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**On the Cover:**
The partnership of Flexible Pavements of Ohio-member Gerken Paving Inc. and ODOT District 2 on S.R. 199 in Wood County has resulted in this paving job being one of the smoothest on record. Find out the factors leading to this project’s success beginning on page 8.

**Correction:** In the Winter/Spring 2010 issue of Ohio Asphalt, the telephone number for Hank Fedders Jr., PE and the location in the captions were incorrect in the article, “Porous Pavement: ‘A Green Step Forward.’” The correct contact number for Fedders, of KZF Design, is 513.621.6211, and the project’s location is in Fort Wright, Ky. Ohio Asphalt regrets any inconvenience the editing errors may have caused.

Flexible Pavements of Ohio is an association for the development, improvement and advancement of quality asphalt pavement construction.

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Growing up in Northeast Ohio my dad worked for the Ohio Bell Telephone — Ma Bell, she was. Dad worked for Ma Bell for 45 years, starting as a lineman before entering WWII and continued after serving our country as a captain in the U.S. Army. During his many years of service at the telephone company Dad saw multiple advancements. By the end of his career he was in management. His was a noteworthy service marked by dedication.

Being in management had its privileges, and my dad had the privilege of using a company car. I’ll always remember that car. It was a Chevy II, no frills, vinyl seats, olive green in its entirety and donning the Ohio Bell logo on the driver and passenger doors. Another thing I’ll remember was a sign clearly posted in red letters on its dashboard; it read … SAFETY HAS NO QUITTING TIME.

Lately, I’ve been dwelling on that thought, SAFETY HAS NO QUITTING TIME. It is a short but poignant phrase. A company that adheres to it will be marked by a culture wherein safe working practices are promoted and workplace accidents are minimized. Safety has become the No.1 initiative in most companies these days; the reason for it is that safety-minded companies have come to understand that the multi-million dollar iron in the back lot, though of much importance to the companies’ prosperity, is not their most valuable asset; rather, the assets most valuable are the people who make the machines move. Many companies that understand the importance of safety have developed a safety infrastructure that tracks, analyzes and rewards (or penalizes) employees based on their safe work practices — or unsafe practices as the case may be.

Following that example, imagine a company that promotes the mindset of attaining quality construction — such as “QUALITY HAS NO QUITTING TIME.” The result would be that whatever is constructed is done with an eye to ensuring the customer has a successful experience in using the product. It would be a company noted by a culture wherein quality work practices are of premier importance. It would be a company noted for its quality infrastructure that tracks, analyzes and rewards employees for the fruit of their quality practices. It would be known for its innovation and desire to constantly be looking for ways to deliver a higher-quality product. And in this company every person, from the president to the laborer, would be busy about ensuring responsiveness to delivering a project that meets all quality expectations. Sound unimaginable? Well, if a “Safety Culture” can be developed then so too can a “Quality Culture.”

Ohio’s Asphalt Industry is committed to establishing a Quality Culture. Those are not mere words. Our history, as many of you have...
read in our *Legacy Document*, gives evidence to this fact. From the 1970s to present, we and our partners have been on a march toward innovation, quality improvement and bold initiatives. Perpetual Pavement, Smoothseal, Porous Asphalt, Warranty Asphalt, wedge-joint construction, Stone Mastic Asphalt, Superpave, Warm Mix Asphalt, FQCS and so goes the list, are just some of the fruit borne by the asphalt industry’s journey toward a Quality Culture. There is, however, more work to be accomplished.

Within the FPO membership there is heightened awareness that QUALITY HAS NO QUITTING TIME! As such, expectations are being established by company leadership to ensure quality construction. Improving surface texture is a particular focus area. The “S” word (segregation) is one that we are seeking to remove from the industry’s vocabulary. In doing so, we will be improving long-term pavement performance. This will build on earlier success as documented by University of Toledo research on cost effectiveness of thin asphalt overlays. That research showed marked improvement in overlays placed on priority system flexible pavements; due both to improved ODOT design strategies and asphalt mix improvements.

Other initiatives as well are being undertaken to improve asphalt construction quality. An ODOT initiative for this year will be that night paving projects will utilize material transfer devices, and pavement temperature will be measured to ensure uniform temperature, density and texture. On the contractor level, many companies have taken the winter months to hold in-house schools or attend quality assurance training that heighten quality expectations for the 2010 paving season.

