bed is in the proper position, the tailgate on the truck should be opened. The asphalt concrete mix will then be delivered in a mass into the half-full hopper. The paver then returns to its original paver speed quickly — rapid start.

Keeping the hopper half full between truckloads of mix also keeps the head of material — the amount of mix — on the augers in front of the screed constant. This in turn keeps the force on the leading edge of the screed constant, which in turn keeps the angle of attack of the screed constant. This permits the paver to place a smooth mat behind the screed.

If the paver hopper is emptied between truckloads of mix, the segregated mix at the tailgate of the truck will pass directly through the paver hopper and onto the augers. When the paver hopper is empty, the amount of mix on the augers will be significantly reduced. This will reduce the force on the leading edge of the screed and will result in a low spot in the pavement surface. The segregated mix will be deposited on the augers in the low spot in the pavement surface. Truckload-to-truckload segregation will be created — one very rough textured area on each side of the paver centerline — at the location of the slat conveyors on each side of the machine.

Folding the Hopper Wings

Coarse aggregate rolls to the sides of the haul truck bed during the truck-loading process when the HMA material is delivered from the silo at the asphalt plant. When the truck bed is unloaded, these large aggregate particles move down along the sides of the bed and are carried into the sides of the paver hopper — into the wings. These large particles will then collect in the wings until the wings are emptied.

Emptying the wings in the paver is a major contributing factor to the severity of the segregation that will occur behind the paver screed. If the paver hopper is kept half full between truckloads of mix, as recommended above, the mix will be pushed out of the front of the hopper when the wings are raised. Two mounds of mix will be formed in front of the paver. This is shown in Figure 4. This action will directly affect the smoothness of the mat being placed when the paver passes over the top of the two mounds of mix.

Figure 2: Paver hopper half full between truckloads of mix.

Figure 3: Paver hopper empty between truckloads of mix.
In order to empty the mix in the wings without dumping mix out the front of the hopper, it is necessary to essentially empty the paver hopper. This is not a good practice. When the wings are folded, the coarse aggregate particles that have collected in the wings are deposited into the bottom of the empty paver hopper. Segregated mix from the tailgate area on the next haul truck will then be added to the segregated mix from the wings. This combined segregated material will then be pulled through the paver on the slat conveyors and deposited on the empty augers. Segregation on the roadway behind the screed will be the result.

In order to keep the hopper half full at all times, it is recommended that the wings on the paver not be raised or emptied. Two different procedures can be used:

- First, the first mix that flows into the sides of the paver hopper – into the corners of the hopper (into the wings) – at the beginning of the paving process each day can be allowed to remain in the wings all day long. This means that the wings are not raised at any time during the day. The mix that is collected in the corners of the hopper, and remains in the wings all day long, is simply wasted at the end of the day. Depending on the size of the paver, perhaps one to two tons of mix will collect in the wings and be unable to be laid.

- Second, and more economically, the capacity of the two corners of the paver hopper can be reduced by fitting the hopper with two fillets, or cutoff plates. This is shown in Figure 5. With the cutoff plates in place, no mix will be collected in the corners of the paver hopper. It is thus not necessary to raise the wings on the paver to get rid of material that was not collected in the first place. With the cutoff plates in place,
the paver hopper can be maintained half full at all times. This will greatly reduce any segregation that might occur. The cutoff plates can be bolted into the sides of the hopper and can be easily removed when necessary.

**Summary of Truckload-to-Truckload Segregation**

Truckload-to-truckload segregation is caused by the manner in which the haul truck is loaded. If the truck bed is loaded in one drop of mix and a conical pile is formed inside the bed, the largest aggregate particles in the mix will roll downhill and collect at the front, the sides and at the tailgate of the truck bed.

Truckload-to-truckload segregation can be eliminated by simply loading the haul truck correctly. One drop of mix should be deposited from the surge silo as close to the front bulkhead on the truck bed as possible. The truck driver should then pull the haul truck forward and the next drop of mix deposited as close to the tailgate on the truck bed as possible. The truck should then be backed up and additional drops of mix placed between the first and second amounts of mix. By loading the truck using the proper multiple-drop procedure, the distance that the coarse aggregate particles in the mix can roll will be greatly reduced and segregation of the mix will be prevented.

In addition to loading the haul truck correctly, keeping the paver hopper half full between truckloads of mix, practicing rapid stop and rapid start paver operations and using fillets or cutoff plates in the corners of the paver hopper— to eliminate the need to raise or fold the wings— will be very beneficial in reducing any amount of segregation that may have occurred during the truck-loading process.

