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■ In Silicone Joint Sealers for Concrete Construction, learn how silicone joint sealants were used in the construction of a new runway at Andrews Air Force Base on CC.net

■ On TCP.com, read about the slim chance for another infrastructure stimulus.

■ Read how full- and partial-depth repairs and diamond grinding on Provincial Trunk Highway #9 lead to highway restoration on CC.net.

In the May issue of CONCRETE CONSTRUCTION
► 2013 Buyer’s Guide: The industry’s Best Directory of Products and Services

In the May/June issue of THE CONCRETE PRODUCER
► How to Manage a Successful Test Project
► The Latest in Trucks
► World of Concrete Wrap-up

On the cover:
World of Concrete 2013 attendees watch Roller-compacted Concrete Live!
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And the winner is... 

THE 2013 POST-TENSIONING INSTITUTE (PTI) Project Award winners exemplify the advantages of modern post-tensioning applications. The project of the year—Wacker Drive Viaduct Reconstruction, submitted by Alfred Benesch & Co. and T.Y. Lin International—is just one example of the many great projects PTI considered this year. Entered in the bridge category, the project is a remarkable example of urban reconstruction. Wacker Drive’s reopening in December 2012 was the first time both the lower and upper levels have been open fully to the Chicago public since 2010. Post-tensioning was one of the most critical elements in accomplishing the project’s main objective, affording exceptional flexibility in the design of every major infrastructure component. The team was able to accommodate heavy loads, unbalanced spans, and geometric anomalies by adjusting the horizontal layout and vertical drape of the strands, which is not feasible using other systems of construction. For details on all the winners, visit go.hw.net/PTIWinners.
Who Makes America? Terex Bid-Well

Who Makes America? Terex Bid-Well

THIS PAST JANUARY, the I Make America campaign launched a nationwide search for who best captures “making America” through hard work, dedication to community, and devotion to American manufacturing. The employees of Terex Bid-Well, Canton, S.D., were voted the winners of the Who Makes America contest. Nominated for their hard work both in the factory and community, the 47 employees of Terex Bid-Well received more than 350 votes via Facebook and email.

The concrete paving equipment manufacturer has been operating in Canton since 1961, and in 2010, it celebrated the opening of a new 80,000-square-foot, state-of-the-art facility. The facility manufactures a product line that helps maintain and modernize America’s critical transportation infrastructure system. Employees at the facility recently celebrated one year accident free.

In addition to its contributions to American manufacturing, Terex Bid-Well makes time to give back to its community. Recently, the team built a screened-in, three-season porch for residents of the Good Samaritan Home for senior services. When a local Eagle Scout took on the challenge of building a regulation-height basketball court, Terex Bid-Well lent its efforts to make the project a success. And several employees serve as volunteer firefighters, ready to put the needs of the community before their own at a moment’s notice.

ASR Distress

The Federal Highway Administration (FHWA) has released an updated field guide for recognizing and evaluating concrete with apparent alkali-silica reactivity (ASR) distress. Developed under FHWA’s ASR Development and Deployment Program, the “Alkali-Silica Reactivity Field Identification Handbook” is available as a compact spiral-bound guide, or it may downloaded for free from FHWA’s online pavement publications. ASR—moisture-aggravated chemical reaction between particular combinations of cement and aggregates—can considerably shorten the service life of concrete structures if left undetected and untreated. The new handbook is FHWA’s most comprehensive visual ASR guide: Nearly 70 updated photos of symptoms in varied scenarios will help agencies identify ASR as quickly as possible. For more information or to download a free digital version of the handbook, visit go.hw.net/FHWA.
Smooth ride.

Husqvarna’s Optimal Texture for City Streets (OTCS) is a diamond saw cut micro texture similar to conventional grinding, except it has been optimized for city streets and thoroughfares. It creates a more consistent, smooth surface, which improves skid resistance and ride quality, and decreases tire noise on new or existing pavement. It can be applied to roadways with speed limits up to 45 mph and creates a user friendly surface for motorists as well as recreational activities. It is also a more environmentally friendly and economical way to resurface roads since additional machinery and resources are not needed.

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PLANNING MAKES PERFECT

ADVICE FOR PLANNING A ROLLER-COMPACTED CONCRETE TEST STRIP.

BY CHRISTOPHER TULL

Whether it’s football, baseball, or any other sport, isn’t it interesting that the best players seem to be the ones who are willing to continually prepare? For example, you can usually find an all-pro quarterback double- and triple-checking items to make sure everything is good to go before game time.

Good roller-compact concrete (RCC) contractors are the same. No matter how successful they have been in the past, they will install a test strip prior to each project to verify the process. The following information can be learned via the test strip:

- The concrete production and construction techniques will produce the same (within tolerances) results as those of the submitted mix.
- The construction techniques will produce the proper thickness.
- The test strip will determine the amount of roll down.
- The aesthetics of RCC are reviewed to see that the owner’s expectations are met.
- Any issues in the process are worked out before in-place work has begun.

