

OHIO ASPHALT

THE JOURNAL OF OHIO'S ASPHALT PROFESSIONALS

ISSUE 1 • VOLUME 10

SPRING 2013

**Sheldon G. Hayes Award
for Highest Quality in Asphalt Paving**
National Asphalt Pavement Association

THE SHELLY CO.
WINS NAPA'S
PRESTIGIOUS
SHELDON G.
HAYES AWARD
Page 10

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

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THE PRESIDENT'S PAGE



CLIFFORD URSICH, P.E.
PRESIDENT & EXECUTIVE DIRECTOR

“I advance the proposition that the asphalt industry’s future viability hinges on it being relevant. Now, I admit that that doesn’t sound very profound or have much pizzazz to it; that’s OK as long as it is true. Relevance in the market is critically important. Even the highest-quality product cannot sell if it is not relevant.”

Welcome to the Next 50 Years of Delivering Ohio’s Best Pavement Value

With the close of the OHIO ASPHALT EXPO came the close of Flexible Pavements of Ohio’s golden anniversary and the beginning of another 50 years of aspiring to provide the best pavement value to Ohio’s pavement owners. Celebrating a golden anniversary presents a wonderful opportunity to review accomplishments, learn from failures and plan for the future. At the EXPO, I was challenged to make remarks about the future of Ohio’s asphalt industry. If I have learned anything in this business it’s that change is the only constant. That being said, the change we are experiencing in transportation bodes well for asphalt’s future in the Buckeye State.

If we were to step back in history 50 years, what would the asphalt industry look like? It would be a budding industry that is comprised of family owned businesses servicing local markets. Batch plants would be the primary manufacturing method for asphalt-mix production. Twelve-hundred tons placed in a day would be considered highly productive. All mixes were prescribed by the owner and all would be composed of virgin materials. Asphalt jargon was as voluminous as “404,” “402” and “301.” For our readers not familiar with this jargon, these numbers represent formulations for surface-, intermediate- and base-course asphalt mixes. My how things have gotten more complicated; but that level of jargon was sufficient in our world where the asphalt market consisted of light- and medium-duty roads and parking lots. Soon, however, the asphalt industry would grow in strength and knowledge as it faced the stress afforded by the onslaught of an OPEC oil embargo, recycling, adoption of QA specifications, portable plants, EPA regulations, SUPERPAVE, Perpetual Pavement, Warm-Mix

Asphalt and a “Great Recession.” With each of these challenges Ohio’s asphalt industry became more knowledgeable and more capable to meet the growing demands of its customers.

SO WHAT WILL THE NEXT 50 YEARS BRING FOR OHIO’S ASPHALT PAVEMENT INDUSTRY?

I have some ideas. Certainly, no person in the early 1960s would in their wildest imaginings have surveyed the landscape and come to the conclusion that we would experience all that we have these past 50 years. For those in the concrete business back then, seeing all those interstates slated to be built out of portland cement, there may have been the temptation to do as the rich fool found in Scripture, who after building his bigger and better barn counseled himself saying, *“Soul, you have many goods laid up for many years to come; take your ease, eat, drink and be merry.”* Little did he realize he would die that very night. Today, asphalt has taken over much of that market. We do well to remain diligent about our work.

I advance the proposition that the asphalt industry’s future viability hinges on it being relevant. Now, I admit that that doesn’t sound very profound or have much pizzazz to it; that’s OK as long as it is true. Relevance in the market is critically important. Even the highest-quality product cannot sell if it is not relevant. Here’s an absurd example: If you are a manufacturer of the finest quality horse whips for buggies, don’t expect to turn the head of a person who would rather use mechanized transportation. The asphalt industry has prospered because our product has been relevant. It has been the pavement alternative that has provided the greatest value.

It has provided the attributes the public desires — and done so at an affordable price.

Being relevant necessitates we know what the customer wants and our being willing and able to meet that desire. Truly, life would be so much easier if all we had to furnish as an industry, or design as an engineer, or specify as an agency was 404, 402 or 301. Being relevant does not afford us that luxury. Rather, it requires we provide pavements that perform to the very high expectation levels of our customers; and so we continually strive for improvements, new formulations, superior riding attributes, greater economy and sustainability.

The December 2012 issue of *PE*, “The Magazine for Professional Engineers,” gives us a course to chart as we embark upon the next 50 years of delivering Ohio’s best pavement value. In the article, “What’s on the Minds of Young Engineers?” *PE* picks the brains of the 2012 Young Engineer of the Year award recipients to see what matters most to them. Topping the list of issues is SUSTAINABILITY. Here’s how it reads...

“SUSTAINABILITY — This most-common issue was chosen as a key concern by about a third of the YEs (Young Engineers) but mentioned by almost half of them. The prevalence of the topic parallels the growing sustainability mindset in the engineering profession.

*In 2006, NSPE (National Society of Professional Engineers) added a statement to its Code of Ethics noting the professional engineer’s duty to protect the environment by adhering to the principles of sustainable development, defined as “the challenge of meeting human needs for natural resources, industrial products, energy, food, **transportation** (emphasis added), shelter, and effective waste management while conserving and protecting environmental quality and the natural resource base essential for future development.”*

Did you catch that? There is a “growing sustainability mindset;” a mindset that says sustainability should be considered in transportation solutions! For those who have long felt that recycling asphalt back into new pavement was more a “necessary evil” brought on by high oil prices, it’s time to rethink that position. Asphalt pavements and the industry that produces them are vital components of a sustainable community. Asphalt pavements provide a “beneficial use” for materials previously considered waste. Reclaimed asphalt pavement (RAP), post-consumer reclaimed asphalt shingles (PC-RAS), ground tire rubber (GTR), slag, foundry sands and so forth are being diverted from waste streams to raw material streams for asphalt roads and parking lots. Porous asphalt provides a solution to the negative consequences of stormwater runoff, and as for sustainable manufacturing technologies, warm-mix asphalt is cleaner, better utilizes energy and has the potential for longer life pavements.