As the asphalt industry charts its future course of action, we observe a necessary element in attaining higher quality. Partnership is that element. The industry cannot do it alone. We are needful of partners who will both encourage and remind us — as often as necessary — that we have committed to a higher standard of quality. To you who specify our product and to you who inspect its quality — we welcome your scrutiny. It is our commitment to ensure your success using asphalt. That commitment propels us forward to face the challenge of making our product more long-lasting, more economical, safer, smoother and of greater sustainability. In doing such, we will have demonstrated that as far as the asphalt industry is concerned QUALITY HAS NO QUITTING TIME!
The Ohio Department of Transportation (ODOT) has removed the restriction on the use of Warm Mix Asphalt (WMA) in its heavy traffic surface courses, Item 442 (Superpave), in the most recent release of Supplemental Specification (SS) 800, dated April 16, 2010, Item 442.01. With this change, foamed WMA, per Item 402.09, can now be used in all traffic classes and all pavement courses, including base, intermediate and surface.

The change to the ODOT construction specifications makes WMA a “permissive” material. That means contractors may utilize foamed-WMA at their will, provided the mixing facility equipment meets ODOT requirements. Specifically calling for WMA in plans is no longer necessary. This change facilitates the most competitive opportunity for ODOT projects, as contractors vie for technologies that make them more efficient. Other agencies utilizing the ODOT specifications will also benefit from WMA’s advantages.

State materials specifications do make provision for other WMA processes, though not specifically cited in WMA specifications. The ODOT Construction & Materials Specifications, Section 100 (General Provisions), permit contractors to propose alternatives to the foamed asphalt process. The contractor must have an open contract with ODOT, and the alternative being proposed must result in a cost savings to the project. The proposed WMA process must be reviewed by the Office of Materials Management and have a demonstrable history of successful use.
Development of WMA in Ohio

Warm Mix Asphalt (WMA) is a generic term referring to a host of different technologies that permit the production of asphalt paving mixtures at lower temperatures than formerly required for conventional “hot-mix asphalt.”

Warm mix got its start in Europe in 1995, in answer to environmental and energy concerns. Warm mix got rolling in the United States after a joint industry/government scan tour of European paving practices in 2002. The U.S. delegation observed good results being obtained in Europe using a variety of proprietary additives and processes used to reduce production and placement temperatures. The tour participants identified the need for research to verify the results in the U.S. This interest in evaluating WMA led to demonstration and research projects throughout the U.S.

2006 was the year that WMA truly got started in Ohio, although previous private experimentation with additive technology did occur. That year the Ohio Department of Transportation (ODOT) sponsored a national demonstration project of three WMA additives, with evaluation to be done through a research project with Ohio University. Asphamin, Sasobit and Evotherm were WMA-additive technologies placed on S.R. 541 in Guernsey County. Shelly & Sands Inc., of Zanesville, constructed the project and the performance and environmental potential of WMA were verified. For more information on WMA, visit warmmixasphalt.com or fhwa.dot.gov/pavement/asphalt/wma.cfm.

The big breakthrough in Ohio occurred in the fall of 2007, when the Shelly Company, of Thornville, and ASTEC Industries demonstrated ASTEC’s new foamed-asphalt process (dubbed “Double Barrel Green”) to ODOT officials. The potential for energy and cost savings of a WMA process that did not require an expensive additive caused ODOT to embark on a number of successful trial projects in 2008. As a result, for 2009, foamed WMA became acceptable under ODOT specifications for all but heavy traffic surfaces. In 2010, that changed to permit WMA for pavements of all traffic and mix types.

Today, many plants in Ohio have been retrofitted to produce foamed WMA using a variety of manufacturers systems. Meeker Equipment’s WMA system, ASTEC’s Double Barrel Green, TEREX Warm Mix Asphalt System, Gencor Ultrafoam GX™, Maxam’s AquaBlack, Reliable’s Aquafoam and STANSTEEL ACCU-SHEAR™ are some of the “foamers” being used in Ohio. To view a video of foamed WMA being sampled, visit http://www.stansteel.com/rawfootage.htm.
So began the e-mail that would tell a tale of one of the smoothest paving jobs recorded in the Ohio Department of Transportation’s (ODOT) history – the Smoothsealing of State Route 199. The construction of S.R. 199 in Wood County is one that demonstrates how careful planning and execution results in the highest-quality asphalt construction. The ODOT District 2 and Gerken Paving Inc. partnership that made this outcome possible is one to be emulated.

