Summary of Changes 2021

Updates to the 3rd Edition
NPCA Manual for Jointed Precast Concrete Pavement
October 2021 Publication

The NPCA Manal for Jointed Precast Concrete Pavement is reviewed on a three-year cycle and updated as needed to ensure the Manual reflects the latest industry practices.

The NPCA Transportation Infrastructure Products Committee oversees the review process with the assistance of the NPCA Engineering & Technology Committee, industry input and NPCA professional staff support.

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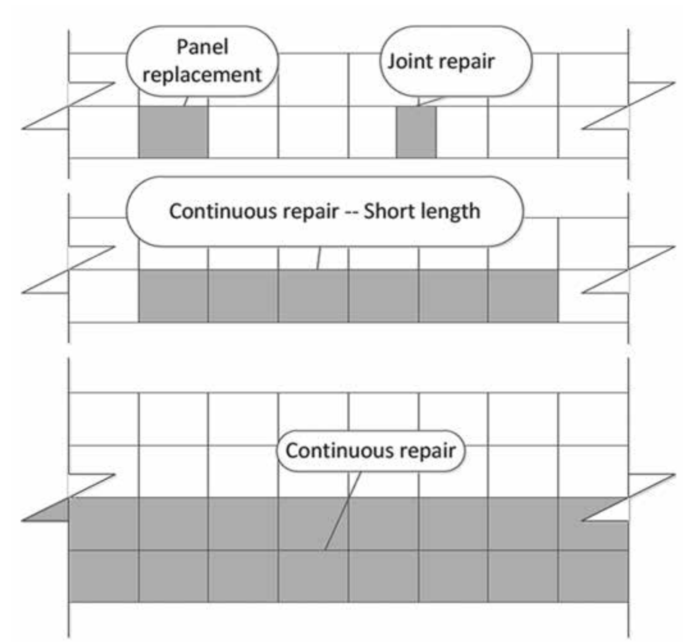

Figure 1-7. Illustrations of the three most common categories of application for PCP systems. Single panel and joint replacement panels are typically not post-tensioned.

construction features are provided to produce good vertical alignment between precast panels (e.g., “tongue-and-groove” systems), the reduced number of effective joints can result in improved ride quality over each assembled slab length. In addition, prestressing forces applied at the plant and in the field typically hold tight any cracks that may develop during or after installation, preventing their deterioration under typical traffic loads.

Suitable Applications for Post-Tensioned PPCP

The most common applications for post-tensioned PPCP systems can be grouped into two categories: short-length continuous repairs (less than 150 feet in length, typically within a single lane) and continuous repairs (greater than 150 feet in length and in one or more contiguous lanes), as illustrated in Figure 1-7. While some forms of PPCP can be used in any of these applications, PPCP is best suited for longer, continuous repairs where the full structural and ride quality benefits of post-tensioning can be realized. Much more information on the design, fabrication, installation and efficiency of PPCP may be found in PCI (2012) and Tayabji, et al (2013).

Jointed Precast Concrete Pavement (JPrCP)

Typical Characteristics of JPrCP

JPrCP is designed to expand and contract at every panel joint; that is, panels are not post-tensioned together and each panel expands and contracts independently. Transverse joint load transfer between precast panels and other precast panels or between precast panels and existing pavement is achieved with standard load transfer dowels.

JPrCP panels are typically sized to be one lane wide (typically about 12 feet) and about 16 feet or less in length. Panel thickness varies with the application. For example, intermittent repair (patching) panels are typically specified to approximately match the thickness of the surrounding pavement. JPrCP panels placed in continuous applications may be equivalent in thickness or thicker than the adjacent pavement, as dictated by design.

Precast panels in different lanes are typically tied across the longitudinal joints, although short runs of panels (less than 45 feet in length) are often not tied to adjacent lanes. Some designers choose to isolate long stretches of new precast lanes from adjacent existing lanes.