The day wherein using “green” manufacturing technologies and reclaimed materials in our asphalt mixes will be preferred by pavement owners is upon us. While participating in the Illinois Asphalt Paving Association meeting this March, I learned of terrific initiatives that broaden sustainability in our brand of transportation. In Illinois, recycling has advanced to include a new asphalt mixture composed of more than 90 percent reclaimed materials.

YEs are defining a new age of relevance in transportation. In that new age the value of asphalt will be defined by more than its smoothness, more than the quiet ride, more than a safe conveyance from one point of interest to another, even more than in asphalt’s quality. Asphalt’s value will be defined by its contribution to a sustainable transportation system.



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Flexible Pavements of Ohio has been recognized by the 130th General Assembly of Ohio for its 50 years of service to the asphalt industry and the state.

THE GENERAL ASSEMBLY OF THE STATE OF OHIO



OHIO SENATE

HONORING FLEXIBLE PAVEMENTS OF OHIO FOR EXEMPLARY ACHIEVEMENT

On behalf of the members of the Senate of the 130th General Assembly of Ohio, we are pleased to congratulate Flexible Pavements of Ohio on the memorable occasion of its Fiftieth Anniversary.

This prestigious milestone is a fitting time to pay tribute to Flexible Pavements of Ohio, for it has attained a remarkable record of service to the area. To aid with the production and installation of the highest quality of asphalt pavements, the association offers its members technical, marketing, educational, and legislative support, and its accomplishments are a justifiable source of pride and an outstanding reflection not only on the group itself but also on its members and on the community.


Since its inception, Flexible Pavements of Ohio has enhanced the quality of life in our society, and its generous contributions have earned it the gratitude and respect of many. We are certain that as this worthy organization maintains its dedication to advocacy, it will continue in the tradition of excellence that has long been its hallmark.

Thus, with sincere pleasure, we commend Flexible Pavements of Ohio on its Fiftieth Anniversary and extend best wishes for ongoing success.




Keith Faber
Senator Keith Faber
President of the Ohio Senate

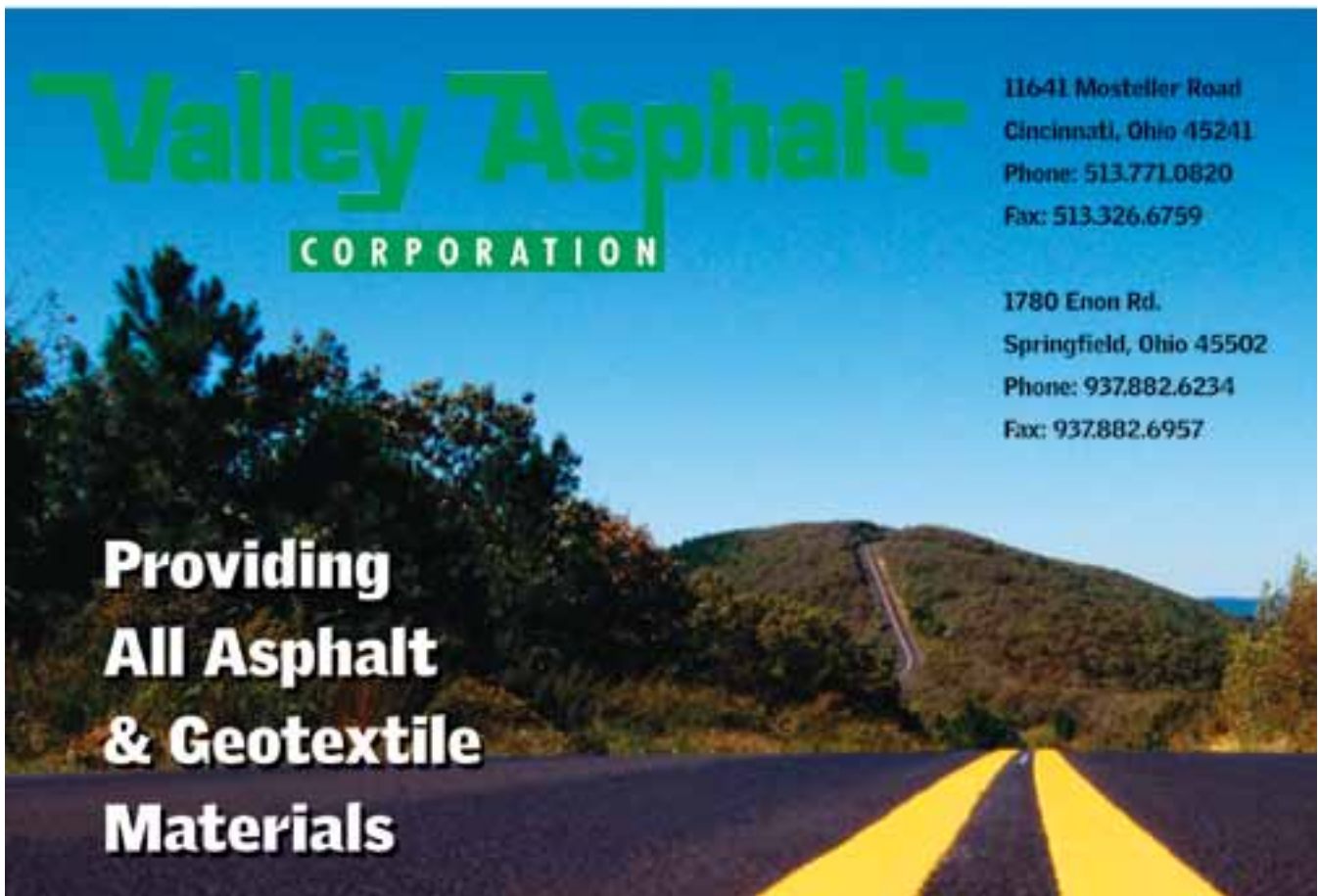
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Shelly Wins NAPA's Prestigious Sheldon G. Hayes Award

Flexible Pavements of Ohio member The Shelly Company was recognized for its commitment to quality by the National Asphalt Pavement Association (NAPA) as the 2012 winner of the Sheldon G. Hayes Award. The award, bestowed annually since 1971, is named for Sheldon G. Hayes, a founder of NAPA and the association's first chairman. Hayes spent his entire career striving for better construction techniques and improvements in the quality of asphalt pavements. The award recognizes the highest quality in asphalt pavement and was presented to Shelly during NAPA's 58th Annual Meeting in mid-February.

