Better Roads

ROAD SCIENCE ILLUSTRATED

PULL-OUT GUIDE

by Tom Kuennen, Contributing Editor

The ABCs of Continuously Reinforced Concrete

Better Roads
For The Government/Contractor Project Team

Continuously Reinforced Concrete Provides Smoothest Concrete Pavements

Superpave's development after 1984 as an antidote to rutted asphalt pavements was part of a larger effort to provide motorists with the ultrasmooth pavements they demand. This put portland cement concrete pavements at a disadvantage, as the expansion joints endemic to jointed plain concrete pavement had the potential to annoy drivers as well as provide a maintenance challenge.

Today, the answer for roadbuilders needing the durability of concrete pavements for heavily trafficked highways — but with a smooth surface — is continuously reinforced concrete pavement. Continuously reinforced concrete is constructed with steel reinforcing bars placed within the concrete, lap-spliced at the ends to be continuous along the entire length of the pavement, up to interruptions such as bridge deck approaches.

Continuously reinforced concrete eliminates the expansion joints that are formed in new concrete to control inevitable slab cracking. Instead of periodic expansion joints and load-transfer dowel bars between slabs, continuously reinforced concrete naturally forms tight transverse cracks to evenly transfer loads. The reinforcing bars control the width of the transverse cracks that form and hold them closed. The transverse cracks are not invasive and don't compromise the structural integrity of the pavement.

The result is a continuous, smooth-riding surface capable of withstanding the heaviest traffic loads. Because of its greater durability, longer life expectancy, and minimal maintenance requirements, continuously reinforced concrete can provide the best long-term value of any pavement type, maintains the Concrete Reinforcing Steel Institute.

A typical jointed plain concrete highway will have expansion/contraction joint spacing, generally 13 to 23 feet apart, and no steel reinforcing. The slab thickness will be from 8- to 16-inches thick over granular or stabilized base, with joints.

But continuously reinforced concrete pavements contain large amounts of steel reinforcement, typically 0.5% to 0.8% of the slab cross-sectional area, thus their higher performance comes at a cost premium. The purpose of the steel is to force the slab to crack at short intervals in the range of 3 to 8 feet.

"The size and type of reinforcing bars vary considerably from agency to agency, but typically, the longitudinal steel consists of 0.62-inch-diameter bars spaced on 6-inch centers," reports the Federal Highway Administration. "If transverse steel is used, it typically consists of 0.5-inch bars placed on 4-foot centers."

While continuously reinforced concrete eliminates the transverse joints, longitudinal joints are necessary to relieve stresses caused by concrete shrinkage and temperature differentials in wider lane widths. As pavements greater than 14-feet wide are susceptible to longitudinal cracking, longitudinal joints should be included when pavement widths exceed 14 feet.

While continuously reinforced concrete has great applicability to today's paving environment, there is nothing new about it. The Concrete Reinforcing Steel Institute reports that it was first developed more than 75 years ago, becoming popular with the construction of the Interstate system in the 1960s and 1970s.

The institute maintains that continuously reinforced concrete is the material of choice in the United States for highways and airport runways for four reasons:

- While continuously reinforced concrete incurs higher initial costs, total life-cycle costs are lower for the owning agency because it requires less maintenance and repair over its long life.
- Continuously reinforced concrete has less impact on the environment as it can use 100% recycled material, and like all concrete pavements, is reputed to reduce the effect of thermal-heat absorption in densely populated metro areas.
- Its smooth riding surface can contribute significantly to greater rider comfort and increased fuel efficiency.
- Continuously reinforced concrete can mean fewer delays for motorists because it virtually eliminates repairs, and reconstruction cycles are extended.

Thanks to the Concrete Steel Reinforcing Institute for its assistance with this article.