**Historic SR 199**

S.R. 199 in Wood County, from West Millgrove to U.S. Route 6, has enjoyed previous fame. In 2005, the pavement was awarded the prestigious Master Craftsman Award for 18 years of uninterrupted service. The project continued to perform, and in 2009, after 22 years of continuous service, S.R. 199 was resurfaced.
under ODOT project number 322(2009). The initial construction of S.R. 199 occurred in 1950. Serving originally as U.S. 23, S.R. 199 was constructed as a flexible pavement, comprised of a water-bound macadam base and asphalt intermediate and surface courses. With the pavement structure largely intact, project 322 only called for repairing shoulders and performing minor repairs at various sections; placement of a 1-inch-thick asphalt leveling; and a follow-up 1-inch-thick surface course.

Factors Leading to Success

Planning and executing were the main elements leading to the extraordinary smoothness on S.R. 199. ODOT did the planning and the asphalt contractor handled the execution. Utilizing roadway profile data furnished by the ODOT Infrastructure Management Section, District 2 planners were able to carefully diagnose the roadway condition and develop a strategy that would maximize the project’s opportunity for success. The profile data served to identify areas of the roadway where “fair,” “modest” and “more extensive” treatments were needed, and helped to identify materials and quantities to address surface irregularity. Of significant help were transverse profiles that pinpointed high-stress locations at intersections and quantified rutting conditions. The pavement surface chosen for use was Smoothseal, ODOT Item 424, Type B, Fine Graded Polymer Asphalt Concrete. Almost 8,100 tons of it would be placed.

Low bidder on the project was Gerken Paving Inc. of Napoleon. With plans in hand, Gerken set out to rebuild failed shoulder areas and repair mainline pavement with partial-depth pavement repairs. District 2 had done a good job at identifying repair areas and provided in the plans the quantities and materials necessary to get the job done right. Next was a two-course overlay; the first course consisting of 9,375 tons of a 1-inch-thick Superpave, 9.5 mm mix that was used to pre-level in preparation for the final course of asphalt. Smoothseal, Type B, (Item 424, Type B) was selected as the surface course. District 2 has substantial experience with Smoothseal, having placed the material as far back as 2002, when it first experimented with it as an alternate to microsurfacing on Interstate 75 at Bowling Green, and U.S. 23 leading into Michigan. When asked why Smoothseal was chosen for S.R. 199, the district points to its previous experience with Smoothseal, citing its satisfaction with its very good performance.

Gerken Paving’s execution of the project was near flawless, with resultant IRI (International Roughness Index) numbers averaging 34 in the northbound lane and 32 in the southbound. “That is a terrific smoothness improvement,” remarked Brian Schleppi, ODOT’s chief for profile measuring. He notes that a review of ODOT’s 2007 network data showed the pavement IRI to be in the 3-digit range!

When asked how the company pulled off such a success story, Andrea Lebarr-Weber, Gerken Paving’s project manager said, “Everyone did

![International Roughness Index (IRI)](image)

SR 199, Wood County from W. Millgrove to US 6

<table>
<thead>
<tr>
<th>Smoothness</th>
<th>Northbound SR 199</th>
<th>Southbound SR 199</th>
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<tr>
<td>Fair</td>
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<tr>
<td>Good</td>
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<tr>
<td>Very Good</td>
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When asked how the company pulled off such a success story, Andrea Lebarr-Weber, Gerken Paving’s project manager said, “Everyone did
their part. As for Gerken, the mixing facility, material haulers and paving crew performed their tasks exceptionally well. They followed the basics, nothing special; kept the paver moving, avoided folding the paver hopper wings, and kept a uniform stream of material coming to the paver. ODOT gave us the material we needed to get the job done right. Their diligent planning enabled our success.”

**Just How Important Is Smoothness?**

The Asphalt Pavement Alliance (APA) recently published a paper SMOOTHNESS MATTERS, available at www.AsphaltRoads.org. Research shows that pavement smoothness is a significant determinant of vehicle fuel economy, as the smoother the pavement the lower a vehicle’s fuel consumption. How does this work? Pavement smoothness affects rolling resistance by influencing friction between the tire and the pavement.