Shelly's award-winning project was the milling and overlay of more than 11 miles of Interstate 70, beginning in Licking County near the State Route 158 exit and ending just past the S.R. 256 exit in Franklin County. The pavement on this four-lane interstate through central Ohio was cracked and deteriorating with an average daily traffic load of 62,000 vehicles with trucks being 26 percent of that volume.

Shelly milled 3.25 inches from the existing roadway before placing a 19 mm asphalt base course topped by a 12.5 mm Superpave asphalt surface course. The company reclaimed the existing asphalt from the roadway and incorporated the reclaimed material into all the mixes used on the project, reducing the project's need for virgin aggregate and asphalt binder.

The paving crews worked at night to minimize traffic disruptions, and placed a base coat of asphalt on all milled surfaces before

stopping work each shift to ensure a smoother surface for traffic in the idle work zone. Nighttime paving combined with a project start date in cooler fall weather made the project more challenging for Shelly. However, by using warm-mix asphalt the company was able to achieve proper compaction and smoothness despite less-than-ideal temperatures. "Warm-mix asphalt allowed us a little more time and gave us a little more

The Shelly Co.
Vice President Larry
Shively (left) and ODOT
District 5 Deputy Director
Joe Rutherford accept
the 2012 Sheldon G.
Hayes Award.



The Shelly Company was recognized for its national honor by its peers during the Quality Asphalt Paving Awards Luncheon at the Flexible Pavements of Ohio's 2013 Ohio Asphalt Expo in March.



flexibility, letting us compact the asphalt more easily," said Larry Shively, The Shelly Company's vice president of Quality Control. "There are also some fuel savings associated with warm-mix asphalt and, environmentally it provides better working conditions for our employees.

"The cooperation and communication between our plant and our crews and partnering with the Ohio Department of Transportation (ODOT) helped us make sure that everyone was on the same page and that everybody understood what was going on," Shively said.

Partnering was an essential element in the success of the project, said ODOT's Keith Geiger, P.E., construction engineer in District 5 (Jacksontown). "When we had a small problem with segregation of the mix on the intermediate course, The Shelly Company went through the plans with everyone and made some changes to the mix design. Then we all met out on the site — including The Shelly Company's vice president — to make sure everyone was satisfied," Geiger said. "It was a good team effort; everyone pulled together, and the quality was at a high level."

Working 12-hour days, six and sometimes seven days a week, Shelly completed the project on time and met incentive clauses for both the smoothness of the road and for its density.

"Before this job even started, I had a conversation with Tim Anderson, our operations manager. He was very dedicated to quality and we wanted to make sure that this would be an award-winning job," Shively said. "Mr. Anderson passed away before the job was completed, so the project became very special to us. We went into it with the mindset that it was going to be a good job, and everyone involved made it happen — the crews, the people at the plants and the technicians." Shively dedicated the award to Anderson on behalf of the company during the award ceremony.

The Sheldon G. Hayes Award finalists are determined through a two-year process. Any highway pavement project using more than 50,000 tons of asphalt is eligible for consideration. Initially, the project must win a Quality in Construction (QIC) Award, which is determined by numerical scores calculated by pavement engineers at the National Center for Asphalt Technology (NCAT) based on how the contractor met specifications and achieved density on the finished pavement.

The year after a project wins a QIC Award, it may be considered for the Sheldon G. Hayes Award. The top-ranked projects from the previous year are tested for smoothness, and then visually inspected by an independent pavement consultant. For 2012, the evaluators praised all the contractors considered for high-quality construction practices that resulted in smooth, safe and durable pavements.

In addition to winning a 2011 QIC Award, this project was recognized in Ohio for excellence in asphalt pavement construction as a recipient of one of FPO's 2011 Quality Asphalt Paving Awards.



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2012 NAPA Awards

Six Flexible Pavements of Ohio members were recognized by the National Asphalt Pavement Association (NAPA) in 2012 with Quality in Construction Awards for excellence in paving on 24 projects throughout the state. Included among the NAPA Quality in Construction Awards was the national association's Sheldon G. Hayes Award for Highest Quality in Asphalt Paving, which was awarded to The Shelly Company. Here are the FPO members and the projects that were recognized by NAPA:

Sheldon G. Hayes Award for Highest Quality in Asphalt Paving

The Shelly Co.

- Interstate 70 in Licking and Franklin counties

Quality in Construction Awards

Barrett Paving Materials Inc.

- Fairborn Streetscape, Phase 1 & 2
- South Airfield Rd.
- State Route 380/S.R. 734 (Project # 490(11))

Gerken Paving Inc.

- S.R. 24 (Liberty & Washington townships)

John R. Jurgensen Co.

- I-70 in Clark County (Project # 243(10))

- I-75 in Warren County (Project # 171(09))
- U.S. Route 62/U.S. 68 in Brown County (Project # 583(10))

Kokosing Construction Co. Inc.

- Runway Rehabilitation & Safety Area Grading at Newark-Heath Airport
- U.S. 33 (Project # 1108(09))

The Shelly Co.