The following steps can assist you in planning for an RCC test strip.

Step 1: Mixture Development

RCC is a unique material. Technically, the science of RCC exists in the overlapping region of soil mechanics and concrete materials.

Proper mix development of RCC is critical to a successful project. This mix must consist of well-graded aggregates. The Portland Cement Association provides a recommended gradation in its guide specification. Many first-time RCC manufacturers will try readily available crush and run materials for the aggregate. While these aggregates can be successfully used, the variability of the crush and run materials is probably too high.
to produce consistent RCC. Your concrete background will be helpful here. Plotting the aggregates on a coarseness factor chart is useful (see Figure 1 on page 15). For larger aggregates, the mix should plot in Zone II. For the small maximum coarse aggregate sizes used in many of today’s mixes, the mix should plot in Zone III.

The concrete and engineering industries want to know what water-cementitious materials ratio to specify. The answer is simple: Do not specify a w/cm. The amount of water required is based on the amount needed for the required compaction. The materials (including the cementitious) are sent to a lab where a modified proctor is performed. This test will identify the optimal water content (a percentage of the total dry weight of all of the materials) that corresponds with the maximum density. Concrete technicians must have the skills to mathematically convert the optimal water content into SSD (saturated surface dry) batch weights for a computerized concrete batch panel or pull weights for manual batching.

Having the correct moisture content (within tolerances) is not only a strength issue — it is a density issue. RCC is delivered in dump trucks so there is no opportunity to correct the water content after batching.

If the moisture content is too far above or below optimal, the mixture will likely have adequate strength, but it will not be physically possible to obtain the required density. RCC pavements without proper density are subject to issues such as surface raveling and freeze-thaw durability.

It will quickly become apparent that a substantial amount of the required water will come from free moisture in the aggregates. A conventional mixture receives about 25% from free water in the aggregates, while the RCC mixture can receive 35% to 40% of its total water from the aggregates.
When the mix design has been finalized and the optimal moisture content has been identified, a trial batch can be mixed and the potential strength of the mixture obtained by molding cylinders according to ASTM C1435, “Molding Roller Compacted Concrete in Cylinder Molds Using a Vibrating Hammer.” Currently, there is no ASTM method for molding RCC beams. Breaking cylinders in split tensile may be useful for determining bending strength.

Mold enough cylinders so that a strength history curve can be plotted. This will be useful when comparing strength gain to tests taken from the test strip.

**Step 2: Procure Equipment**

Plan in advance to pair the equipment with the project. Larger projects may warrant a high production pugmill and a high-density paver. Smaller projects may have the RCC manufactured in ready-mix trucks and placed with a conventional paver. This checklist can assist in making sure you have all of the equipment needed before the pour.

- RCC production facility: Large project (pugmill); Medium project (central mix plant); Small project (dry batch plant)
- Paving machine: High-density paver (thick, high-tolerance pavements) or Conventional paver (thinner, lower tolerance pavements)
- Trucking: Make all deliveries in dump trucks
- Rollers: Large roller for compaction; smaller roller to minimize rolling marks
- Curing equipment: Curing compound and application equipment
- Quality control equipment: Nuclear gage for testing density; Equipment for making ASTM C1435 cylinders (molds, hammer drill, round bit for the drill); Hand-held moisture gage; Drill for taking cores; Laboratory access for specimen testing

**Step 3: Select the Test Strip Location**

The test strip can be incorporated into the work. The test strip should be large enough so that all facets of the job, including fresh joints, can be installed. Most test strips are a minimum of four loads of RCC.

**Step 4: Manufacture RCC**

Batch the RCC for the test strip within tolerance but slightly above the optimal moisture content. This will account for any moisture loss during transportation. Many producers calibrate hand-held moisture meters to assist with providing a mixture at the proper moisture content.

The production facility that will be used for the project should manufacture the RCC for the test strip. Do not install the test strip with RCC made from a local ready-mix plant when a pugmill will be used for the project. If the material supplier is a different company than the installation contractor, the RCC supplier will likely want to mold cylinder specimens in accordance with ASTM C1435 so there is documentation that the mixture was properly batched.

**Step 5: Install the Test Strip**

The paver used for the test strip should be the one to be used for the project. The test strip is the perfect time to make sure the paver is operating properly. Spot check for proper thickness as the paving progresses.

If the project is too wide to place in a single pass, place at least two loads on one pass of the test strip and then back up and proceed with the second pass.

The intersection of the two passes is considered a fresh joint. RCC fresh joints can present a challenge if not correctly constructed. A joint is considered fresh if RCC is placed against previously placed RCC within 60 minutes and the joint remains moist. About 12 inches of the first pass is not rolled. When the adjacent RCC is placed, the 12 inches of unrolled RCC is rolled with the subsequent pass to produce a homogeneous pavement.

