Continuously Reinforced Concrete Pavement (CRCP) — Executive Brief

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U.S. Department of Transportation
Federal Highway Administration

What Is CRCP?

Continuously reinforced concrete pavement (CRCP) provides long-life performance with minimal maintenance at a competitive cost. CRCP contains continuous longitudinal steel reinforcement and has no transverse joints, except as required at end-of-day construction and at bridge approaches and transitions to other pavement structures. Continuous reinforcement is a mechanism for managing the transverse cracking that occurs in all new concrete pavements.

In new CRCP, volumetric changes caused by cement hydration, thermal effects, and external drying are restrained by the pavement base layer and the longitudinal reinforcement, causing tensile stresses to develop in the concrete. These stresses, referred to as *restraint stresses*, increase more rapidly than does the strength of the concrete at early ages, so at some point, full-depth transverse cracks form, dividing the pavement into short, individual slabs. The transverse cracks are closely spaced (3.0–6.0 ft [0.9–1.8 m]) and have small crack widths (< 0.02 inches [0.5 mm]), which help to maximize the aggregate interlock between adjacent CRCP panels.

In CRCP, the short panel lengths and high load transfer between adjacent panels reduce the flexural (i.e., bending) stresses due to traffic loads and temperature and moisture curling. The transverse cracking in CRCP is different from the transverse cracks associated with the most commonly used type of concrete pavement—jointed plain—in which the number and location of transverse cracks are managed by timely sawing.

Long-Life Performance

CRCP is an excellent solution for highly trafficked and heavily loaded roadways, such as interstate highways. Well-designed and well-constructed CRCP accomplishes important objectives. It eliminates joint maintenance for the life of the pavement, thereby reducing cost and helping to meet the public's desire for reduced work zones and related travel delays. In addition, it provides long-term, high load transfer across the transverse cracks, resulting in a consistently smooth and quiet ride.

Key Words

- CRCP
- continuous reinforcement
- concrete pavement

State Department of Transportation Experience

Highway agencies select CRCP with the expectation that it will provide at least 40 years of exceptional performance with minimal maintenance when properly designed and constructed. This is becoming increasingly important in high-traffic, heavy-truck areas, where delays are costly. Some of the most highly trafficked corridors in the United States, including I-75 in Atlanta, GA; I-90 and I-94 in Chicago, IL; and I-45 in Houston, TX, have demonstrated the long-term, low-maintenance performance of CRCP.

Data from the Federal Highway Administration's (FHWA's) Long Term Pavement Performance program show that the majority of heavily trafficked sections of CRCP projects in 22 states have maintained their smoothness for at least 20–30 years, at which time shallow grinding restores both smoothness and surface texture. In addition, CRCP can easily be widened to provide additional capacity, and after many years of service, can be successfully overlaid with either concrete or asphalt for extended life.

Design

The American Association of State Highway and Transportation Officials (AASHTO) Pavement Mechanistic–Empirical (ME) Design procedure allows the engineer to have significant control on how the various inputs and features selected for a particular project affect the final CRCP design. Although there are approximately 150 potential inputs for CRCP design, changes to all of these inputs are not necessary each time a design is completed. As a result, many of the default values can be left unchanged. On the basis of detailed studies, it is recommended that the CRCP design engineer focus on changes to the following inputs:

- Slab thickness
- Base type
- Soil type
- Steel content (bar-size and depth)
- Shoulder type
- Climate location
- Construction month
- Concrete strength
- Concrete elastic and thermal properties
- Lane width
- Traffic
- Reliability

Placement of Reinforcement

Proper placement of reinforcing steel is an extremely critical aspect of CRCP construction. Detailed schematics should be provided by the contractor, approved by the engineer, and inspected in the field prior to paving to assure compliance with project standards and specifications. Longitudinal alignment and depth of the steel relative to the slab surface have a significant effect on CRCP performance. Reinforcing steel is currently placed manually, either on chairs or on transverse bar assemblies. The location of longitudinal and transverse bars, laps, and splices must be inspected regularly throughout the length of the project. Quality assurance measures are needed to check that the steel has not shifted during the construction process.