- Honda MAP Parking Lot
- U.S. 24 (Project # 8015(09))
- City of Lakewood Resurfacing Program
- Delaware County Resurfacing Program
- Perry County Airport
- Scioto Downs Racino
- S.R. 32 East from I-275 (Project # 508(11))

- S.R. 32 Eastbound from S.R. 104 (Project # 74(12))
- S.R. 32 Westbound from S.R. 104 (Project # 586(11))
- S.R. 104 (Project # 44(12))
- I-76 (Project # 395(11))
- I-271 in Summit County
- The Ohio Turnpike Westbound (Project 39-12-02)

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"Paving and compaction are in our DNA," said Tim Albright, the company's vice president of sales and marketing. "We know what it means when a customer has a paver down. It's an all-hands-on-deck situation. We know we need to do whatever is necessary to get that paver operation up and running."

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The Products

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conditions. Backed by a statewide network of 10 branch locations with experienced paver specialists, the dealership is literally a local phone call away. "Customers can be confident that, no matter where they are working around the state, they have 24/7 access to the best support in the territory," said Bill Nittinger, Dynapac regional manager, of Columbus Equipment Company's support capabilities.

The Results

Apparently, customers are indeed confident. "We know Columbus Equipment will honor and back up the equipment," said George Karvounides of Karvo Paving Company. "Columbus Equipment does a

"Columbus Equipment does a good job of standing behind what they sell. If you call them, they're here and they find a way to get you going again."

Dave Forsythe; Thornville Shop Superintendent, The Shelly Company

Columbus Equipment Company also offers Carlson Paving Products for the commercial-class contractor. Similar to Dynapac, the Tacoma, Washington-based company's products have earned an industry-wide reputation for quality and reliability—defined by multiple variations of its widely-used EZ Screed, and its recently-released, re-buildable CP-90 Commercial Paver. "We run our equipment hard and have had fewer problems with the CP-90 than any other paver we've ever owned," attested Bob Hoge, shop foreman for Akron-based Perrin Asphalt & Concrete Co., Inc.

The People

Coupling manufacturing innovation, expertise, quality and reliability with the experienced support staff of Columbus Equipment Company results is a combination contractors find hard to ignore. Particularly in today's competitive environment, when even the most reliable equipment needs regular servicing to withstand the inevitable wear and tear that comes from handling abrasive materials in harsh operating

good job of standing behind what they sell. If you call them, they're here and they find a way to get you going again," added Dave Forsythe, Thornville shop superintendent at The Shelly Company. For decades, well-respected companies such as Karvo Paving Company and The Shelly Company have entrusted the operational well-being of their equipment to Columbus Equipment Company.

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The construction of more durable longitudinal joints is an area of emphasis for the asphalt paving industry and its customers. Changes in the mid-1990s to coarse-graded mix types to reduce deformation under heavy traffic loadings have been successful in mitigating pavement rutting. However, their use has challenged the industry to become more skillful in longitudinal joint construction. Tight, impermeable joints are necessary for ensuring long-term durability. To achieve this impermeability, a very high level of compaction is needed. This level of compaction is more difficult to achieve at a cold, longitudinal joint than in the center of a mat. This has manifested itself as joints that deteriorate prematurely in comparison to the overall surface. This early joint deterioration must be eliminated to achieve the full life of our asphalt pavement surfaces. The solution requires careful workmanship in placing and compacting the asphalt concrete at the joint. Several studies and articles have been offered to describe the necessary craftsmanship.

FHWA/AI study: In 2012, the Asphalt Institute (AI), working for the Federal Highway Administration (FHWA), completed a study of joint construction practices and published a report, "Best Practices for Constructing and Specifying Longitudinal Joints."¹ Dr. Mark Buncher of AI contributed an article that was published in the summer 2012 issue of *Ohio Asphalt* that summarized the findings of the report. That *Ohio Asphalt* issue and article is archived on the Flexible Pavements of Ohio (FPO) website at: http://www.flexiblepavements.org/sites/www.flexiblepavements.org/files/ohio-asphalt-pdf/oa_summer_2012.pdf. To help disseminate the information, the Ohio Department of Transportation (ODOT) hosted a half-day seminar based on the report on Feb. 21, 2013.

Previous Guidance: The National Asphalt Pavement Association (NAPA) published a manual on the subject in 1997². The National Center for Asphalt Technology (NCAT) has been studying and comparing joint

construction techniques since 1992 and has issued four reports of their findings^{3,4,5,6}. Manuals on hot mix asphalt (HMA) pavement construction^{7,8} contain guidance on placing and compacting cold longitudinal joints. Still, there is a lack of consensus within the industry on a best technique for constructing good-performing longitudinal joints. The NAPA manual states: "a variety of techniques have been successfully used to construct good longitudinal joints." The NCAT research identifies several techniques that produced better results than others within the scope of their review. Still, there is not complete agreement between the various manuals of practice as to a proper or best technique. The industry needs practical guidance on straight-forward methods that can produce good results, consistently and economically.

Theory versus Reality

It is a universally held theory that lack of density (or compaction) is the reason for permeability and subsequent deterioration at longitudinal joints. It is often supposed that the "weak link" is a lack of density at the edge of the mat placed in the first pass of the construction sequence. This edge of the mat is termed "unconfined" since it lacks lateral support that restricts the mat from moving under the weight of compaction equipment. Without lateral support, attaining maximum achievable density is hindered. The unconfined edge of the first pass cannot be compacted to the same potential density as the center of the mat or the confined edge of the matching pass. In theory, the confined edge of the matching mat can be compacted to the same density as the rest of the mat if properly placed and rolled. However, in practice, it is often the matching pass side of the joint that gives the poorest performance. While the first pass will have an acceptable degree of density, if correctly rolled, it is possible to place the matching pass so that the area next to the joint receives little or no compaction. If the paver operator fails to place enough extra thickness of un-compacted material to roll down to full density or if the extra depth of material is pushed away from the joint by use of a rake or lute, the roller will bridge the matching side of the

joint and compaction will not be achieved. It is therefore necessary that an adequate depth of material be placed with the matching pass to ensure enough material for complete compaction without the roller bridging on the cold side or first pass. Having the matching pass end up 1/8th inch higher than the first pass when fully compacted ensures that enough material was placed. Requiring the joint to end up flush invites starving the joint of enough material for full compaction.