The most thorough investigation of this issue was a full-scale field study conducted by the Federal Highway Administration at the WesTrack pavement test track in Nevada. This study indicated that trucks running on slightly smoother pavement could reduce fuel consumption by 4.5 percent. Some experts estimate that it is possible to reduce fuel consumption by as much as 10 percent by rehabilitating the roughest pavements.

Beyond fuel economy, smoothness also impacts pavement maintenance and road-user costs. In 2006, the Virginia Transportation Research Council published the report, “Impact Of A Smoothness Incentive/
Disincentive On Hot-Mix Asphalt Maintenance-Resurfacing Costs," by McGhee and Gillespie (http://www.virginiadot.org/vtrc/main/online_reports/pdf/06-r28.pdf). This research addressed the impact of potential pay adjustments for smoothness on maintenance contract prices for hot-mix asphalt and examined the financial value of the resulting product—presumably smoother pavements. The analysis included maintenance cost savings for the owner/agency, as well as any reduction in delay and operating costs for the motoring public.

The research draws the following conclusions:

“A detailed statistical analysis of 5 years of Virginia’s plant mix resurfacing schedules found no statistically definitive impact on bid price as a result of the Virginia Department of Transportation’s (VDOT) special provision for rideability for asphalt pavements. A similar analysis on a more focused data set, however, did document a lifetime reduction in the International Roughness Index (IRI) of almost 9 in/mi. This reduction in roughness (increase in smoothness) implies an increase in pavement service life, which translates into reduced annual maintenance costs. Although the analysis supports as much as 7 years in additional functional life, an example calculation demonstrates that just a 2-year life extension will supply approximately $1,295 (about 6% of material costs) in owner/agency savings for every lane-mile of highway that is resurfaced under the special provision for rideability. If VDOT continues to employ the special provision with the frequency it has averaged over the past 4 years (1,053 lane-miles per year), using the special provision will save on the order of $1.3 million per year.

“The lifetime decrease in roughness can lead to even more dramatic user-cost savings. One real example provided in the report demonstrates a fuel-cost savings (for trucks alone) of $160,000 over a 10-year period for each lane mile of highway that is resurfaced under the special provision for rideability.”

The moral of the story is: Smoothness does matter. It is the largest factor in fuel economy. Improved smoothness saves pavement maintenance dollars and can lead to user-cost savings. Also noteworthy from the Virginia study is that the incentive-based smoothness specification showed no statistically definitive impact on bid price (increase of decrease) over that of conventional projects, yet pavement smoothness improved.

SR-199 Partnership Leads to Additional Honor

ODOT District 2’s and Gerken Paving’s partnership has indeed led to a successful asphalt paving project. So much so that S.R. 199 was honored yet again; this time at the Flexible Pavements of Ohio’s 48th Annual Meeting, held last February in conjunction with the World of Asphalt. A plaque was presented to Gerken Paving Inc. for achieving the highest quality in asphalt paving as exhibited by superior workmanship and riding quality. An award well deserved.
The concept of Perpetual Pavements was introduced in 2000 by the Asphalt Pavement Alliance (APA). They defined a Perpetual Pavement as an asphalt pavement designed and built to last longer than 50 years without requiring major structural rehabilitation or reconstruction, and needing only periodic surface renewal in response to distresses confined to the top of the pavement. At that time, it was recognized that many well-built, thick asphalt pavements that were categorized as either full-depth or deep-strength pavements had been in service for decades with only minor periodic surface rehabilitation to remove defects and improve ride quality. The advantages of such pavements include:

1. Low life-cycle cost by avoiding deep pavement repairs or reconstruction,
2. Low user delay costs since minor surface rehabilitation of asphalt pavements only require short work windows that can avoid peak traffic hours, and
3. Low environmental impact by reducing the amount of material resources over the pavement’s life and recycling any materials removed from the pavement surface.

Pavement engineers have been producing long-lasting asphalt pavements since the 1960s. Research at institutions such as the University of Washington and the University of California has shown that well-constructed and well-designed flexible pavements can perform for extended periods of time. Many of these pavements in the past 40 years were the products of full-depth or deep-strength asphalt pavement designs, and both have design philosophies that have been shown to provide adequate strength over extended life cycles. It is significant that these pavements have endured an unprecedented amount of traffic growth. For instance, from 1970 to 1998, the FHWA estimates the average daily ton-miles of freight increased by 580 percent, and the average freight loading continues to increase 2.7 percent per year. As the demand on existing pavements in the U.S. increase with probably minimal funding for expansion and rehabilitation, efficient design of new and rehabilitated sections through Perpetual Pavement design will become increasingly important. Congestion on the existing system is at a point that requires pavements that can be maintained with minimal disruption of traffic.