The amount of roll down necessary will also be determined during the test strip placement. This is vital information needed for the RCC to be installed at the proper elevation. Often, RCC is used on local streets and roads where it is placed between con-
crete curbs. If it is the finished surface, the RCC pavement elevation must match the curb elevation. If RCC will receive a future asphalt wearing surface, the amount of roll down must be predictable for the thickness of the asphalt surface to be uniform.

Predictable roll down is also important at construction joints. If the roll down is underestimated, a lack of compaction can occur at the joint, leading to future durability issues. If the pavement does not roll down as much as anticipated, there will not be uniform elevation between placements.

Curing is critical. Due to the large areas quickly being placed, the proper equipment must be used to cure the surface before it has a chance to dry out. If a curing compound will be used for curing, the test strip will allow the contractor to dial in the application rate needed to properly cover and cure the pavement's surface.

**Step 6: Quality Control/Assurance**

As previously noted, the strength and durability is not only related to the mix design, but to the density. During the test strip, the density and moisture content is monitored via the nuclear gage calibrated to the modified proctor of the approved mix. Wet density is typically monitored, as the cement's hydrogen ions can provide misleading nuclear density results. Once the wet density and moisture content are known, the dry density and percentage of maximum dry density can be calculated. Monitor further moisture content with a hand-held moisture gage.

As the paving progresses, perform routine density testing directly behind the paver and after each rolling pass. Use this data to develop a targeted rolling pattern. Once the rolling pattern is developed, density testing is used to verify proper compaction throughout the project.

Most specifications require that the in-place strength be verified. This can be done by sawing specimens from the pavement. The test strip is an excellent opportunity to verify that the mixture and construction techniques produced results similar to those determined during the mix development stage. The contractor must understand that the environment the paver operates in will have a substantial impact on the rate of strength gain. Remember, those lab-cured cylinders tested during the mix development phase were cured at 73 degrees F. If the pavement is placed in warmer conditions, the rate of strength gain will be quicker than lab-cured specimens. A colder placement environment will produce a slower rate of strength gain.

During the test strip, the relationship between lab-cured specimens and in-place cored cylinders or sawed beams can be developed. A lab-cured ASTM C1435 cylinder should be made. Nuclear density testing can be performed on the pavement made with the same load of RCC sampled and tested. Cores taken from the pavement can be tested in compression or split tensile. Sawed beam can be tested for flexural strength. By weighing and measuring each core and sawed beam, the density of the in-place pavement can be calculated and compared to the nuclear gage density results. The quality control team can then analyze all of the data to fully understand the in-place strength of the pavement.

The construction team can also implement maturity methods based on forecasted weather. This information will be valuable when the construction team is working long hours to complete a project before cold weather sets in. **CC/TCP**

Christopher Tull, P.E., LEED AP, is founder and owner of CRT Concrete Consulting Inc. Contact him at chris@crtconsulting.com.
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ALL HANDS ON DECK

Virginia turns to overlay paving for deteriorating bridge decks.

BY RICK ZETTLER

About 11.5% of the nation’s nearly 600,000 bridges are rated as structurally deficient. As the average age of America’s bridges pushes beyond 40 years, the status of our bridges looks only to deteriorate further, according to Transportation for America, a campaign that is calling attention to infrastructure. Funding for bridge repair and replacement lags substantially behind levels called for by the Federal Highway Administration to even maintain the status quo.

More than 25%, or about 16,500, of the structurally deficient bridges in the U.S. on record in 2011 can be found in just three states — Pennsylvania, Oklahoma, and Iowa. Pennsylvania leads the way with 26.5% of its bridges being structurally deficient.

The challenge for states is to either find additional funding to make up for the difference in federal dollars, which are becoming increasingly harder to plan for, or develop more economical ways of repairing aging bridges. One cost-effective alternative to complete deck replacement is overlay paving. “Virginia is aggressive with concrete overlays of bridge decks,” says Darrell Carman, construction manager for Infrastructure Corporation of America (ICA), Nashville, Tenn.

From the end of 2012 through the first two months of 2013, ICA has completed five concrete overlay projects in Virginia. The state’s aggressive approach to rehabilitation might be one reason why it is toward the bottom of the list for the number of structurally deficient bridges. Only about 9% of the state’s bridges are deemed structurally deficient.
Silica fume overlay

Offering 15 years of experience in highway and bridge construction and rehabilitation work throughout several southern states, ICA has extensively worked with the Virginia Department of Transportation to advance repair and reconstruction of structurally deficient bridges. ICA served as the design-build contractor for 23 bridge rehabilitation projects throughout DOT Region 3, from late 2009 through late 2012. This was part of the state’s push to repair or replace 119 structurally deficient bridges within a two-year period.

Most recently, ICA’s crews completed a bridge rehabilitation project on State Route 608 crossing the Roanoke River, straddling Pittsylvania and Bedford counties in southeast Virginia. “The bridge measured 513 feet long by 24 feet wide and required a silica fume concrete overlay,” explains Dale Stancill, ICA’s project manager.

