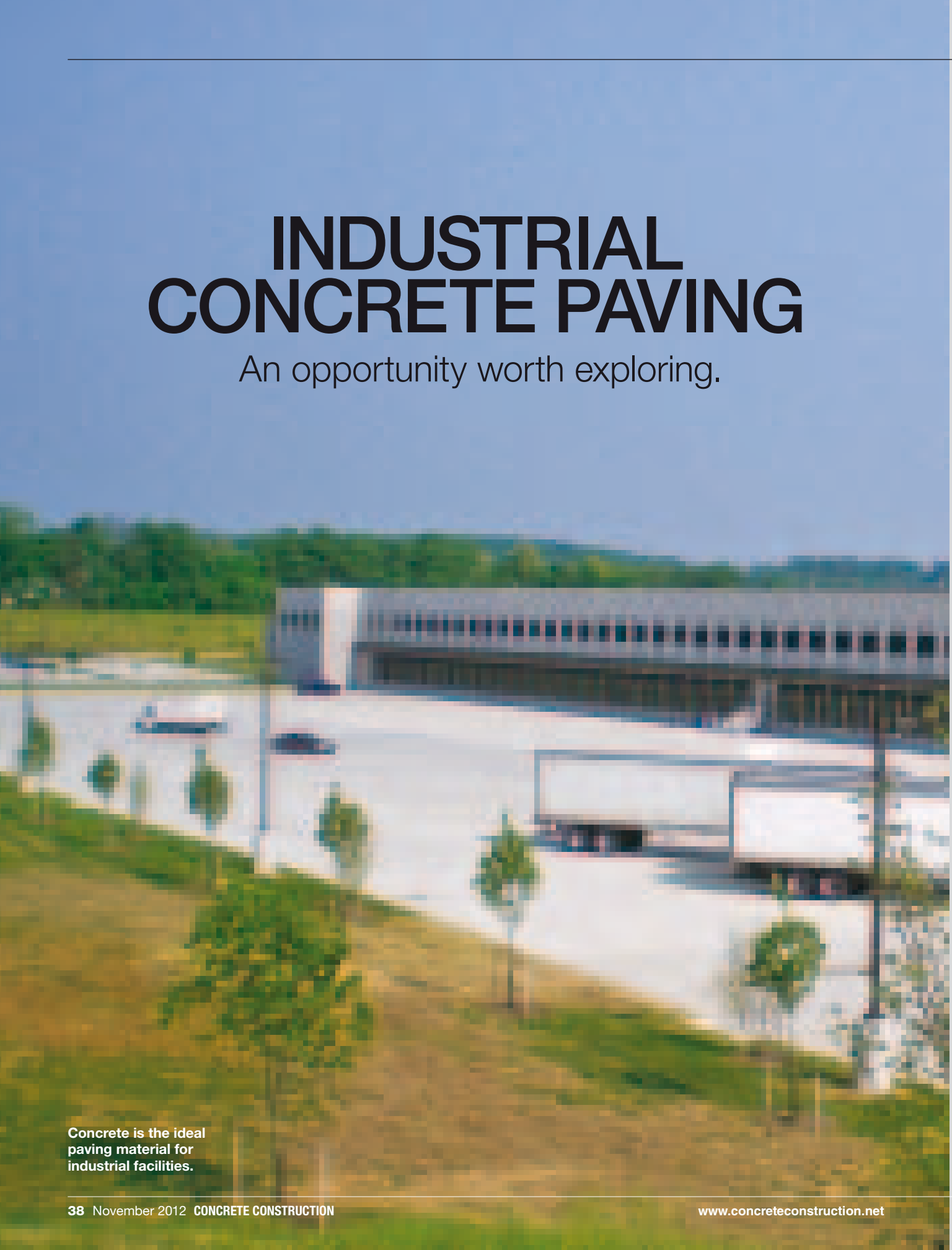
INDUSTRIAL CONCRETE PAVING

An opportunity worth exploring.