Full-depth pavements are constructed by placing asphalt pavement on modified or unmodified soil or subgrade material. Deep-strength pavements consist of asphalt pavement layers on top of a thin granular base. Both of these design scenarios allow pavement engineers to employ a thinner total pavement section than if a thick granular base were used. By reducing the potential for fatigue cracking and by confining cracking to the upper removable/replaceable layers, many of these pavements have far exceeded their design life of 20 years with minimal rehabilitation; therefore, they are considered to be superior pavements.

Pavements which are either under-designed or poorly constructed exhibit structural distresses, such as fatigue cracking and rutting, before their design life is achieved. The successes seen in the full-depth and deep-strength pavements are the result of designing and constructing pavements that resist these detriments to the pavement’s structure. In recent years, pavement engineers have begun to adopt a methodology of designing pavements to resist bottom-up fatigue
cracking and deep structural rutting, the two most devastating pavement distresses, and through this change in thinking the idea of Perpetual Pavements or long-lasting pavements has evolved.

The approach to the design of Perpetual Pavements requires a different strategy than that which has normally been applied to pavement design in the past. Empirical pavement design must rely on relationships between observations of pavement performance, a scale that represents traffic, some gross indicator of material quality such as a structural coefficient, and the thickness of the layers. For a given level of material quality, the thickness of the pavement increases with increasing traffic.

A somewhat unified approach to designing Perpetual Pavements was adopted by a number of experts based on mechanistic-empirical concepts originally proposed by Professor Carl Monismith in the design of the I-710 freeway in California. The premise to this approach was that pavement distresses with deep structural origins could be avoided if pavement responses such as stresses, strains and deflections could be kept below thresholds where the distresses begin to occur. Thus, an asphalt pavement could be designed for an indefinite structural life by designing for the heaviest vehicles without being overly conservative.

This contrasts to empirical methods that predated the Perpetual Pavement design approach. In those design procedures, greater volumes of heavy vehicles resulted in greater pavement thickness. This was due largely to the way these empirical methods were developed. For instance, the 1993 American Association of State Highway and Transportation Officials (AASHTO) Guide for the Design of Pavement Structures was based on the results of a road test conducted in the late 1950s and early 1960s. In that two-year study, pavements were subjected to 1 million axle load applications, and failures were monitored over time. The heaviest single axle load used at the Road Test (30,000 lb) applied about 8 million equivalent single axle loads (ESAL) (18,000 lb equivalents) to the thickness asphalt section. Since that time, pavement structures have been designed for heavy traffic volumes that exceed the 8 million ESAL level by 25 times, thus forcing pavement designers to extrapolate the road test results far beyond the conditions for which they were developed. The result of this extrapolation was ever-increasing thickness with higher traffic volume, instead of recognizing the pavement thickness at which the heaviest loads could be sustained without additional structure. Thus, the idea of Perpetual Pavements came into existence as much to prevent over-design as to provide a long-life structure.

Since the time of the introduction of Perpetual Pavements in 2000, some of the important milestones have been:

- The Asphalt Pavement Alliance presented 69 Perpetual Pavement awards through February 2010.
- The International Society for Asphalt Pavements dedicated a special session to Perpetual Pavements in 2002.
- Three international conferences have been held on the topic at Auburn University in 2004, and Ohio University in 2006 and 2009.
- The Transportation Research Board held a workshop session on Perpetual Pavements in 2001.
- The Federation of European Highway and Road Laboratories (FEHRL) has undertaken a series of efforts to define long-life pavements.
- Three major national studies on Perpetual Pavements were initiated through the National Cooperative Highway Research Program (NCHRP).
- State studies on Perpetual Pavements have been or are currently being conducted in Kansas, Ohio, Wisconsin, Pennsylvania, Oklahoma, Texas, Michigan, New Mexico, Illinois, Washington and California.
- Perpetual Pavement design workshops have been held in Ohio, Kansas, Oregon, Colorado, Texas, Minnesota, Tennessee, Georgia, Hawaii, Wisconsin, Oklahoma and Indiana.
- The National Center for Asphalt Technology (NCAT) Test Track has pavement test sections designed as Perpetual Pavements which are instrumented to validate the design concepts.
- Two pavement design computer programs specifically for Perpetual Pavements have been developed at Auburn University.
- The concept of the endurance limit has been incorporated in the new AASHTO Mechanistic-Empirical Pavement Design Guide (MEPDG).