For decks similar to the Route 608 Bridge that are candidates for an overlay, ICA starts the process by milling off the top one-half inch of the deck. “This removes from the concrete any remaining salt used by the road crews during winter,” says Carman.

The deck is cleaned and cracks are repaired with either a class B concrete for minor cracking or class C concrete for patches that go all the way through the deck. Crews then shotblast the deck and sandblast the ends, and the deck receives a second cleaning. Water is sprayed over the deck and a plastic covering is put in place. “The water soaks into the old concrete, which helps the overlay bond with the existing concrete,” says Carman.

For this project, and most of their other bridge deck overlay jobs, ICA uses a Terex Bid-Well 2450 automatic roller paver. With its 24-inch truss depth, this paver gives ICA’s crews the ability to pave a range of deck widths from 12 feet to 63 feet. For the Rt. 608 project, the silica fume concrete was placed ahead of the paver at an average depth of 1.5 inches, and the paver’s augers metered the concrete evenly in front of the paving carriage, says Carman.

The water soaks into the old concrete, which helps the overlay bond with the existing concrete,” says Carman.

For this project, and most of their other bridge deck overlay jobs, ICA uses a Terex Bid-Well 2450 automatic roller paver. With its 24-inch truss depth, this paver gives ICA’s crews the ability to pave a range of deck widths from 12 feet to 63 feet. For the Rt. 608 project, the silica fume concrete was placed ahead of the paver at an average depth of 1.5 inches, and the paver’s double flighted augers metered the concrete evenly in front of the paving carriage. Silica fume concrete can achieve very high strength and is extremely durable due to its very low permeability. This allows it to resist freeze-thaw damage and to protect the reinforcing steel from corrosion induced by deicing or marine salts, making it the perfect choice for bridge applications.

Just ahead of the finish rollers, the paver imparts vibration to the concrete. “The system delivers a more uniform concrete surface and desired densities, and it facilitates the sealing of difficult-to-finish concrete due to harsh mix designs, delays, low-slump specifications, and
wind exposure,” says Larry Eben, district manager for Terex Bid-Well. The paver’s two 4-foot-long paving rollers finish the concrete to provide a smooth bridge deck. Following directly behind the rollers, the fully adjustable drag pan helps to seal the concrete, while the burlap drag delivers the specified deck texturing.

The narrow 24-foot-wide bridge was paved in two 12-foot passes so traffic could continue to cross the bridge during paving. To keep the paver’s end from sticking out into traffic, ICA equipped it with the available swing leg design. “The offset legs provide an additional 2 feet of length for variable-width and zero-clearance paving,” says Eben.

**Full depth repair**

When the bridge deck and substructure deteriorate to the point where concrete overlay is not feasible, ICA handles these full deck replacement jobs as well. This was the case for a design-build rehabilitation project that ICA completed last year for the 219-foot-long Rt. 257 Bridge crossing Interstate 81. The six-month project required repairing the substructure, removing the deck, installing overhangs, and full-deck paving of 7.5 inches. The 34-foot-wide structure was paved in two phases, requiring the paver to be set to a 14-foot paving width.

The 4000 psi concrete was pumped in front of the paver at approximately the required thickness. “We set the augers so they were halfway into the concrete,” says Carman. The crews once again used the swing leg to keep the paver’s end out of the traffic flow. “We also positioned one set of paver legs on the barrier rail and one on the concrete.” The crews paved the 14-foot-wide passes within four hours. The paver was heavy enough to pave through the harsh, 3-inch-slump concrete, yet it is light enough to be easily positioned on the deck. Its optional four-wheel travel dolly aids in on-site moving. “The paver is not so heavy that it can’t be moved with a lightweight vehicle rather than requiring a crane,” says Carman.

Crews used the paver’s fogging system to help keep the concrete moist and cool. This atomizes the water to produce a true, light fog, and the independently adjustable nozzles can be positioned to direct the fog to where it’s needed. A carriage fogger riser was used on the paver, which keeps the fogging system above and away from traffic, so crews can fog using a 12-foot section. The fogging system kept the concrete in front of the paver wet for bonding and behind the paver moist for curing.

With ample time to complete the project, ICA used a standard concrete mix design, which stayed wet for seven days and reached full cure in 28 days. Once one side was completed, traffic was moved over to the rehabilitated section and the other side of the deck was removed and paved. At the end of the project, vehicles driving along Rt. 257 in northern Virginia had one less structurally deficient bridge to cross.

Rick Zettler is president of Z-Comm, a marketing communications company specializing in the construction industry. E-mail rzcomm@msn.com. For more, visit www.terex.com/roadbuilding/en/index.htm.
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QUIETER CONCRETE PAVEMENTS
Many variables contribute to tire pavement noise.

BY ROBERT OTTO RASMUSSEN, RICHARD C. SOHANEY, GARY J. FICK, AND E. THOMAS CACKLER

Concrete pavements can be designed and constructed to be as quiet as any other conventional pavement type in use today. This report provides an overview of how this can be done—and done consistently.