To combat this deficiency, many agencies have or are contemplating a density requirement for longitudinal joints, usually about 2 percentage points less than the average required for the mat as a whole. ODOT addresses joint compaction by including density measurements taken at the joint in the calculation for determining payment. The approach taken by ODOT will help ensure that the agency is not paying for poor longitudinal joint construction. How the contractor obtains compaction on these projects is not specified. Which technique to use to build good joint density is still up to the contractor.

So, is there no single method that can consistently produce good-performing longitudinal joints using conventional equipment without a lot of extra work and expense? Yes, there is!

FPO Recommended Technique

First pass: Use a paver that has an end gate that extends all the way to the back of the screed for some confinement of the edge. (All pavers built since December 1997 have this feature as a result of a NAPA committee agreement².) Operate the screed in the vibrating mode. The extra 10 percent initial compaction provided by vibratory mode may be critical. It is certainly more economical than adding additional roller passes to obtain the same density. Operate the paver maintaining a true line in straightaways and smoothly along road curvatures so the mat has an invariable edge that can be properly overlapped with the matching pass. Roll the unsupported edges of the mat as quickly as possible with a double drum vibratory roller, operated in the vibratory mode if the mat thickness permits. Position the roller with the drum roll edges extending about 6 inches over the mat edge. Set the frequency to the maximum setting. Set the speed so as to obtain 10 or more impacts per foot. Set the amplitude as appropriate for the thickness of the mat (thinner layers require lower amplitude or may prohibit vibration). This technique gives the highest level of compaction possible on the unconfined edge and minimizes cracking and shoving of the material at the edge of the mat. Don't try to use a rubber-tired roller on this first pass, as it will cause the unconfined edge to push out.



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Compacting the First Pass



fig.1

Seal the joint face: Sealing the exposed vertical face of the first pass with a heavy coating of binder or sealant can help ensure good bond and help compensate for the lower density inherent in the unsupported edge of the first pass. ODOT Specifications 401.17 require that the entire face of a cold longitudinal joint be sealed with either PG binder 702.01, or rubberized asphalt emulsion 702.13, overlapping the edges of the joint 1/2 inch prior to placing the adjacent mat. Proprietary joint sealants can also be used.

Matching pass: Place the matching pass in a straight line with a consistent overlap onto the first pass of 1 inch to 1 1/2 inches so as to

provide some extra mix to be rolled into the joint. (Note: if the matching pass is placed against a vertical, sawed or milled edge, the amount of overlap must be only about 1/2 inch.) Place the proper depth of un-compacted mat to allow for proper roll-down to optimum density and to end up flush with the first pass (this is usually considered to be 1 1/4 the thickness of the compacted first pass). Don't rake the joint!

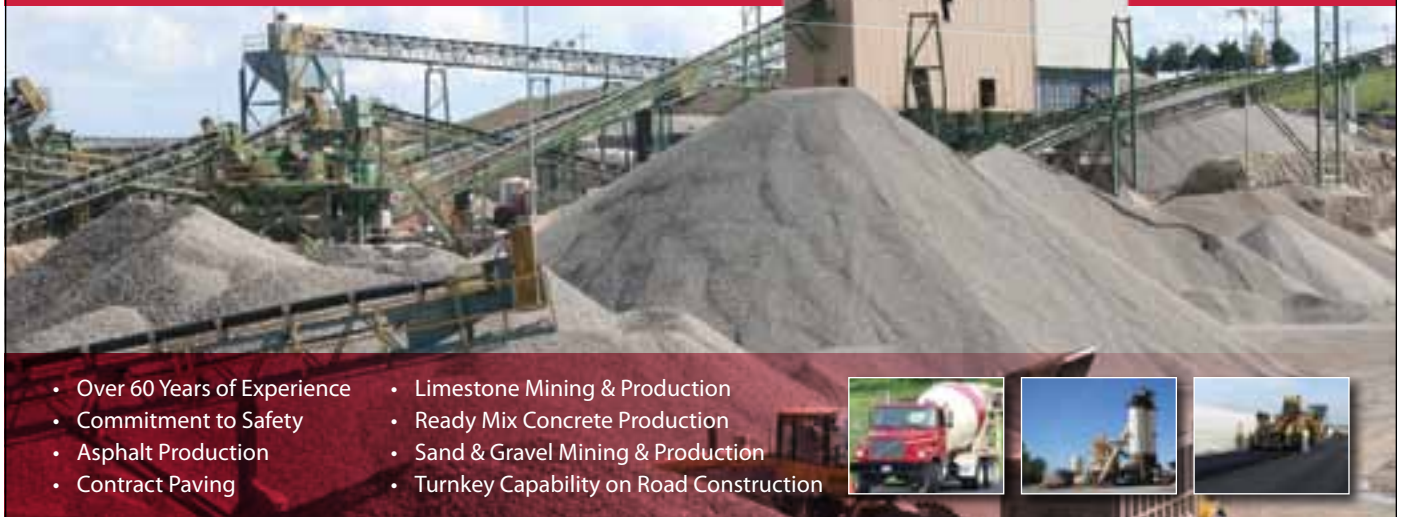
Placing the Matching Pass



Roll from the hot side with the rolls of the vibratory roller hanging about 6 inches over the first pass. Use the same roller settings as previously recommended. Using a rubber-tired roller may be beneficial in getting good joint density. Even if the paver operator fails to get just the right amount of thickness or overlap, the rubber-tired roller may be able to get optimum density at the joint. If a rubber-tired roller is used, place the

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center of the outside tire over the joint. Having the matching pass end up 1/8 inch higher than the first pass when fully compacted ensures that enough material was placed to permit full compaction.