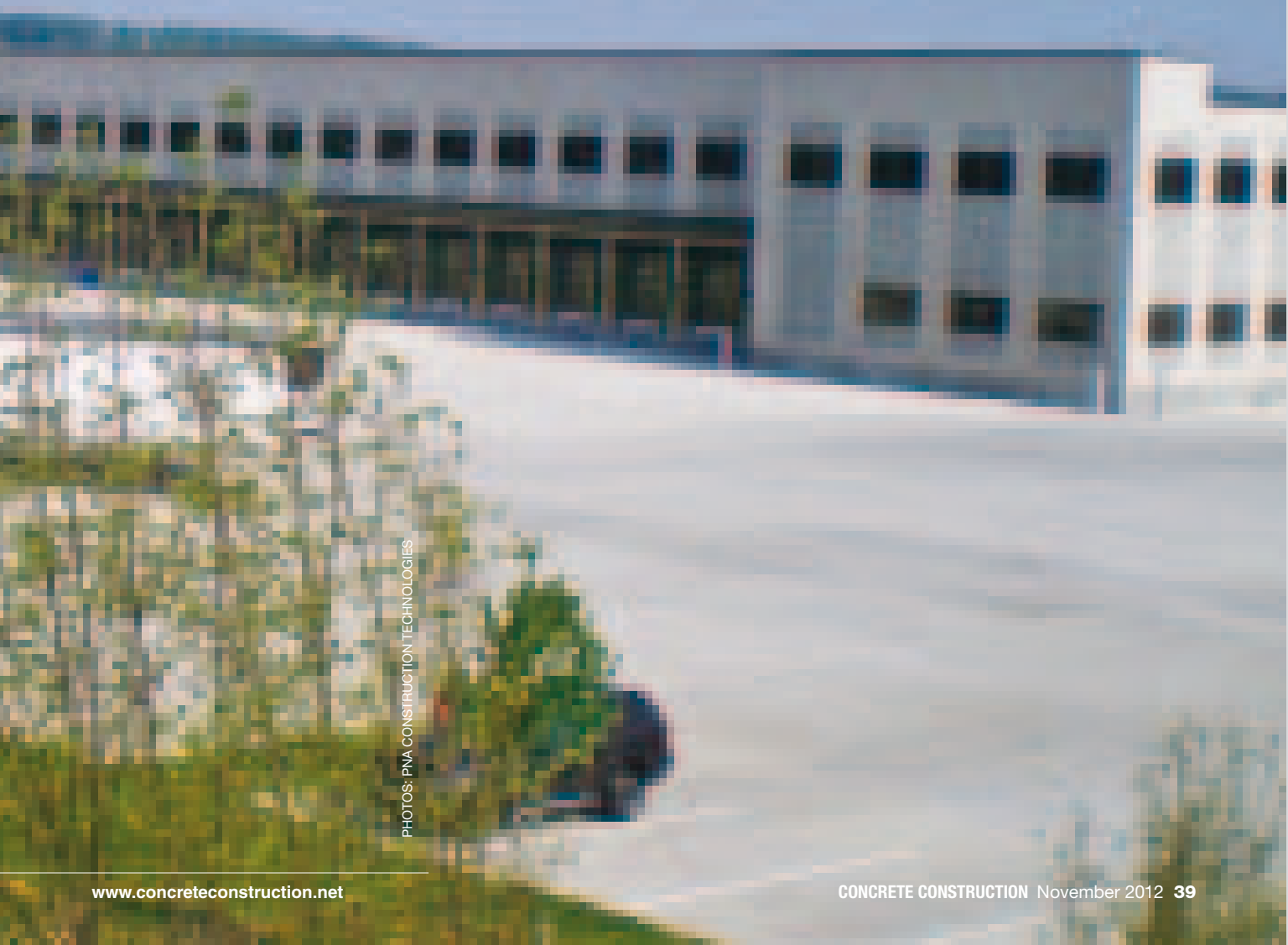
Concrete is the ideal paving material for industrial facilities.