 Quieter concrete pavements are built around the world using typical concrete pavement textures, including diamond grinding, drags, longitudinal tining, and even transverse tining. They can be durable and cost-effective to build. Also, the data indicate that quieter concrete pavements do not sacrifice safety. In fact, there is not a direct relationship between friction and noise; quieter surfaces vary in friction just as louder surfaces do.

 One reason why not all concrete pavements are quiet is the lack of a collective understanding about what makes them quiet. To address this need, the National Concrete Pavement Technology Center at Iowa State University has amassed the largest existing database of concrete pavement surface characteristics, including measurements of noise, texture, and friction. Nearly 1,600 test sections from North America and Europe have been evaluated.

 From this, the Concrete Pavement Surface Characteristics Program (CPSCP) has come to understand the fundamental surface properties that increase noise and has developed better practices to avoid them. As part of the evaluation, CPSCP has cataloged both the best and worst of virtually every nominal concrete pavement texture in use today. With so many measurements, distributions have emerged showing what noise characteristics are possible for each nominal texture type. The variability within these distributions is due to differences in design, construction, age, climate, traffic, and many other factors.

 The graph below illustrates the range of tire-pavement noise levels that have been measured to date. The pavements are broken down by nominal texture type and shown as normalized distributions of the noise levels evaluated using OBSI. The pavements measured under the CPSCP tend to be earlier in life since one of the program goals is to link the measurements to construction factors that are generally only available for earlier sections.

 Based on the work conducted to date, an A-weighted tire-pavement noise level of

![Graph showing normal distributions of on-board sound intensity (OBSI) noise levels for conventional concrete pavement textures. Illustration: The Transtec Group Inc.]
VIRTUALLY ALL CONVENTIONAL NOMINAL TEXTURES HAVE THE POTENTIAL TO BE CONSTRUCTED AS QUIETER CONCRETE SURFACES, THOUGH SOME ARE MORE LIKELY TO BE QUIET THAN OTHERS.

between 101–102 dB, measured using OBSI at 60 mph, appears to be a reasonable target threshold for new concrete pavements. With this in mind, and referring to the graph on page 21, the following can be concluded:

• Most conventionally diamond-ground surfaces that were measured met the target threshold.
• About a third of the drag textures measured also met the target threshold.
• About a quarter of the longitudinally tined surfaces measured met the target threshold.
• A small but important fraction of transversely tined surfaces that were measured met the target threshold. For those that met the target, the nominal tine spacings were at or below 1/2 inch.

These data suggest that virtually all conventional nominal textures have the potential to be constructed as quieter concrete surfaces, though some are more likely to be quiet than others.

While selecting the nominal texture might be a logical first step toward achieving a quieter pavement, this was not the sole intent of this study. Instead, the goal was to develop better practices to help owner-agencies and contractors achieve the quietest surface possible within any given nominal texture. This requires the combined experience of both concrete paving contractors and paving equipment manufacturers.

Summary of better practices
To build a quieter concrete pavement, one must:

1. Recognize which properties of a pavement surface make it quiet and which make it loud.
2. Design the pavement surface in such a way as to avoid the adverse properties.
3. Construct the pavement surface to avoid those adverse properties, but also in a way that is both consistent and cost-effective.

The first item has been addressed in large part under the CPSCP and through the results of numerous other studies. The key relationships can serve as a reference for those seeking to better understand the link from the design and construction to the most relevant as-built properties affecting tire-pavement noise.

Better practices to improve surface
properties, and thus tire pavement noise, are really about establishing increased control over texture and other surface properties. It’s important to recognize the impact of subtle operational characteristics on the texture as constructed.

Predictable tire-pavement noise levels depend less on how the texture is imparted than on recognition and management of the sources of variability. Fresh concrete is inherently variable in both stiffness and plasticity. Concrete changes from batch-to-batch, and it changes within a batch. Wind and sun play a major role, as does the timing of the concrete mixing, transport, placement, texturing, and curing.

Visit www.concreteconstruction.net for a sidebar summarizing practices to help reduce noise. Many of these also improve smoothness, durability, and reduce costs.

Controlling concrete pavement surface texture
The methods and practices used today to impart and control surface textures are often ineffective in meeting a nominal texture pattern, much less doing it consistently. Even if timing, dragging, and diamond grinding are all done with the best equipment, other variables will ultimately affect the final texture. Some

Concrete Pavement Surface Properties that Affect Tire- Pavement Noise

Surface texture (bumps and dips)
• Avoid (flatten) texture that repeats itself at intervals of 1 inch or larger.
• Avoid extremely smooth (for example, floated or polished) surfaces; instead, provide some fine texture (on the scale of 1/8 to 1/4 inch).
• Texture should be negatively oriented, meaning that any deep texture should point down (grooves) rather than up (fins).
• Striations or grooves should, if possible, be oriented in the longitudinal direction, rather than the transverse direction.
• If grooves are oriented in the transverse direction, they should be closely spaced and randomized when possible.