Paving

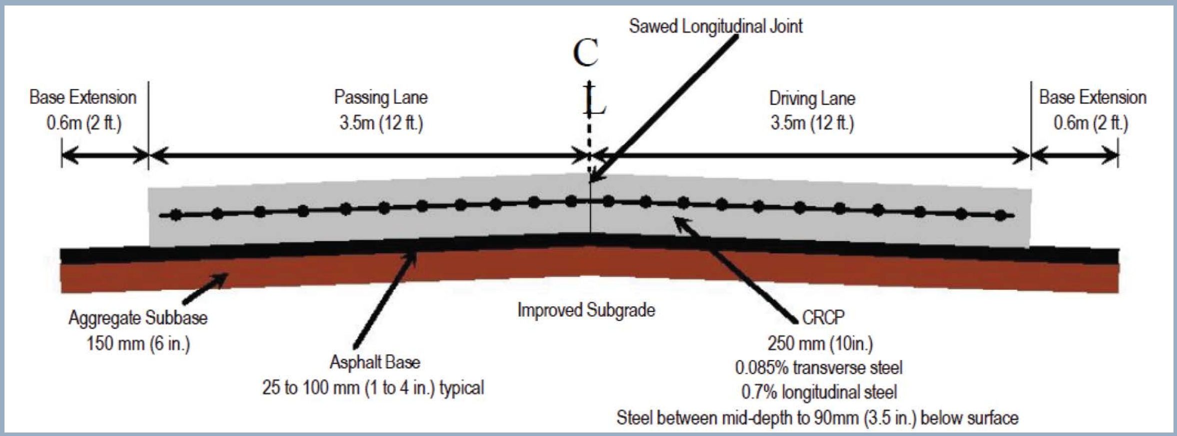
Concrete paving can utilize either fixed-form or slip-form operations. Fixed-form paving requires the use of side forms, which typically are removed the day after paving. Slip-form paving does not require the use of forms, as this method instead extrudes the concrete in the desired cross-sectional shape and is the most efficient and common paving operation for roadway pavements. Although a number of factors affect the pressure that the paver exerts on the concrete, the only factors that can be adjusted during paving are the speed of the paver, the frequency of the concrete vibrators, and the head of concrete in front of the paver.

Concrete Placement

In CRCP paving, haul vehicles cannot drive onto the base because of the presence of the reinforcing steel; therefore, the concrete typically is discharged from end-dump trucks at one side of the paver onto a high-speed belt placer. This method allows rapid and efficient unloading of trucks and places the concrete in the proper location in front of the paver. Another less desirable option is the discharging of concrete onto the grade by using chutes from transit-mixer trucks or agitators; however, this method can be slow and greatly increases the possibility of displacing reinforcing steel and segregating the concrete.

Concrete Consolidation

The concrete is consolidated to achieve the required strength and durability, reduce entrapped air, and ensure bonding between the concrete and steel. Vibrators must not come in contact with the longitudinal reinforcing bars for extended periods of time, because this



Typical CRCP cross-section.

can cause weakened mortar to concentrate around the steel bars. Extra care should be taken to attain sufficient consolidation by manually vibrating the concrete at end-of-day headers and construction joints.

Concrete Curing

Adequate curing is of paramount importance to any concrete pavement. The most common practice is to apply an external curing compound, which effectively forms a membrane on the concrete surface to prevent moisture loss through evaporation. This practice also reflects some of the solar radiation. Other curing methods include water spraying or fogging, wet burlap, and plastic sheeting. Regardless of the curing method, a moist condition on the surface of the pavement should be maintained throughout the entire curing period, which typically is 7 days.

An innovative curing method that is gaining popularity is internal curing, in which saturated lightweight fine aggregate is substituted for a small percentage (typically 10 percent) of the normal-weight fine aggregate. The water in the highly absorptive lightweight fine aggregates is not available as mixing water and does not increase the water-to-cementitious material ratio of the concrete. Subsequent to hardening of the concrete, internal curing proceeds with the water that migrates from within the lightweight aggregate.

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