By Nigel K. Parkes

The concrete industry has taken great efforts to promote the use of concrete for parking lots for cars and pickups but little design guidance has been developed to advance the use of concrete for the thicker pavements needed for industrial applications. Pavement for 18-wheel truck traffic at industrial sites such as distribution centers and warehouses, intermodal and logistics centers, manufacturing plants, truck stops, and big-box retail facilities are ideal locations for the use of concrete. In today's highly competitive market, we all need to identify opportunities where we can use our experience and existing knowledge to extend our markets and grow our businesses. This is just such an opportunity.

Oil refineries have enhanced their processing capabilities in recent years, which has reduced the supply of the oil derivatives used in asphalt. As a result, concrete is often the least expensive paving alternate even on a first-cost basis. In industrial paving applications, concrete is almost always the most cost-effective option because it is placed in a single lift while asphalt must be placed in two or three lifts. This makes concrete for industrial paving a perfect opportunity for concrete contractors.

As a concrete contractor, you know that concrete is the best choice for your customers' paving to deliver durability, serviceability, aesthetics, and low life-cycle costs. But how do you convince owners and developers to make the switch from asphalt? What



PHOTOS: PNA CONSTRUCTION TECHNOLOGIES

Plate dowels help maintain joint stability under heavy industrial loads, allow for two-directional doweling, and can be positioned close to the intersection of joints.

is required to make it successful? What do you recommend?

Establish the owner's criteria for success. The measure of success of installed industrial paving depends on the owner's or tenant's satisfaction with the final product. But there are a number of criteria from which to measure success, so first you should establish the owner's expectations. Ask your clients the following questions to understand how they will define success:

1. What is your expectation for the pavement's life? Concrete pavements often continue to perform well, long after the first fatigue cracks have developed but when will the owners expect to see fatigue cracking and how much can they tolerate?
2. What is the natural subgrade material at the site? Concrete's greater stiffness compared to asphalt means that a subbase is rarely needed, although sometimes one is used to provide a good working platform for paving operations. Schedule or onsite drainage usually dictates whether or not a subbase is needed rather than the load-bearing capacity of the subgrade.
3. What is the expected traffic? Will the paved area be open to random traffic or will there be defined traffic lanes? Will every area be exposed to the same volume and type of traffic or will some areas have more limited weight or levels? Not all the pavement needs to be the same thickness.

Finding design guidance

The most significant issue slowing the adoption of concrete for industrial pavements is the lack of design standards. This shortfall is currently being addressed by ACI Committee 330, Concrete Parking Lots and Site Paving, which is developing guidance for civil and geotechnical engineers who design these facilities. That is not to say you need to wait until this is complete to pursue this work. Although there are no specific industry standards or guides yet for designing concrete pavements for industrial facilities, there are a number of publications and software programs that can be used to determine the four most important aspects: pavement thickness, joint spacing, joint layout, and joint details.

Determining pavement thickness. If you know the expected truck traffic and loadings, the subgrade support, and the owner's criteria for success (amount of acceptable fatigue cracking after a given time), then there are a number of software packages available for determining suitable pavement thickness. StreetPave by the American Concrete Pavement Association (ACPA) or OptiPave by TCPavements are probably the best software for pavements intended to carry standard 18-wheel truck traffic. Both are readily available and are fairly easy to use.

Establishing the maximum joint spacing. Saw cutting the joints at a proper spacing will reduce warping and curling stresses and therefore minimize mid-panel cracks. When it comes to determining a suitable joint spacing, the current ACI slab-on-ground guides ACI 302.1R-04, "Guide to Floor and Slab Construction," and ACI 360R-10, "Guide to Design of Slabs-on-Ground" provide a good reference, but for heavier truck traffic, it is wise to limit the maximum joint spacing to 15 feet if the shrinkage characteristics of the concrete mixture are unknown or fall

What to submit

During the bidding and submittal process, your proposal should include:

- The owner's criteria for design—document your understanding of the owner's expectations outlined in their responses to your initial questions.
- The geotechnical report—make sure you are not held responsible for any problems arising from information that was not shared with you at the outset or that was inaccurate.
- The pavement thickness design methodology adopted.
- The joint spacing, layout, and details—be sure to list all of the supporting literature and reference materials.