As research continues on many different fronts, greater refinements in the design of Perpetual Pavements will improve the structural and economic efficiency. As progress continues to be made, even more state

*continued on page 16*

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**Graph 1:**
- Expenditures per 4-Lane Mile (in $2001)
  - PCCP
  - HMA

*Graph 2:*
- Lane Miles
  - HMA (Lane Miles)
  - PCCP (Lane Miles)

*A study of Interstate Highways in Kansas by Professor Steve Cross showed that over a 40-year period asphalt pavements (HMA) cost less than concrete pavements (PCCP). Perpetual Pavements are economical.*

*A study of Interstate Highways in Washington State by Professor Joe Mahoney showed that asphalt pavements are as old or older than concrete pavements. Asphalt pavements have a track record of long life.*
The Ohio Department of Transportation (ODOT) won its second APA Perpetual Pavement Award in 2004 for a section of southbound State Route 25 in Wood County. This section of S.R. 25 was originally built in 1937 and 1940. Now, after 73 years of service, it's still going strong – with only resurfacing in 1948, 1965, 1983, 1990 and 2003.

Congratulations to ODOT on a pavement that has stood the test of time.

SOME THINGS ACTUALLY GET BETTER WITH AGE – INCLUDING ASPHALT PERPETUAL PAVEMENTS.

The pavement structure lasts indefinitely. Every 18 to 20 years, the surface is milled up and recycled; an overlay is placed during off-peak hours; and road users get a good-as-new highway. There's no need for the entire highway to be removed and replaced from the ground up. Perpetual pavement is a pavement that remains a permanent asset; a pavement that our grandchildren's grandchildren will be able to use; a pavement that's infinitely reclaimable, reusable and renewable.

Think smart.
Decide diligently.
Perpetual pavements make sense.

ASPHALT. AGE 73

The Ohio Department of Transportation (ODOT) won its second APA Perpetual Pavement Award in 2004 for a section of southbound State Route 25 in Wood County. This section of S.R. 25 was originally built in 1937 and 1940. Now, after 73 years of service, it's still going strong – with only resurfacing in 1948, 1965, 1983, 1990 and 2003.

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departments of transportation and local agencies will consider methods to incorporate the concepts of Perpetual Pavement design into their asset management strategies to more wisely spend their infrastructure funds.

Since 2001, the Asphalt Pavement Alliance (APA) has given out more than 56 Perpetual Pavement Awards to agencies who have submitted long-lived pavement sections across the country.

NAPA, through the APA, has developed a new technical document — Perpetual Asphalt Pavements: A Synthesis — which can be found on the APA Web site at www.asphaltroads.org.

“The Evolution of Perpetual Pavements — An Overview,” is a copyrighted article being reprinted with the permission of the National Asphalt Pavement Alliance (NAPA). The article appeared in the May/June 2010 NAPA publication HMAT.

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**Figure 7. Distribution of Perpetual Pavement Awards.**

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Did you know that the leading cause of fatalities for workers in work zones is being run over or backed over?

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Perpetual Pavement in Ohio

Ohio has a long history of asphalt base pavements that have performed as perpetual pavements. Asphalt base pavements built as early as the 1930s are still in service today, having received only resurfacing to maintain the surfaces. Interstate Highway pavements built with asphalt bases have shown exceptional performance and none have had to be reconstructed to this time. More recently, the Ohio Department of Transportation (ODOT) has conducted experiments and research to validate the perpetual pavement design concept.

Early Projects - Perpetual Pavement Awards

A 1978 report (“Early Full Depth Hot-Mix Asphalt Pavement Construction in Ohio,” NAPA, QIP 100) documented the performance of 23 asphalt base pavements constructed during the late 1930s and early 1940s. The report concluded that these asphalt base pavements, after being in service for 36 to 44 years, had performed very well and showed every sign of continuing that performance well into the future. Two of these early asphalt base pavements have received formal recognition with Perpetual Pavement Awards in 2003 and 2004.