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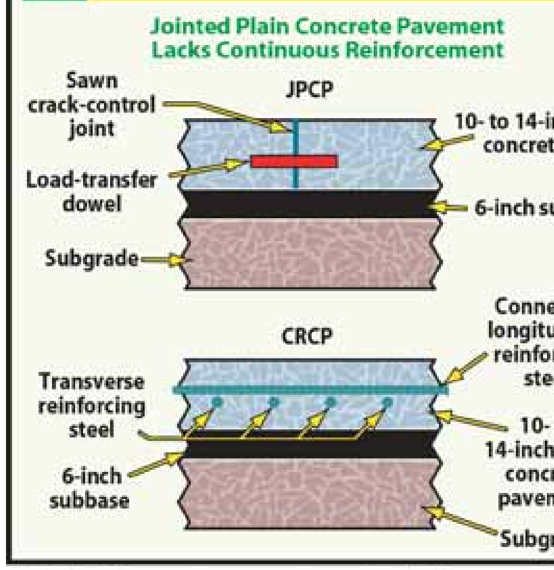
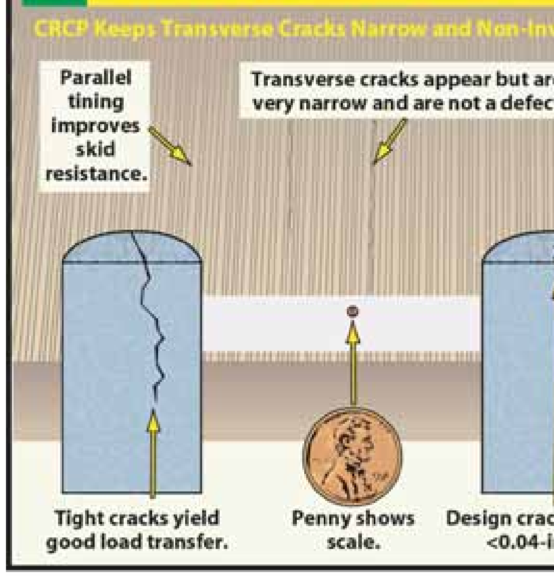
The ABC

1 JPCP vs. CRCP



Jointed plain concrete pavement consists of slabs sawn tra
to create crack-control joints. Slabs are connected by dowe
which transfer loads. Continuously reinforced concrete pav
eliminates transverse control joints by connecting reinforcin
into long strings which keep subsequent transverse shrinka
cracks tiny.

4 CRCP Keeps Cracks Small



Use of longitudinal steel in CRCP eliminates the need for co
JPCP's transverse control joints, other than at bridges and
structures. As the concrete slab cracks, the rebar keeps crac
and helps maintain load transfer across the cracks. Tight cra
good load transfer and are effective in reducing water penetr

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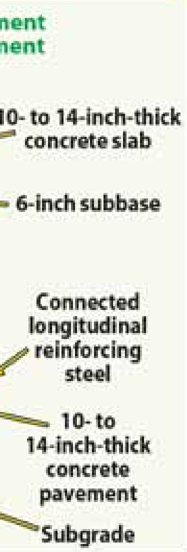
ABC's of Continuously Reinforced Concrete



s sawn transversely
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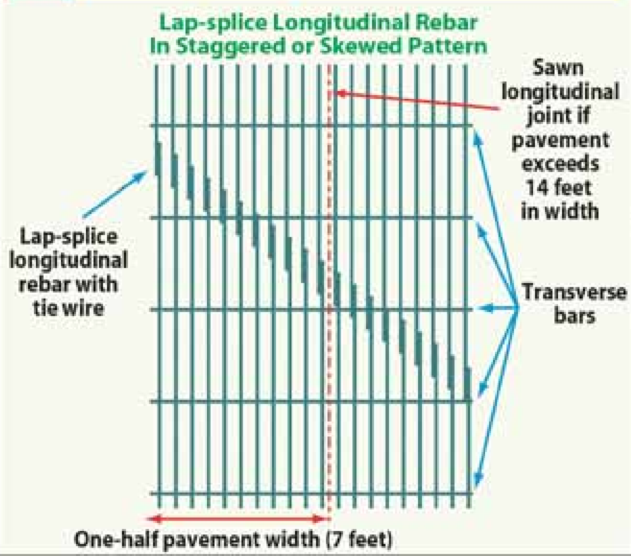
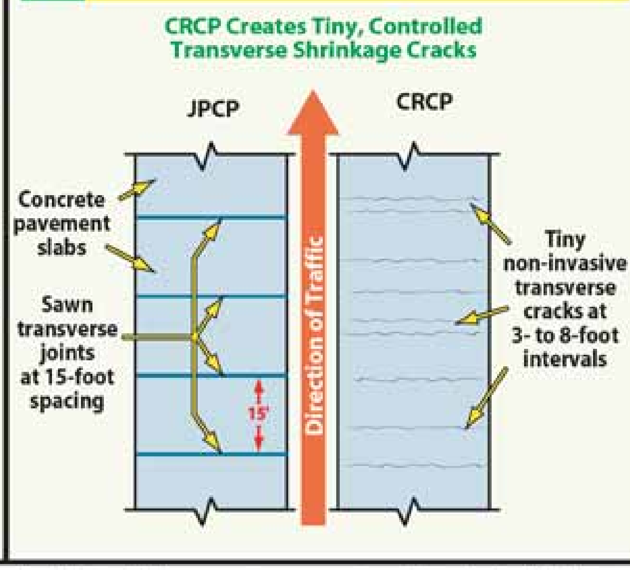
2 Overlap Longitudinal Rebar