Compacting the Matching Pass



AI Recommended Technique: In its report¹, the Asphalt Institute (AI) recommends a slightly different approach that constitutes a variation of the “pinch joint.” Its recommended technique differs from that described above by making a first roller pass on the matching pass, 6 inches away from the joint on the hot side to move or “pinch” additional material toward the joint. This technique has been successfully used to construct good performing joints.

AI acknowledges that there is not complete agreement on the best joint construction technique. The notched wedge joint has also been successfully used to construct durable joints and is useful as a safety measure where needed.

Summary: Construction of good-performing cold longitudinal joints requires the proper equipment and its careful use by skilled operators. Following the procedures recommended here can consistently produce good-performing joints with a minimum of extra work and cost.

Of course, avoiding cold longitudinal joints is preferred, where feasible, if project and traffic conditions permit. Full-width paving eliminates any

joint concerns. Although echelon paving is costly, requiring multiple pavers and their crews, the hot longitudinal joint it produces can be compacted to the same density as the overall mat. A hot longitudinal joint has none of the inherent weaknesses of a cold longitudinal joint.

Acknowledgement: *Ohio Asphalt* wishes to acknowledge the assistance of James A. Scherocman, P.E., consulting engineer, in the writing of this article. Without his helpful input, review and critique this article would not have been possible.

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PREVENTING & CORRECTING RUTTING IN ASPHALT PAVEMENTS

INTRODUCTION

In recent years changes in the mix types and layer thicknesses used by the Ohio Department of Transportation (ODOT) have greatly reduced rutting on its freeway system. However, during the extremely prolonged heat of the summer of 2012 rutting developed on some heavily traveled roads, especially those that have a pavement build-up consisting of a series of maintenance overlays placed over many years. Some of these older mixes, even though deeper in the pavement structure, are not as rut resistant as newer materials. In addition, rutting is still sometimes observed on other roads and streets, especially at what we call high-stress locations; ramp terminals, intersections, grades, any places where heavy vehicles stop, start, turn or climb steep grades. These types of pavement defects are avoidable, as the asphalt pavement technology exists to prevent or correct such problems.

WHY PAVEMENTS DEFORM

Prevention or correction begins with an understanding of the types and causes of pavement deformation. There are four causes of rutting or as it is sometimes known, channelization:

- Mechanical deformation or displacement of the subgrade beneath the asphalt pavement
- Plastic deformation of the asphalt mixtures near the surface of the pavement
- Consolidation or the continued compaction under the action of traffic
- Surface wear, the actual wearing away of surface particles under the action of traffic

While the specific mode of failure must be determined before selecting a solution, this article focuses on the issue of plastic deformation and will deal with the prevention or correction of plastic deformation failures.

Plastic Deformation is a material failure of the asphalt concrete. The mix is displaced from under the tires and typically humps up outside the wheel tracks. Plastic deformation is typically most prevalent at locations where pavement stresses are high and where the loading is prolonged by stopped or slowly moving traffic, and typically appears during the hottest time of the year. Plastic deformation sometimes appears as shoving or corrugations in the pavement as well as rutting. A cross-section of a pavement exhibiting plastic flow deformation will typically look like Figure 1.

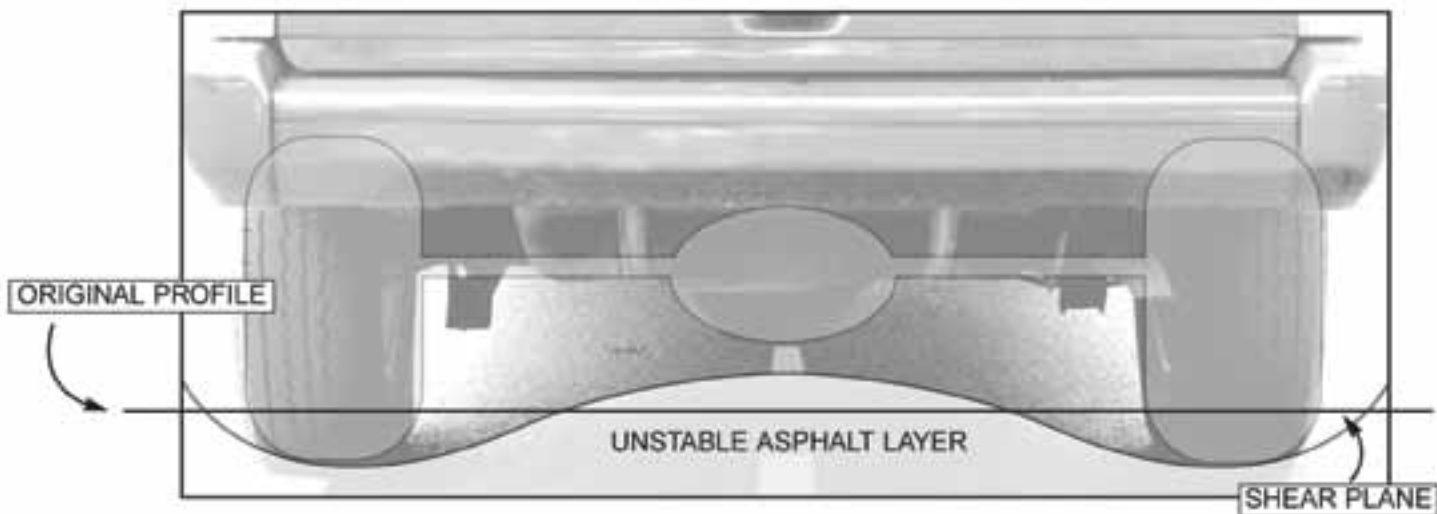


Fig. 1 When Plastic deformation occurs to asphalt concrete the mix is displaced from under the tires and typically humps up outside the wheel tracks.