Concrete properties
• The mortar (at least, near the surface) should be consistently strong, durable, and wear-resistant. Mix design is a key factor, but so are proper placement techniques, including finishing and especially curing.
• Use siliceous sands whenever possible to improve durability and friction.
• For diamond-ground pavements, the makeup of the concrete is exposed at the surface. Because concrete used in paving consists mostly of coarse aggregate, the nature of this constituent will significantly affect the ability of the surface to retain the texture necessary for both quiet and safety. As with any pavement-related decision, carefully consider friction. With respect to diamond grinding, base the selection of projects and grinding patterns on experience and a careful evaluation of the concrete material, and more specifically, the coarse aggregate type.
• For tined textures, ensure an adequate and consistent depth of mortar near the surface to hold the intended geometry.

Joints
• Joints can contribute not only to overall noise level, but also annoyance.
• Narrow, single-cut joints are preferred over widened (reservoir) cuts.
• Avoid faulted joints by providing adequate load transfer.
• Avoid excess joint sealant, especially if it protrudes above the pavement surface.
• Prevent spalled joints through proper design, materials selection, and construction.
of these variables are listed in the sidebar on page 23.

The photos at the top of page 22 and 23 show how variability in the as-constructed texture can lead to very different tire-pavement noise levels (shown as OBSI measured at 60 mph with the SRTT). These photographs were taken on a CPSCP test site on U.S. Highway 30 in Iowa. In each figure, the texture’s appearance differs between the louder and quieter areas. One or more of the texture characteristics can be observed in the louder sections.

The RoboTex 3-dimensional texture profiler provides texture scans. These depict the subtle curvature of the lands between tire grooves in the louder section, while the tire grooves are much less aggressive in the quieter sections. Note, too, that the texture depth in all cases was very similar; the differences in geometry of the lands was the major contributor to noise, largely due to the land (tine) spacing, which was more than 1 inch in many cases. This as-constructed variability in texture is another example of the impetus for better practices. As better practices are followed, the probability of constructing the nominal texture should increase.

**Conclusions**

For today, the concrete pavement industry can promote better practices. For tomorrow, the solution will likely be automation of the texturing operation. Over the years, slipform concrete paving operations have become more automated. To meet the demands for predictable low-noise surfaces, automation will eventually allow the paver, texture cart, and grinding operators to monitor the texture being produced and make adjustments on the fly. Ultimately, this approach may be the best way to achieve a specified target texture on concrete pavements. For now, we can make significant improvements by adopting better practices.

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Gary J. Fick is president of Trinity Construction Management Services, Inc., Edmond, Okla.

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This article is based on the best paper presented at the International Conference on Concrete Pavements, July 2012.

Visit www.concreteconstruction.net and www.thecementproducer.com for a web-exclusive sidebar that summarizes better practices. It refers to several issues that affect tire pavement noise. Many of these practices will also improve smoothness, durability, and, in some cases, will reduce costs.
Site Prep Equipment

A. Track loaders
The Mustang RT Series Track Loaders includes two new models—the 1750RT and 2100RT. Both offer a proprietary undercarriage that is fully-welded to the loader chassis, offering more integral durability than a bolt-on undercarriage, or an over-the-tire track design. Rollers are manufactured from steel, offering better abrasion resistance and wear characteristics compared to rubber. Hydraulic plumbing to the drive motors is internal to the chassis, offering augmented protection to essential tubes and lines. Mustang. www.mustangmfg.com

B. Roller flattens with force
The Bradco Vibratory Roller attaches to skid-steers and compact loaders to compact soil, sand, gravel, crushed stone, or fill material by delivering 9370 lbs of dynamic force at 20 gpm. Its hydraulic drives are isolated and protected for maximum performance and reliability. It can be equipped with either a smooth or padfoot drum to match your material type. Paladin Attachments. www.paladinattachments.com

C. Compact excavator with extendable arm
The M-Series E55 compact excavator comes with an extendable telescoping arm option for an additional 30 in. of reach when fully extended. When retracted, it delivers similar tear-out force as a standard arm. It’s also the first extendable arm for a compact excavator that allows the use of a hydraulic clamp for picking up and placing materials, such as rocks, landscaping materials, and debris. It’s controlled via a rocker-style thumb switch on the joystick. Bobcat Co. www.bobcat.com

D. Compact size, large excavator features
Five compact CX B Series excavators—CX17B, CX27B, CX31B, CX36B, and CX50B—have zero-tail swing and a center-swing boom that enables operation in tight spaces, while also retaining large excavator features such as an undercarriage with heavy-duty travel motors for excellent speed and traction, and heavy plate guards that prevent damage to the hydraulic lines. They’re equipped with a hydraulically controlled backfill blade for stability and light dozing work. Case Construction Equipment. www.casece.com CC/TCP
Concrete Provides Quick Fix
City selects concrete over asphalt for intersection repair.