“Segregation: Causes & Cures,” Part 3, which originally appeared in the Summer 2005 issue of Ohio Asphalt discussed two other types of segregation, random and side-to-side. These types of segregation are less commonly seen than truckload-to-truckload segregation, but can be equally damaging to pavement performance when they occur. This original article is archived for viewing at www.securewebexchange.com/flexiblepavements.org/admin/assets/newsletters/newsletter_44.pdf.

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Eliminating Delamination in Asphalt Overlays

Louisiana Researchers Evaluate the Importance of Tack Coat

BY SKIP PAUL, P.E.
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One of the most avoidable causes of cracking and potholing in surface pavements is the type of delamination that occurs when the surface lift separates from the pavement structure below it due to insufficient bonding between the layers. Delamination is characterized by crescent-shaped cracks resulting from horizontal forces induced by traffic load. It is most commonly found in pavements subject to the stresses of stop and go traffic, or where vehicles turn frequently. This form of delamination can be prevented with a strong tack coat treatment prior to the placing of the surface course.

The Louisiana Transportation Research Center is breaking new ground in this area with the ongoing study, Optimization of Tack Coat for HMA Placement (National Cooperative Highway Research Program project 9-40). In this work, Louisiana researchers are determining the optimum application methods, equipment type, calibration procedures, application rates and asphalt binder materials for tack coats. They also will recommend revisions to relevant AASHTO methods and practices related to tack coats. Louay Mohammad, Ph.D., Louisiana State University Civil and Environmental Engineering professor and manager of the Engineering Materials Characterization Research Facility at the research center is currently spearheading the project as its principal investigator.

Why Tack Coat?

“A tack coat provides necessary binding between pavement surface layers to make sure they act as a monolithic system to withstand the traffic and environmental loads,” explains Dr. Mohammad. “Strong tack coat binding between pavement layers is critical to transfer radial tensile and shear stresses into the entire pavement structure.”

Mohammad also stresses that an insufficient bond decreases the pavement bearing capacity and may cause slippage. In addition, insufficient bonding may cause tensile stresses to be concentrated at the bottom of the wearing course. Such concentrated stresses may accelerate fatigue cracking and lead to total pavement failure.

To evaluate the quality of the bond strength of tack coat materials for this NCHRP research, a new test device named the Louisiana Tack Coat Quality Tester has been developed. Researchers evaluated three emulsions (CRS-1, SS-1h, and trackless) as well as PG 64-22 asphalt cement on an existing pavement surface with the Quality Tester. They found that each tack coat material developed its maximum tensile strength at a different temperature, and that each product’s softening point had a strong relationship to the temperature at which it exhibits its maximum tensile strength. They concluded that they can conduct the tack coat pull-off test in the field at the softening point.

The research team also developed a direct shear device, known as the Louisiana Interlayer Shear Strength Tester to measure the interface shear strength of cylindrical specimens. The device is designed to fit into any universal testing machine. It has a nearly frictionless linear bearing to maintain vertical travel and can accommodate sensors that measure vertical and horizontal displacements. The Shear Strength Tester can

Trackless Tack Specified in Ohio

“Trackless Tack,” HTSS-IHM, as produced by Blacklidge Emulsions Inc., has been demonstrated and proven on several projects in Ohio. (See the Ohio Asphalt article in the Fall 2007 issue at www.flexiblepavements.org/admin/assets/newsletters/newsletter_56.pdf.)

Recent NCHRP research (see the accompanying article in this issue) has verified the superior bond produced by this product.

Now the Ohio Department of Transportation (ODOT) has received concurrence from the Federal Highway Administration to specify Trackless Tack as a proprietary product. ODOT will be using a plan note to call for Trackless Tack on selected projects where its performance is desired.
also apply a constant normal load up to 689 kPa and it accommodates specimens with 100-mm or 150-mm diameters. Researchers used the device to evaluate the interface shear strength of emulsified tack coats under a wide range of testing conditions commonly encountered in field applications. Three types of emulsified tack coats (CRS-1, SS-1h, and trackless) were considered at three application rates, 0.14/m², 0.28/m², and 0.70 l/m². In addition, a “no tack coat” condition was included in the analysis. The effects of construction conditions such as wet (rainfall) and dusty conditions were also evaluated. Laboratory direct shear tests were performed at 25°C. To simulate these test conditions, cores were extracted from a full-scale test site at the Center’s Pavement Research Facility. This test site was designed and constructed using conventional tack coat application and paving equipment over an existing asphalt pavement surface.