In the case of plastic deformation, the mix lacks the internal strength to resist permanently deforming under the stress imposed by the loaded vehicle tires. The internal strength of the mix is affected by the internal friction characteristics of the aggregates, especially the fine aggregate and the visco-elastic properties of the asphalt binder. Angular aggregates have the higher internal friction to help resist deformation under load. Stiffer or more elastic binders resist becoming sufficiently viscous at high pavement temperature to enable the pavement to deform under constant or slowly moving loads. In addition the two materials must be combined in the optimum proportions through a rigorous mixture design procedure that ensures the proper air voids are incorporated in the compacted mixture. Excess asphalt content will enable plastic deformation within the mix.

Prevention of plastic deformation depends on specifying mixtures that are properly designed, have an adequately angular aggregate structure and have a grade of asphalt binder that is sufficient to resist flow at the expected high pavement temperatures in the climatic region and the loading conditions, both magnitude of load and speed of loading.

Correction of a plastic deformation condition will usually consist of removing all the deformed asphalt concrete and replacing it with material that is adequately stable to resist the stress and temperature conditions.

DETERMINING THE MODE OF FAILURE

Before attempting to correct these defects it is necessary to conduct a forensic investigation to verify the type of deformation present. This investigation may be as simple as a visual inspection on small and relatively low-cost projects all the way up to an extensive program of sampling and testing. There are several methods that may be used.

The most commonly used method is trenching. In this method parallel, transverse, full-depth sawcuts are made across the pavement, and the intervening material is removed to expose the full cross-section

of the pavement. It is then straightforward to identify the deforming pavement layers and determine the mode of failure. In the case of plastic deformation, it is usually possible to identify which individual pavement layers are deforming. The correction of plastic deformation involves removing all the deformed layers and replacing them with stable mix.

Where trenching is not feasible, it is usually possible to make the same determination from cores. In this method, cores are taken across the rutted lane at the points of maximum rut and at maximum heave and at relatively un-deformed areas for comparison of the layers. The surface of the cores should be referenced in elevation so that the deformation can be accurately plotted. By using the surface elevations of the cores and measuring the visible layers in the cores it is possible to graphically represent the cross-section of the pavement, determine the mode of failure and identify the deforming layers. Figure 2 is an example of cores taken across a severely rutted lane.



Figure 2

An analytical method for determining the mode of failure was developed under the National Cooperative Highway Research Program (NCHRP) project 1-34A¹ by researchers Thomas White and John Haddock at Purdue University. This method uses the numbers from a measured transverse surface profile to calculate coefficients that indicate the mode of failure. This method may be most useful where destructive methods of testing are

not feasible. Details of the analysis method can be found in the Appendix of the reference.

TREATMENTS TO PREVENT OR CORRECT PLASTIC FLOW DEFORMATION

As previously stated, correction of a plastic flow failure involves removing all the deforming pavement layers and replacing them with mix that is designed to withstand the high stresses and high temperatures without deformation. If a forensic investigation has been performed, the affected layers will have been identified through that process. Where such an investigation is not warranted or feasible, the “rule of thumb” is to place 4 inches of stable material. It is generally accepted that most plastic deformation occurs in the top 4 inches of the pavement. However, forensic investigations have occasionally documented deformation occurring

deeper in the pavement. Thus, there is some risk involved in using the “rule of thumb” as it is usually not possible to stop rutting by placing stable material over deforming material. *ODOT’s Pavement Design Manual*² recommends planing the rutted pavement to a depth of 3 inches below the deepest point of the rut.

Rutting in asphalt overlays over concrete pavement presents special concerns. The interface between a thin asphalt overlay and a concrete surface can be a shear plane where stresses concentrate. It is not uncommon for asphalt concrete overlays to shove on the surface of the concrete, exacerbating the problem of rutting. If the forensic investigation does not reveal that at least 2 inches of stable material can remain on the concrete after milling all of the deformed material, then

the recommended treatment in these cases is to mill all the asphalt overlay from the surface of the concrete and to scarify or roughen the concrete surface with the milling machine to provide some mechanical interlock for the surfacing materials. A rubberized tack coat, Item 702.13, or Trackless™ Tack³ is usually used on concrete to improve adhesion.

CHOOSING RUT-RESISTANT MATERIALS

There are several options in ODOT’s specifications for materials that will stand up in high-stress applications. Item 442, Superpave Asphalt Concrete, Type B, 12.5mm is generally adequately stable for high-stress locations on roads and streets having moderate volumes of heavy trucks. By the ODOT specification, these mixes incorporate a polymer-modified binder, performance grade PG 70-22M for the surface course only. For use in high-stress locations, we recommend that the amount of polymer modification be increased by specifying PG 76-22M (per 702.01) for both the surface and intermediate courses. For economy on smaller projects, we suggest placing the same material as both the intermediate and surface course. These mixes can be placed as thin as 1.5 inches; however, on a high-stress application we suggest placing two, 2-inch-thick courses to achieve a 4-inch buildup of rut-resistant mix. On large projects, the intermediate course could be a 442, Type A, 19mm with PG 76-22M binder placed at least 1.75 inches thick for economy.

On new construction, the designer must determine the extent of the pavement to receive a special high-stress treatment. ODOT² recommends

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at least 250 feet back from the stop termini at an intersection. If a number of high-stress locations exist in close proximity, it is probably most economical to treat the entire project area with the more rut-resistant mix.

For roads and streets having high volumes of heavy trucks, tougher material is needed. Item 442, Superpave Asphalt Concrete, Type A uses all crushed aggregates for both the coarse and fine aggregate portions of the mix. These mixes can be expected to have greater stability than the Type B mixes. The binder recommendation is the same, PG 76-22M.

For extreme situations, such as over concrete pavement, it is critical that the concrete has texture to ensure mechanical interlock with the asphalt overlay. This mitigates slipping or tearing of the asphalt pavement when exposed to heavy traffic. To improve texture, cold-milling has successfully been used. A case study in Fostoria was performed in 1993 on the overlap of U.S. Route 23, State Route 12, S.R.18 and S.R. 199. In 2013, this pavement will celebrate 20 years of uninterrupted service⁵. The ultimate mix for such situations is Item 443, Stone Matrix Asphalt Concrete (SMA). Properly designed, SMA can be extremely stable under load, but is challenging to design and produce. Use PG76-22M binder for both the surface and intermediate courses.