Proper joint spacing and layout are essential for maintaining joint stability.

Industrial pavements present an opportunity for concrete contractors to expand their markets.

in the typical to high-shrinkage range.

Developing a good joint layout. Next to establishing the maximum joint spacing and proper subgrade preparation, the layout and timely cutting of joints will have the biggest effect on minimizing the number of out-of-joint cracks. Saw cutting before the shrinkage stresses exceed the concrete strength is critical. Early-entry saws allow contractors to make the cuts in a timely manner. But the development of a good joint layout plan for industrial facilities can be tricky. Many things can affect the joint layout such as the geometry of the area (especially with complicated intersections between separate areas and around landscaping) and the location of in-pavement structures such as buildings, drainage fixtures, and light pole bases. Take the time to develop a good plan. ACPA provides excellent guide documents for laying out joints.

Detailing joints to perform. Joint stability is critical for durability and serviceability in concrete pavements subjected to vehicular traffic. The load-transfer mechanism used should hold the concrete together in the vertical plane to maintain joint stability (which is the deflection of the concrete on one side of the joint relative to the adjacent concrete) at between 0.010 inches and 0.025 inches depending on the type of wheel loads anticipated in that area of the paving. The harder and smaller the wheels, the lower the required joint stability will be for good joint performance.

Concrete paving at industrial facilities is usually constructed in large block placements using laser screeds or wet screeds, similar to that of industrial slabs-on-ground. In these applications plate dowels can provide the joint stability required, allow for two-directional doweling, and can be positioned close to the intersection of joints, without inducing stresses or radial cracking. Recommendations for the size, shape, and spacing of plate dowels best suited to each joint application can be found in ACI 302 and 360 and in the new National Concrete Pavement Technology Center's, "Guide to Concrete Overlays of Asphalt Parking Lots."

Misguided specifications

Without guidance from the industry for designing paving at industrial facilities, many engineers turn to either the local or state DOT specifications or to a dangerous cocktail of historical methods. This can create significant problems for contractors and owners.

Most DOT specifications assume that concrete paving is placed in lanes with slipform paving machines, and call for tie bars in "longitudinal joints" and traditional round dowels in "transverse" joints. When the paving in industrial facilities is placed in large blocks with saw-cut joints in both directions, how does a concrete contractor differentiate between longitudinal and transverse? The use of tie bars or traditional round dowels in these pavements with multiple saw-cuts in both directions can create extensive restraint and cracking, causing contractors to lose their retainage, or worse.

Without any specific guidance, some designers turn to historical practices that have been eliminated or modified in other areas of our industry. Things such as keyways in joints or reinforcement to prevent cracks are still prevalent in the design of paving for industrial facilities. The justification for the use

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of these practices is often tradition and perceived local standards of care.

Keyways, for example, have long proven to be a source of significant deterioration of concrete at the joints in both interior and exterior applications, and numerous ACI and ACPA publications explain why they should not be used in concrete flatwork subject to wheeled traffic. Yet we often see this detail in exterior paving applications—resist this.

Then there's the myth that reinforcement prevents cracking, which is still rife in this segment of our industry. Propagated by the term, "reinforcement for crack control" many owners and designers believe that reinforcement reduces the number of out-of-joint cracks. This leads many civil and geotechnical engineers to specify reinforcement in jointed concrete pavements when it is unnecessary. Although continuously reinforced concrete pavements (CRCP) are often used with great success in long-life highway applications, the amount of reinforcement required is almost always cost prohibitive in industrial applications. In properly jointed concrete pavements, mid-panel reinforcement is not required and can actually contribute to out-of-joint cracking. Too much reinforcement can lock the joints, and cause panels to crack. Too little, such as welded wire reinforcement, does not provide sufficient load transfer at joints, which can lead to the pumping of subgrades, joint faulting, and cracking.