After the surface of a busy asphalt intersection in Mississauga, Ontario, Canada, failed, city and public works officials opted for concrete pavement to provide a more permanent solution.

The city fixed the intersection of Courtney Park and Kennedy with asphalt in 2007 and 2010 and intended to repair it with asphalt again in 2012. The asphalt already had up to 100 mm, or 4 inches, of rutting in just two years since the last resurfacing. There were two options:
1. Asphalt: Mill 140 mm, HDBC - 100 mm (two lifts), HL-1 - 40 mm.
2. Concrete: Remove asphalt (225 mm), 32 MPa (4600 psi) Class C-2 concrete.

The solution: Due to the severity of the rutting and the two previous failed asphalt repairs, the City of Mississauga chose the concrete option.

There would be only eight days between identifying the problem and the reconstruction, so a full engineering study could not be conducted. Since the in-place cross section of asphalt was 225 mm, it was easiest to completely remove the asphalt and replace it with concrete. This would assure durability and provide a very conservative design for this fast-tracked project.

Rain was forecast for the night of the concrete pour, so the start time was moved to an earlier time. High early strength, 5000 psi concrete with macro-synthetic fibers was ordered and the first load of concrete arrived at the jobsite at 3 p.m. Placement, finishing, and testing were completed by 6:30 p.m. In addition to standard testing, maturity meters were installed in the concrete to determine when the pavement could be opened to traffic. This testing showed that 2200 psi was attained in less than eight hours and 2900 psi was attained in 14.5 hours.

The paybacks
For such a small section of concrete pavement, the actual and future potential paybacks to the city and the environment were substantial. If concrete was first considered five years earlier, the city would have saved 14 hours of traffic delays at the intersection.

<table>
<thead>
<tr>
<th></th>
<th>Asphalt Estimated Cost</th>
<th>Concrete Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007 asphalt</td>
<td>$12,000</td>
<td>$0</td>
</tr>
<tr>
<td>repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010 asphalt</td>
<td>$2000</td>
<td>$0</td>
</tr>
<tr>
<td>repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012 proposed</td>
<td>$18,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>repair</td>
<td>225 mm concrete</td>
<td></td>
</tr>
<tr>
<td>alternative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$30,000</td>
<td>$30,000</td>
</tr>
</tbody>
</table>

Above: The asphalt turning lane in the intersection of Courtney Park and Kennedy in Mississauga, Ontario, had severe rutting. It was last repaired in 2010.

Right: Officials had eight days to develop a repair. They selected concrete due to the material’s lower life-cycle cost and long-term durability.

PHOTOS: RMCAO
There were also significant potential life-cycle cost savings and reduction in the amount of time the road had to be closed due to frequent asphalt repairs over a 20-year period.

Over the expected 20-plus-year life of concrete, asphalt would have needed to be replaced several times. Due to the conservative design, concrete is expected to last more than 100 years as constructed. Athena Sustainable Materials Institute determined the several environmental impact savings (see chart above).

With the growing trend toward life-cycle cost and environmental impacts being required, this project highlights how concrete pavements can address significant pavement performance issues in a very short time, while also addressing several cost savings and road safety issues in municipal pavement infrastructure. CC/TCP

Submitted by the Ready Mixed Concrete Association of Ontario. For more information, visit www.rmcao.org. To see a video of the project, go to http://go.hw.net/aqadd.

### 20-year Life Cycle Analysis

<table>
<thead>
<tr>
<th>Metric</th>
<th>Asphalt Estimate</th>
<th>Concrete Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$100,000-plus</td>
<td>$32,000</td>
</tr>
<tr>
<td>Lane closure time (hours)</td>
<td>83</td>
<td>18</td>
</tr>
<tr>
<td>Cars off the road</td>
<td>154</td>
<td>9.7</td>
</tr>
</tbody>
</table>

### 20-Year Life Cycle Assessment

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Asphalt Estimate</th>
<th>Concrete Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil fuel consumption (MJ)</td>
<td>4,350,000</td>
<td>431,000</td>
</tr>
<tr>
<td>Weighted resource use (kg)</td>
<td>1,060,000</td>
<td>220,000</td>
</tr>
<tr>
<td>Global warming potential (kg CO2 eq)</td>
<td>787,000</td>
<td>49,500</td>
</tr>
<tr>
<td>Acidification potential (moles of H+ eq)</td>
<td>252,000</td>
<td>10,900</td>
</tr>
<tr>
<td>Respiratory effects potential (kg PM 2.5 eq)</td>
<td>498</td>
<td>34.9</td>
</tr>
<tr>
<td>Eutrophication potential (kg N eq)</td>
<td>20.8</td>
<td>11.4</td>
</tr>
<tr>
<td>Ozone depletion potential (kg CFC-11 eq)</td>
<td>0.000027</td>
<td>0.000148</td>
</tr>
<tr>
<td>Smog potential (kg NOx eq)</td>
<td>4300</td>
<td>183</td>
</tr>
</tbody>
</table>

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CONCRETE’S HARD
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Concrete demolition and repair is hard, noisy, dirty work—especially if you’re still removing concrete with jack hammers. With Jetstream’s X-Series hydro-demolition capabilities, we make the work easier, quieter and cleaner for you and your crew.