Kraton is now marketing a very heavily polymer-modified binder dubbed HiMA⁴. HiMA shows great promise for preventing deformation under high stress and temperature.

These are not the only possibilities for treating high-stress locations. For lighter traffic applications it may be sufficient to modify a standard mix by just upgrading to a polymer-modified binder. ODOT's specification makes this simple by defining two polymer-modified binder grades, PG 70-22M and PG 76-22M. Mixes modified by the use of reclaimed asphalt shingles (RAS) will show improved rutting resistance because the recycled material includes very stiff asphalt and fibers, substantially stiffing the mixture while reducing cost. For very small projects other options include modified-standard mixes that incorporate polyester fibers, SS 826, or Gilsonite, SS 857.

Our rule of thumb recommendation is summarized in table 1:

Table 1: Conventional asphalt pavement course and material treatments for high-stress locations.

Thickness	Material Specification
1 3/4 in. Minimum	Item 442, asphalt concrete intermediate
2 1/4 in. Recommended	course, 19mm, Type A or B, (446), PG 76-22M
1 1/2 in. Minimum	Item 442, asphalt concrete surface course,
1 3/4 in. Recommended	12.5mm, Type A, (446), PG 76-22M

Notes for Table 1: PG and polymer-modified binders per 702.01
All specification references are to the 2013, ODOT, C&MS

SUMMARY

The solutions for preventing rutting deformation in new pavement construction and for correcting existing deformed pavements are readily available. The solution includes ensuring adequate structural capacity of the pavement, determining the mode and extent of the failure or area requiring special treatment, preparing the existing pavement to ensure bond with the asphalt overlay and in specifying appropriately rut-resistant materials for the anticipated loads and climate.

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The Long & Winding Road to Greener Asphalt

By Connie O'Connor, Cincinnati Nature Center

Often we're faced with the difficult task of balancing environmentally friendly choices with other factors, such as cost and practicality. The Cincinnati Nature Center (CNC) has similar decisions to make, and we recently recognized the need to pave the gravel drive leading to the Nature Preschool, along with portions of the Nature PlayScape parking lot. Paved surfaces allow for easier snow removal and maintenance, less dust and mud and less suspension-ruining ruts and potholes.

Concrete and asphalt are the most common and affordable options for paving a road. Semi-permeable or porous pavement is environmentally preferred, because rainfall can penetrate the pavement, drain into stone beds and back into the subsoil, helping to reduce stormwater runoff and erosion, improving water quality and filtering water back into natural aquifers. However, CNC's clay-based soil is not conducive for this choice. Therefore, we chose to keep some areas of the parking lots unpaved to help absorb surface water, paving only where necessary. Then we searched for the answer to the question, "Which is the best environmental choice, concrete or asphalt?"

When you think of green products, asphalt and concrete don't usually come to mind. But every year an estimated 100 million tons of old asphalt pavement is removed, 80 percent of which is recycled while the remaining 20 percent is sent to landfills. Most of the recycled material is used as road base, and the remaining material is used in new mixes.¹ In comparison, only about 50 percent of old concrete gets recycled, mostly as road base.² Asphalt is the most recycled product, surpassing steel, aluminum and plastic combined. Recycling old asphalt pavement instead of landfilling makes sense economically – no landfill disposal fees and less virgin materials to buy. Recycling also saves landfill space and reduces the environmental impact of mining new materials.³ Pavement can also provide a way to reuse other materials, such as old roofing shingles or coal by-products. In Ohio, 10 million tons of coal combustion by-products are generated each year, and about 20 percent of this is reused in concrete and asphalt pavement.⁴ The Ohio Department of Transportation estimates that \$37 million in savings is associated with using recycled materials.

Most asphalt needs to be hot when laid onto a roadway. However, warm mix asphalt is a variation of traditional hot mix asphalt and is 40-50°F lower in



Cincinnati Nature Center thanks the John R. Jurgensen Company and Valley Asphalt Corporation for their generous support and efforts in building the new drive to the Nature Preschool and Nature PlayScape parking lot.

temperature, which can reduce energy consumption by 20 percent and greenhouse emissions by 15 percent. Warm mix production also allows for more recycling options. The number of companies embracing the innovative warm mix option continues to grow as research proves its stability and practicality.

Valley Asphalt in Newtown understood CNC's desire to use the most innovative processes available, including recycled materials and a warm-mix to reduce environmental impact. Their commitment to sustainability is seen on their own property, where they were the first asphalt company to ever achieve LEED certification for their offices.*

According to Dave Patterson from Valley Asphalt, 170 tons of recycled asphalt were incorporated on CNC's newly paved drive and parking lot. That's the equivalent of 11 truckloads of old asphalt that did not get landfilled. In addition, 28 tons of recycled asphalt shingles were incorporated, which is the equivalent of approximately 12 roofs of shingles.

Making a decision to pave an existing gravel driveway or parking lot is one that many individuals and businesses face. Industry innovations such as recycling old pavement instead of landfilling, recycling and remixing material at the work site on large roadway projects, reducing the temperature used to manufacture and lay the mix, and providing the option of semi-porous surfaces all reduce environmental impact. While these innovations are becoming cost-saving industry standards, it's still a good idea to confirm that these techniques are being used by any contractors you select for home or business paving.

* *The Leadership in Energy and Environmental Design (LEED) program is a voluntary third-party verification of green buildings.*

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Connie O'Connor is the director of Education for the Cincinnati Nature Center. This article, which appears in Newsleaf, A Publication for Members of Cincinnati Nature Center (March-April-May 2013, Volume 42, Issue 2) is being reprinted with permission from the Cincinnati Nature Center. For more information on the center, visit www.cincynature.org.



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