Interstate Highway Performance Study

In 1995, Willis Gibboney, PE, former ODOT Flexible Pavement and Interstate Pavement engineer, completed a study (“Flexible and Rigid Pavement Costs On The Ohio Interstate Highway System,” December 1995, Gibboney, Willis B.) comparing the performance of asphalt base and concrete pavements on the Ohio Interstate Highway System. His study concluded that the asphalt base pavements had provided up to 34 years of service without the need for reconstruction or rehabilitation and with moderate maintenance costs compared to the contiguous concrete pavements. That performance continues to this day, showing that most Ohio Interstate Highway asphalt base pavements are performing as perpetual pavements.

Perpetual Pavement Demonstration & Research

In 2005, ODOT opened to traffic an experimental research perpetual pavement on U.S. 30 in Wayne County. The project was designed from the soil up to be a perpetual pavement, using the latest design thinking at the time. Ohio University was retained to evaluate the pavement against the design criteria. The conclusion of this research is that the pavement is meeting all the performance parameters anticipated by the design criteria. General recommendations indicate perpetual pavements can be built wherever there is a need to completely reconstruct an existing pavement or to build a new pavement. It may also be possible to examine existing asphalt pavements around the state, including an examination of their maintenance and repair histories, to determine those that could be designated as perpetual pavements. It is foreseen that some existing asphalt pavements in good condition can be retrofitted to meet the perpetual pavement requirements by adding layers, thereby increasing their expected life. While the response measurements here provide only a hint of long-term performance of the U.S. 30 pavements, they generally appear to be living up to their intent of reduced wear and damage from traffic, which promises an enhanced lifetime.

This research has been thoroughly documented in ODOT research reports and Ohio Asphalt magazine. For more information on perpetual pavements in Ohio, visit http://www.flexiblepavements.org/perpetual_pave.cfm.
SEGREGATION: CAUSES & CURES, Part 1

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: 1) random, 2) side to side or longitudinal and 3) truckload to truckload. Each type of segregation is caused by a different problem or problems. 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.
TRUCKLOAD-TO-TRUCKLOAD SEGREGATION

Truckload-to-truckload type segregation, sometimes incorrectly called “end of load segregation,” is shown in Figure 1. This type of segregation typically occurs as two very rough textured areas in a transverse direction, one on each side of the centerline of the asphalt paver. The size of the segregated area is dependent on the condition of the hopper and augers when the segregated material is deposited into the hopper from the truck. If the paver is stopped, and the augers and hopper nearly empty, the segregated material will move directly through to the pavement surface when paving resumes and the segregated areas will normally be relatively small and concentrated in two slightly oblong shapes, generally no more than five-feet long. This is, of course, poor technique and should be avoided. If the segregated material is added to a hopper that is half full with the amount of mix at the center of the auger shaft, the segregated material will be distributed over a much larger area and the segregated areas will occur at two long, less distinct, longitudinal ovals, up to 15 feet in length.

It is often believed that truckload-to-truckload type segregation has a variety of causes. Most of those incorrect beliefs are related to the production of the HMA mix at the asphalt plant. Segregation of the coarse aggregates in the plant stockpiles, improper loading of the cold feed bins with segregated materials, variation of the aggregate feed into the asphalt plant, separation of the coarse aggregate particles from the rest of the aggregate inside the mixing drum, and improper discharge of the mix from the drum onto the slat conveyor are all factors mentioned as possible causes of truckload-to-truckload segregation. In fact, none of these are the cause.

It is also often believed that truckload-to-truckload segregation is related to the operation of the surge silos at the asphalt plant. Transport of mix up the slat conveyor, delivery of the mix at the top of the silo, either directly into the silo or into a hopper or “batcher” at the top of the silo; free fall of the mix into a silo – which is relatively empty; and not keeping mix in the silo above the top of the cone are mentioned as all being additional possible causes of truckload-to-truckload segregation.

Again in fact, none of these are the cause.

It is common sense why none of these potential problem areas are the cause of truckload-to-truckload segregation. In essence, if the largest aggregate particles in the mix separated from the rest of the mix at any of these locations, it would be almost impossible for those particles to collect ONLY at the end of a truckload of mix. It would be virtually impossible for those particles to collect at the end of each truckload on a continuous basis – truckload to truckload to truckload.