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For more information on Jetstream’s X-Series hydro-demolition equipment, call 800.231.8192 or visit waterblast.com today.
Bonded or Not

Q: I have been told that unbonded concrete overlays are the best way to rehabilitate a deteriorated asphalt or concrete pavement. But can’t the overlay be thinner if it’s bonded to the old pavement?

A: Let’s start by explaining the difference between bonded and unbonded concrete overlays, whether placed on an existing concrete or asphalt pavement.

Bonded overlays become part of the underlying existing pavement—they work together. They are 2 to 5 inches thick and are usually applied to strengthen an existing pavement or for preventive maintenance. Bonded overlays cannot be used if the existing pavement is in poor condition.

Unbonded overlays, 4 to 11 inches thick depending on the desired life span and anticipated traffic, are a pavement structure on their own—the existing pavement is only used as a supporting base. This means they are thicker than an unbonded overlay, but are the only choice if the pavement is in less than good condition.

As the name implies, bonded overlays must be bonded to the existing pavement since the load-carrying capacity of the pavement is relying on the strength of the existing pavement. This means good surface preparation is necessary. It also means that the joints (and any cracks) in the overlay must match up exactly with the joints in the existing pavement; otherwise the joint or crack will reflect through the overlay. And since the old pavement and the overlay move as one, the thermal expansion properties of the two materials must match. For these reasons, bonded overlay projects are more challenging; although, since they are thinner, they do use less material.

Unbonded overlays are used whenever the condition of the existing pavement is poor. They are basically a new pavement so the strength of the existing pavement is not relied upon to carry the load. The damage can even include that due to alkali-silica reaction. On existing asphalt pavements, nothing special must be done to prevent bonding since
An unbonded overlay on asphalt can be placed with very little surface preparation. PHOTO: SIX-S CONTRACTING

Concrete is so much stronger it will move independently of the asphalt whether intentionally unbonded or not. In fact, white-topping overlays (concrete over asphalt) tend to benefit by some bonding to the asphalt. An unbonded overlay on an existing concrete pavement, though, must be completely unbonded. This is sometimes accomplished by installing 1.5 inches of asphalt between the existing pavement and the overlay, or more recently by using a woven fabric bond breaker (see Innovations, page 30).

Many public agencies have the erroneous idea that concrete overlays are expensive or difficult to install. In reality, concrete overlays are simple to install and unbonded overlays require very little work in advance. Typically, the damaged surface is milled off and major failures in the existing pavement are repaired. And concrete overlays have the maintenance and life span advantages of new concrete pavements. In Colorado, CDOT budgets annual maintenance costs of $1270/lane-mile for asphalt overlays and only $400/lane-mile for concrete overlays.

Anyone considering concrete overlays should get the “Guide to Concrete Overlays,” which is published by the National Concrete Pavement Technology Center. It is available for free download at www.cptechcenter.org/publications/overlays. CC/TCP
The Canadian Journal of Commerce reports that knotweed control added 70 million pounds to the costs for the London Olympics and it is being found even in Vancouver.

**Concrete Buster**

Japanese knotweed takes invasive weeds to a new level with its ability to actually break concrete if allowed to grow in cracks and joints. It is extremely invasive and can cover disturbed ground very quickly. Knotweed is spreading rapidly, especially in the eastern U.S. The risk for contractors is that with its addition to the list of invasive weeds that must be controlled, it could cost you a lot of money to keep it in check on a jobsite.

**Cool It**

Unbonded concrete overlays must be, well, unbonded. The overlay must be able to act as an independent structure or else the stresses can build up between the overlay and the existing pavement (see Problem Clinic, page 28). During construction, most geotextile bondbreakers are black (often just a layer of asphalt) and can therefore absorb the sun’s heat before the overlay is placed. That heat can lead to cracking stresses in the overlay. Propex Reflectex reflects the sun’s heat, keeping existing pavement cool while providing a 100% bond break between existing pavement and the overlay. Visit www.geotextile.com.

**Auto Start/Stop**

Engines used to consume more fuel starting than if they were just left running. But modern engines start much more efficiently and significant fuel can be saved simply by turning the engine off whenever possible. Volvo Penta has taken that to the next step with an automatic start/stop option for its industrial diesel engines. The engines turn off, even at stop lights, after five to 10 seconds of idling and start back up as soon as any of the controls are touched. The company estimates this can save 5% or more in fuel consumption. “Fuel consumption is by far the biggest cost for operators of industrial equipment,” said Volvo’s president Ron Huibers. “When fuel can represent up to 90% of the machine’s lifetime operating costs, a reduction of up to five% in fuel consumption is extremely valuable.” For more, visit www.volvopenta.com.
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