The FHWA recommends a minimum width splice overlap length of 25 bar diameters if slices are staggered or skewed across the pavement as shown here. As pavement widths in excess of 14 feet are subject to longitudinal cracking, a longitudinal joint should be formed one-third the depth of the slab thickness for them.

3 Controlled Shrinkage Cracks



Left, jointed plain concrete pavement consists of typical 15-foot-long slabs created by sawing shrinkage crack-control transverse joints, which can impact ride quality and require maintenance. Right, continuous reinforced concrete pavement eliminates transverse joints; Instead, shrinkage cracks form, but they are held together by the continuous rebar, and are very tiny.

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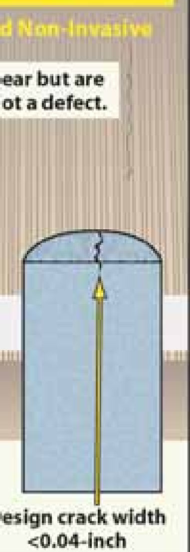

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keeps cracks tight
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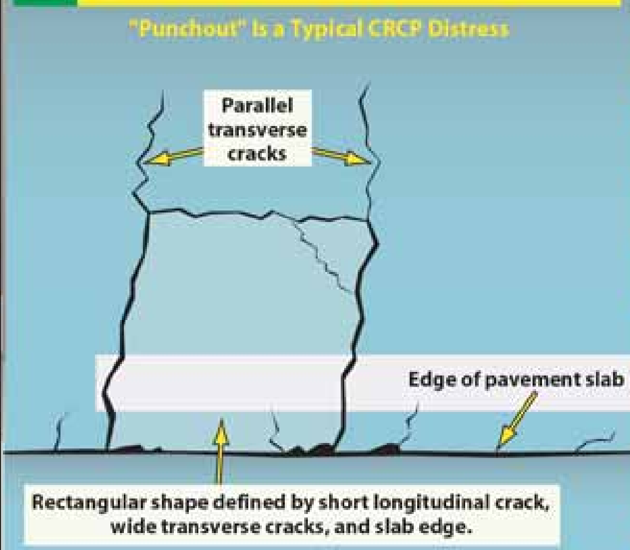
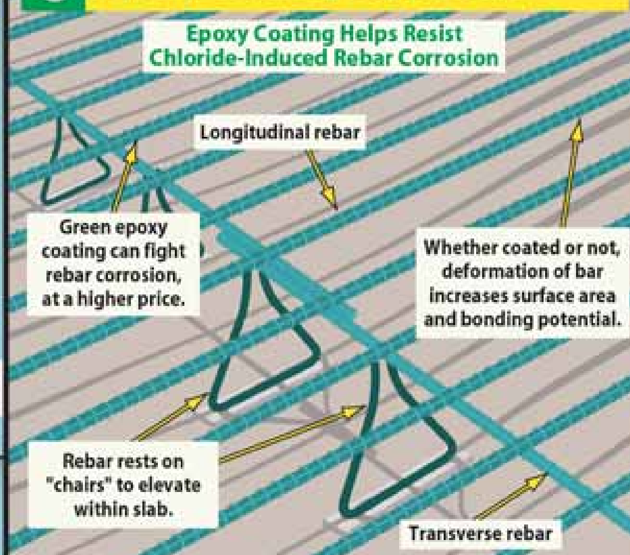
5 Punchouts Are Avoidable



CRCP punchouts constitute a type of distress that typically occurs between closely spaced transverse cracks, which have widened due to temperature swings, concrete shrinkage, low steel content, and a loss of aggregate interlock within the slab. Traffic exacerbates spalling and pumping of material from the underlying base, resulting in collapse. Adequate use of rebar, non-erosive base materials, and deep enough slabs greatly reduce punchouts.