A preliminary analysis of the results showed that the trackless tack coat produced the highest shear strength at the three application rates, while SS-1 and CRS-1 resulted in the medium and lowest strengths, respectively. The majority of the cases showed a statistically significant difference between clean and dusty conditions. However, no significant difference was found between dry and wet conditions.

**Results on the Roadways**

Dr. Mohammad explains, “It’s worth noting that the test method for the measurement of the interface bond strength using the LISST device developed during this NCHRP project was successfully used in a recent forensic analysis of a distressed pavement.” Louisiana researchers also discovered that low interface shear strengths, less than 40 psi, measured between the wearing and binder course confirmed the potential for future problems.

In summary, to prevent future delamination failures, agencies should ensure the total structural design is sufficient and insist on good tack coat material that must be applied uniformly at sufficient rates to produce minimum shear strength at the interface of the top two layers.

**References**


Harold “Skip” Paul is the director of the Louisiana Transportation Research Center. This National Asphalt Pavement Association copyrighted article originally appeared in the May/June 2010 issue of HMAT magazine.
Asphalt-base pavements continue to provide the best value for many reasons:

- Asphalt-base pavements are the long-lived pavement
- Maintenance of asphalt-base pavements is simple, relatively inexpensive and fast
- Asphalt-base pavements are being shown to be the sustainable pavement
- Asphalt-base pavements are smoother, quieter and look better

Experience in constructing and maintaining the interstate highways in Ohio has shown that asphalt surfaces generally perform best atop asphalt bases. Pavements originally constructed as deep-strength asphalt have been shown to last longer and cost less to maintain than any other combination of materials. In addition, none of them have ever had to be removed and replaced. The surfaces on these deep-strength asphalt base pavements have generally lasted longer and provided a better level of service before needing an overlay than on pavements with concrete bases. After an overlay was eventually placed on these asphalt-base pavements, the overlay has generally been long lasting as well. Asphalt-base pavements are the real long-lived pavement.

This kind of replacement has never been necessary for a deep-strength asphalt pavement on Ohio’s interstate system. What this means to the owner of an asphalt-base pavement is that it is easy to project the future maintenance costs, just plan on resurfacing periodically — depending on how much traffic the pavement carries. Conversely, a failed concrete base will eventually require huge replacement costs. Sooner or later, that concrete-base pavement will have to be replaced. No such time bomb is waiting on owners of deep-strength asphalt pavements. So why risk it?

For thick asphalt-base layers, greater than 4 inches, ODOT Item 302, asphalt concrete base, (also known as the big rock base) has proved to be economical, stable and durable. In this time of intense pressure to reduce pavement cost, the use of a deep-strength, asphalt base using ODOT Item 302 is part of the answer.

With recent advances in design and materials technology, asphalt-base pavements can be made very long-lasting, indeed. A perpetual pavement’s asphalt base never fails from fatigue loading. The projects that have won national Perpetual Pavements Awards reflect the outstanding capability of deep-strength asphalt-base pavements to provide long life with low maintenance. For details on the Perpetual Pavements Award projects see: www.asphaltroads.org/perpetual-pavement/award-winners.html.

With an asphalt base and a long-lasting, polymer-modified, renewable surface, it is now feasible to build a pavement that will provide a high
level of serviceability for as long as the pavement is needed.

Asphalt-base pavements have many other attributes that increase their value to the public and its owner agencies.

Maintenance of asphalt-base pavement is simple, relatively inexpensive and fast. Usually a simple mill and fill overlay is all that is required to restore the pavement. Maintenance of traffic requirements are readily accommodated. The work can be done overnight if necessary.

Asphalt pavements are being shown to be the sustainable pavement, as it is a leader in recycling/reuse. Almost all reclaimed asphalt pavement (RAP) is reused in making new asphalt concrete. New technologies, such as Warm Mix Asphalt, are reducing the energy requirements for producing asphalt concrete and lowering emissions as well. Porous asphalt pavement, as part of a stormwater management best practice, is being used at an increasing frequency to improve stormwater quality and to reduce runoff volume. Asphalt-base pavements are being shown to have a lower carbon footprint and to enable obtaining LEED certification points.

And, asphalt pavements are smoother, quieter and look better, as paint lines are more visible and last longer on asphalt.

The conclusion is clear: For the best value pavement start with an asphalt base.