Figure 1

Loading the Haul Truck

The primary cause of truckload-to-truckload segregation is the loading of the HMA mix from the silo into the haul truck. Segregation of the mix occurs just as segregation of the aggregate occurs when the material is dropped on top of a conical pile. The largest aggregate particles in the mix roll down the sides of the pile and collect at the bottom of the pile.

Figure 2 shows the loading of an end-dump haul truck from the silo at an asphalt plant. In this case, all of the mix is delivered into the truck bed in one drop. As the mix builds up in the truck bed, the largest aggregate particles in the mix begin to roll downhill. Those particles roll to the front of the bed, the sides of the bed, and to the back of the bed or to the tailgate on the truck. If the drop of mix is deposited into the middle of the length of the truck bed, then an equal amount of coarse aggregate (segregated material) will roll to both the front and
the back of the truck bed. If the mix is deposited more to the front of the truck bed, which is typically the case for weight distribution, more large aggregate particles will roll to the tailgate area on the truck.

Truckload-to-truckload segregation is really a combination of two factors. The first part consists of the segregated material that comes out of one truck last—the large aggregate that collects at the front of the truck bed. The second part consists of the segregated material that comes out of the next truck first—the large aggregate that collects at the tailgate of the truck bed. Since most end-dump trucks tend to be loaded front of center, more of the segregation on a truckload-to-truckload basis comes from the large aggregate particles that collect at the back of the truck bed. Therefore, in most cases, truckload-to-truckload segregation is more “beginning of the next load” compared to the “end of the first load.”

Figure 3 shows large-aggregate particles that have rolled downhill toward the front of the truck bed and collected at that point. Figure 4 illustrates large-aggregate particles that have rolled downhill toward the tailgate of the truck bed and have collected at the back of the truck. When the segregated material, which comes out of one truck last (at the front bulkhead in the truck), is added to the segregated material that comes out of the next truck first (at the rear tailgate of the truck), truckload-to-truckload segregation occurs.

In order to completely eliminate the truckload-to-truckload segregation problem, it is necessary to load the end-dump truck correctly. This means that a normal tandem or tri-axle truck needs to be loaded with three drops of mix instead of one. The first drop of mix, as shown in Figure 5, is immediately next to the front bulkhead of the truck bed—as far forward as reasonably possible. This process will reduce the distance that the coarse aggregate particles can roll to the front of the truck bed and thus significantly reduce the amount of segregation that will occur during the loading operation. Then it is necessary for the truck driver to pull the truck forward so that the second drop of mix can be deposited into the truck bed adjacent to the tailgate on the truck (see Figure 6). This process will reduce the distance that the coarse aggregate particles can roll to the back tailgate and also significantly reduce the amount of segregation that will occur during the loading operation. The truck driver then needs to move the truck backwards so that the third drop of mix can be made into the center of the length of the truck bed, between the first and second drops of mix, as illustrated in Figure 7. Properly loaded, the haul truck will have mix more than halfway up the height of the tailgate, as shown in Figure 8. The 3-drop loading procedure is illustrated in Figure 9.

If a semi-truck trailer is used to haul the mix to the paver, multiple drops of mix should also be deposited into the length of the truck bed. The first drop of mix should be made as close to the front bulkhead of the bed as possible to reduce the distance that the coarse aggregate can roll. The second drop of mix should be made as close to the tailgate on the truck bed as possible, also to reduce the distance that the coarse aggregate can roll. The remaining weight of the mix should be split, probably into three additional equal portions, and placed throughout the center portion of the length of the truck bed. The

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The key to eliminating the truckload-to-truckload segregation problem is to keep the first portion of the mix delivered from the truck bed into the paver hopper from being segregated, and to also keep the last portion of the mix delivered from the truck bed into the paver hopper from being segregated.

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

Truckload-to-truckload segregation is caused by the manner that 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 of the bed, on the sides of the bed and at the tailgate on the truck bed.

Truckload-to-truckload segregation can be eliminated by merely 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.
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 will be greatly reduced and segregation of the mix will be prevented.

“Segregation: Causes and Cures,” Part 2 in the next issue of Ohio Asphalt will discuss the other operational issues that can affect truckload-to-truckload segregation, including the unloading of the haul trucks and the operation of the paver.

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