6 Epoxy Coating Fights Rust



Epoxy coating of reinforcing steel resists rebar corrosion resulting from penetration of chloride from deicing brines, although at a higher cost. Green covering of rebar identifies epoxy coating. Such rebar must be very carefully handled to eliminate nicks or microabrasions which may foster corrosion. Debonding of epoxy when in the slab can be a problem, and questions remain as to its cost-effectiveness.

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Voices of Experience

Buddy Gratton, P.E.

Gratton is deputy commissioner, Georgia Department of Transportation.

Georgia DOT Specs CRCP for High-Level PCC Pavements

At the Georgia DOT, our approach to pavement design is to select the best product for our roadways based on environmental conditions, traffic patterns, and economic considerations. Over time, rigid pavement structures appear best at reduced faulting under continuous, heavy traffic loading; continually reinforced concrete pavement is one of several types of rigid pavements we've used in Georgia with some success since the early 1960s.

For our many roadways with very high truck volumes and high traffic patterns, such as our limited access freeways, CRCP is one of a number of viable options. We will also consider jointed plain concrete and asphalt, and decide what will be the best product in the application for each specific roadway location, using life-cycle costing. Very often, CRCP will come out to be the best product for the job.

Here in Georgia, we are seeing an estimated 10 to 15% cost increase for CRCP over jointed plain concrete pavement. However, these increases are minimal, as we expect to perform significantly less routine maintenance on CRCP during its life cycle. With a lot less need for transverse joint sealing, we look forward to a smoother ride over the continuously reinforced sections.

It's an understatement to say that the stretch of I-95 through Georgia is a well-traveled road. Yet, the CRCP section of I-95 has maintained integrity really well against the heavy truck loads and constant high traffic volumes. We discovered over the life of that pavement that there was little or no transverse steel, and that, typically, stresses would occur as longitudinal cracking in the middle of the slabs. Longitudinal and transverse steel in CRCP has sufficiently addressed that issue and we now are looking for a life span of 50-plus years for our continuously reinforced concrete pavements.

For CRCP applications on urban expressways, we will use No. 11s on 6- or 7-inch centers for longitudinal rebar, and No. 5s on 12-inch centers for transverse. The rebar is placed right in the center of the slab. We may use high early strength concrete in locations where we need to open to traffic very quickly. We've done lane replacements over a weekend, removing the existing pavement and base, replacing both, and opened the pavement to traffic by Monday morning. If it's a project with ample time to work, we'll typically forgo the high early strength requirement.

In summary, CRCP works well in many applications here in Georgia, and allows us to meet our environmental, travel demand, economic, and quality standards on behalf of the traveling public.

Michael N. Plei, P.E.

Plei is transportation structures engineer, CMC Steel Group, Seguin, Texas.

CRCP is Modern Option for Smooth, Durable Pavements

Concrete cracks. As it cures and hardens, it shrinks. Also, over time, it will expand and contract due to weather. As concrete is weak in tension, it will crack.

We have two ways of dealing with that cracking; saw-cut transverse joints will control where the crack occurs, with resulting slabs connected with dowel bars, or we can continuously reinforce the pavement, letting it crack where nature wants — using rebar to hold the cracks tightly closed — and not have joints in the pavement at all.

Thus, continuously reinforced concrete pavements provide a more durable pavement than either jointed plain concrete pavement or bituminous pavements, which will stay smoother longer than other pavements. This is especially critical due to the incredible increase in trucks that we have seen and is forecast. This boom in trucks has an effect on the performance of whole pavements, because many of them have deteriorated a lot quicker than people thought they would. But others have lasted a lot longer, considering they were designed for lower levels of trucks.

Roads also undergo environmental stresses. They deteriorate due to temperature fluctuations and rainfall. Research shows that CRCP holds up the best. It's not the least expensive cost option, but it's the most economical in the long term.

CRCP will be built on the same kind of subbase as a jointed plain concrete pavement, depending on the state's specifications. Longitudinal bars are placed continuously in the direction of the traffic, lap-spliced a minimum of 24 inches, and tied together with wire, with no need to weld. They eliminate the need for transverse control joints; as the concrete cracks, the longitudinal bars keep the cracks small and tight, and maintain load transfer across the cracks.

The longitudinal bar laps are skewed or staggered. Over time, we have found that it results in better performance. Transverse bars support the longitudinal bars, but also resist stresses that develop in the transverse axis.

CRCP can be continuous for miles and miles. In North Dakota, there is a CRCP that runs about 50 miles without a stop; made possible due to the lack of a river or other crossings. We have a number of states that have been building CRCP for a long time, and other states that are taking a new look a generation later.