More Information

For more information on asphalt-base pavements and the life of overlays on asphalt-base pavements visit the Flexible Pavements of Ohio, Federal Highway Administration and ODOT websites:

www.flexiblepavements.org. On the website, view the “Technical Resources/Technical Documents” menu item and click on “Economic Evaluation of Ohio’s Flexible and Rigid Interstate Pavements;” also visit the “Sustainable Pavement” page.


http://www.dot.state.oh.us/Divisions/TransSysDev/Research/reportsandplans/Pages/PavementReportsDetail.aspx#14783 Research project report,

(1) SJN 14783, Evaluation of Variation in Pavement performance between Districts, University of Toledo, Dr. E. Chou, et. al., 2004.
Converting to Warm-Mix Asphalt

Warm-mix technologies allow for production and placement of asphalt pavement material at lower temperatures than conventional hot-mix technologies. Conventional asphalt pavement material is produced at temperatures ranging from 280°F down to 212°F. The potential for warm mix has won broad support among road managers and contractors. In the years following the first public demonstration of warm mix in the U.S. in 2004, scores of warm mix projects have been constructed in 40 states. Warm mix was originally explored for its environmental benefits, which include reduced fossil fuel consumption and reduced emissions, including greenhouse gas emissions. Contractors and agencies have also discovered numerous construction and performance benefits, including the potential to extend the paving season in northern climates, the potential to store pavement mix for longer periods, a longer window of opportunity for compacting pavement, and increases in recycling rates.

Running warm mix can reduce energy consumption during the manufacturing of the asphalt pavement mixture by an average of 20 percent, which decreases total lifecycle greenhouse gas emissions by 5 percent. In terms of greenhouse gas emissions, this equates to cutting 1 million tons of asphalt production annually. Combining warm mix with reuse/recycling yields even greater benefits. Warm mix with 25 percent reclaimed asphalt pavement could potentially offset asphalt pavement lifecycle greenhouse gas emissions by 15 to 20 percent. The potential for total savings in greenhouse gas emissions using both warm mix and recycling is about 3 million tons per year.

NAPA, FHWA, AASHTO and researchers created a Technical Working Group whose purpose is to evaluate warm-mix technology performance, quantify environmental benefits, develop performance specifications, provide technical guidance and disseminate information. The partnering approach has been of immense support to efforts to deploy warm mix. So far, implementation has proceeded with virtually no complications. Demonstration projects, trials and test projects have included the full variety of asphalt mixture types. At least 10 states have adopted permissive specifications, clearing the way for contractors to produce and place the mix at low temperature as long as it meets all other criteria.

Experience with applied research and technology development suggests that warm mix may make it possible to increase the rates of reuse/recycling even more. Applied research on this topic will be helpful in speeding the rate of acceptance of combining the two technologies.

Another opportunity for applied research is full documentation of emission reductions, with specific focus on greenhouse gas emissions. Such research would also assist agencies in taking full advantage of warm mix to meet air quality guidelines.

Doubling the Use of Reclaimed Materials in Asphalt Pavements

The use of reclaimed asphalt pavement (RAP) has been widespread for about 30 years. Asphalt pavement is America’s most recycled material.
Every year, more than 100 million tons of asphalt pavement material is reclaimed and virtually all of it is reused or recycled into new pavements. Materials from other industries, including roofing shingles and ground rubber from used tires, can also be beneficially incorporated into asphalt pavements. The key to this is sound engineering, design and technology.

Increased use of RAP as a percentage of the total asphalt mix can significantly reduce greenhouse gas emissions by eliminating the significant fuel consumption required to acquire and process raw materials for virgin mix. Currently, RAP makes up 12 percent of the average asphalt mix by volume, with the remainder comprised of virgin aggregate and asphalt cement.

Contributing to this average are states that routinely use 30 percent RAP and states that permit minimal use. If we increase RAP usage to 25 percent of the average mix, we will reduce total lifecycle greenhouse gas emissions by 10 percent, which equates to 2 million tons offset annually.

One of the unique qualities of asphalt cement is that it is rejuvenated when RAP is incorporated into new pavement, becoming an integral part of the binder. This is referred to as the highest and best use.

In view of the high reuse/recycling rate in lead states, including a preponderance of evidence that the quality of asphalt pavements incorporating RAP is equal to or better than pavements using all virgin materials, there is ample opportunity to double the quantity of RAP used within five years.

Part of the challenge is to encourage agencies in rural areas to allow milling on pavements prior to the placement of asphalt overlays. This will provide more material for recycling in areas where RAP is scarce, and it will improve the performance of the rehabilitated pavement by removing distresses from the existing surface.