Truck-dumping of concrete provides the most cost-effective placement method, but ruts from concrete truck tires can often lead to an uneven subbase, which is a significant cause of random cracking. If rebar or WWR has already been positioned, the contractor may not be able to repair or re-grade any rutting of the subbase during the concrete placement. Not only is it time consuming and expensive to install reinforcement properly, but it can also mean that you will need to pump the concrete in order to maintain the subgrade tolerance and minimize cracking.

Finally, a "local standard of care" practice that has created problems

Tackling Curbs and Gutters

New mid-size slipform machine shines in retrofit project.

If you're pursuing work in the industrial pavement sector, you'll likely find it beneficial to offer curb and gutter capabilities as well. And if you're just making the transition from interior flatwork, you may not have or want to buy a full-size slipform curb and gutter machine right away. For one recent project at West Virginia University in Morgantown, the Green River Group purchased and used a new mid-size slipformer to place new curbs quickly and efficiently.

The project was a $1.2 million retrofit of a 6-acre parking lot, which included three bio retention areas, the associated drainage work, base course and wearing course asphalt to re-surface the existing parking lot, and the addition of 1200 lineal feet of curb.

The curb configuration was tricky—a 20-inch straight-up curb, with 14 inches below grade, leaving a 6-inch curb exposed. After other crews cut out the old asphalt and prepared the subbase, the curb crew came in and placed the concrete curb, working in tight conditions and on different levels.

PHOTO: PHOENIX CURB MACHINES

The Green River Group used a new Phoenix 7500 curb machine, which owner Steve Calvert had seen at World of Concrete 2012 and purchased for the project. Things went smoothly, even though the crew had just one day of training on the machine. At less than 10,000 lbs, the Phoenix 7500 is more compact and easier to transport than full-size units. It requires only two people to run: one operating the technical components and one ahead of the machine communicating with the concrete truck. Calvert says of the curb machine, "It has all the elements we need. We are trying to develop a full-time curbing crew, and it will help us do that with less expense and less capital outlay, than larger curb machines [that cost] at least 33 percent more." *–Ken Hooker*

originated in Texas where it is standard practice to use regularly spaced "redwood" expansion joints. Expansion joints (whether redwood, cork, impregnated fiberboard, or plastic) are a frequent source of problems. They are not needed since properly spaced saw-cut contraction joints are nearly always able to accommodate any thermal expansion of the concrete.

This leads to another controversial topic: whether or not to seal the joints? There are two primary reasons for sealing joints: to reduce the amount of rain water that can pass into the subgrade and to prevent incompressible materials from getting into the joint. Joint sealant manufacturers usually require a minimum saw-cut width of ¼ inch but this is based on the need for a minimum width-to-depth ratio of the sealant material to maintain bond with both sides of the joint. But if the facility owner is unprepared to maintain the joint sealants then the wide ¼-inch joint can create a channel that actually collects water that then drains through the joint. If, on the other hand, you are relying on the saw-cut joints to accommodate any expansion then it is better to disregard the joint sealant manufacturers' recommendations, cut the joints as thin as possible ($^1/_{16}$ inch), and fill them with an elastomeric sealant material. This will prevent the ingress of incompressible materials and limit the amount of water passing to the subgrade, regardless of the owner's sealant maintenance program (or lack thereof).

Getting the work

With contractors working harder than ever, finding industrial concrete paving opportunities with new and existing clients will allow you to get additional work for a relatively low cost of acquisition. While no specific industry guides yet exist, there are tools, documents, and reference materials available to help you convince owners, developers, and designers to make the switch from asphalt to concrete. Most of what you have learned over the years about interior concrete slabs-on-ground applies to exterior pavements. You already know how to cost-effectively deliver durable, low-maintenance concrete flatwork that meets your client's expectations. So why not use your knowledge and work force to extend the work you do for your existing customers and look to secure new customers? **CC**

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