FHWA has organized the RAP Expert Task Group (ETG), which brings together stakeholders from government, industry and academia to investigate obstacles to increasing RAP use. As part of this mission, ETG has identified states with particularly high and particularly low levels of reuse/recycling. The ETG is also charged with achieving the desired increases through technology transfer/accelerated deployment strategies, and eliminating artificial and arbitrary barriers to increased recycling in favor of performance-based pavement criteria.

There are also opportunities for applied research, including quantifying the environmental benefits of increased RAP use, developing technologies and procedures to better preserve the aggregate gradation in RAP, and improving performance testing methods and specifications for use of RAP and roofing shingle mixtures. All these activities would contribute to increasing the overall rate of recycling and therefore provide reductions in emissions of greenhouse gases.

**Economic Sustainability**

Reuse/recycling is not only an environmentally sustainable practice, it is an economically sustainable one. NAPA estimates that we have 18 billion tons of asphalt pavement already in place on America’s roads and highways. Because of this ability to reuse and recycle this material indefinitely, our highways are a resource for future generations. Not only are our roads a primary engine of the economy, they have a high residual value as a source of construction materials. As a note, the process of reclaiming and processing these materials has a very low environmental impact.

*If you would like to read the entire report, you can view a digital copy at www.sustainableasphalt.turn-page.com. Reprinted with permission of NAPA.*
Ohio Asphalt Paving Conference Returns to Fawcett Center in February with NCAUPG Annual Meeting

Registration is now open for the Ohio Asphalt Paving Conference (OAPC) to be held February 2 & 3, 2011, at the Fawcett Center on The Ohio State University campus in Columbus. The conference will be held for the first time in collaboration with the regional meeting and conference of the North Central Asphalt User Producer Group (NCAUPG).

Combining the two events will not only provide up to a day and a half of excellent presentations on the latest developments in the hot mix industry, but improves the quality of the individual conferences while making them both available to Ohio industry professionals. You can register for the event online at www.flexiblepavements.org/events.cfm.

The Ohio Department of Transportation is one of 12 state DOTs involved in the NCAUPG, along with industry personnel from northeastern United States, two Canadian Provinces and the Federal Highway Administration. NCAUPG’s goal is to promote uniform and consistent principles for improved pavement performance. This will be the first time its annual meeting and conference has been held in Ohio.

One of the stated goals of FPO is to provide ongoing education and training opportunities for members. In carrying out this goal, FPO has tried to bring national and regional venues to Ohio so our members and customers have access to top-notch speakers and the latest information on HMA without having to travel out of state. Recent examples of this include the World of Asphalt, the Warm Mix Asphalt Demonstration Project and The International Perpetual Pavement Conference. Having this collaboration between NCAUPG and the OAPC is yet another opportunity for us in Ohio to learn the latest in HMA from industry leaders and the specifying community.

In keeping with the tradition of the NCAUPG, the conference will be expanded to two days. However, registration for the joint conference will be set up as either one day or two days. This will accommodate those who do not want to travel overnight, as has been the tradition of the one-day OAPC. One-day registration is $65 and the registration for both days is $105. As in the past, continuing education credits will be provided for all presentations. Topics for the OAPC/NCAUPG conference will address sustainability, quality, safety and other timely issues.

The OAPC operates as a nonprofit conference and remains one of the best values for the money. Joining with the NCAUPG in 2011 will only enhance that value and provide an excellent opportunity for those interested in staying abreast of developments in the asphalt industry.

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More and more cost-conscious subcontractors and suppliers are utilizing lien filing services, rather than conventional law firms, to perfect their preliminary notices and mechanic’s liens. Many of us who practice construction law have not only expressed concern about the quality provided by these firms but also are of the belief that many of these lien filing services were engaged in the unauthorized practice of law. The Ohio Supreme Court has agreed and ruled that preparing a mechanic’s lien or advising on lien rights is only to be done by attorneys licensed in this state.

The Ohio Supreme Court in the case of Ohio State Bar Association v. Lienguard Inc. et al., 2010, Ohio 3827, has determined that Lienguard and out of state attorney Allen R. Popper improperly engaged in the practice of law and are permanently enjoined from preparing, signing, filing and pursuing liens in Ohio. Subcontractors and suppliers who want to protect their lien rights in Ohio are encouraged to only utilize licensed Ohio attorneys to do so.

Don Gregory serves as General Counsel to Flexible Pavements of Ohio and represents the construction industry. He can be reached at dgregory@keglrbrown.com.
WE PURSUE A COMMON GOAL:
THE PERFECT ROAD.