JPrCP is designed to function similarly to jointed cast- in-place pavement, so no structural reinforcing ~~steel~~ is required for service loads. However, precast panels do need to be reinforced for handling and transportation conditions. A minimum amount of ~~steel~~ conventional reinforcing (typically taken as the amount required by ACI 318 for temperature and shrinkage requirements in structures) is used. Some system manufacturers use additional reinforcing ~~steel~~ (often double the previously mentioned ACI requirements) placed in two layers, as shown in Figure 1-8, to provide additional resistance to temporary stresses that may be induced when traffic is allowed to use grade-supported panels before they are fully supported by grout. This is discussed in more detail in later chapters.

been placed and has achieved sufficient strength to resist the initial prestressing forces (the release strength), the strands are cut or released and the bond between the concrete and the strand resists the relaxation of the strand, leaving the embedded portion of the steel in tension and the surrounding concrete in compression. Pretensioning in long-line beds works well for planar (flat) panels since the strands reside in a single plane during fabrication. It is sometimes impractical to reinforce non-planar (warped) panels by pre-tensioning since reinforcing for these panels needs to be placed in a non-planar configuration (see Chapters 6 and 7).

- “Post-tensioning” refers to the installation of narrow tubes or ducts in the concrete panel forms at designed locations. The concrete is cast around these ducts and other embedded panel components. Prestressing strands are threaded through these ducts after the panels have been placed and are tensioned on-site. Tension is maintained with special locking devices at the joint faces. The ducts may also be grouted after tensioning is complete. When multiple panels are to be connected and drawn together by the post-tensioning process (as they are in precast post-tensioned concrete pavement, mentioned in Chapter 1), the ducts must be maintained in very precise locations during fabrication to allow the strand to be threaded through all the panels.

Pre-tensioning is the most common form of prestressing for JPrCP systems. Post-tensioning is rarely used.

Design of Slab Reinforcing

Deformed Bars

Conventional steel reinforcing is typically included at a rate of at least 0.2% (by area of concrete), as described earlier in this chapter. The 0.2% reinforcing quantity appears to be based on experience and typical American Concrete Institute requirements for minimum steel content to resist temperature and shrinkage in structural concrete members (ACI, 2014). Panels are typically reinforced in each direction to prevent catastrophic and dangerous panel failures during lifting and handling operations. Long, narrow panels can be reinforced in only the long direction if there is no risk of panel failure in the short direction.

Some agencies require that conventional steel reinforcing be protected from corrosion (typically with a 5- to 10-mil coating of epoxy meeting the requirements of ASTM A775/A775M, “Standard Specification for Epoxy-Coated Steel Reinforcing Bars,” or ASTM A934/A934M, “Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars”) when used in environments with deicing chemicals, salt water exposure or other corrosive agents. Additionally, non-corrosive reinforcing bars meeting the requirements of ASTM D7957/D7957M, “Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement” or CAN/CSAS807, “Specification for Fibre-Reinforced Polymers,” may be considered for design with approval of the owner agency. However, bare steel embedded in concrete is protected from corrosion through passivation and will not corrode, except where there is insufficient cover or at cracks, so epoxy coating is often not necessary.

Structural Fiber Reinforcing

Structural steel and synthetic fibers are increasingly being used in concrete pavement mixtures to enhance the fracture toughness and postcracking behavior of the concrete. Recommended dosages range from 3 to 7 pounds or more of synthetic fibers per cubic yard of concrete. Steel fiber dosages are significantly higher (25 to 50 pounds or more per cubic yard of concrete) because of the higher density of steel. These products should be used with careful consideration of the manufacturer’s recommendations and after preparing trial batches to ensure that the resulting fiber-reinforced concrete has uniformly distributed fibers, acceptable workability and finishing characteristics, and good hardened properties. The use of steel fibers should be considered carefully if a tined surface texture is specified because the texturing process may pull some surface fibers into a vertical orientation. This may be perceived as a tire puncture hazard by some agencies.

Figure 4-25. Examples of available corrosion-resistant dowel products.

high-strength grout during installation. This approach has been used successfully on several projects (Figure 4-23).

Alternate Dowel Materials and Shapes

Solid, cylindrical carbon steel dowels (often epoxy-coated for corrosion protection) are most commonly used in both CIP and precast concrete pavements. However, other types of dowel materials and shapes are seeing increased use, particularly for pavements with longer service life expectations.

Corrosion-resistant and Non-corroding Dowels

Conventional epoxy-coated dowels provide good protection against dowel corrosion if the epoxy layer remains intact. Unfortunately, normal manufacturing processes often leave small defects in the coating (called "holidays"). Coatings can also be damaged in normal shipping, handling and construction operations. When defects or damage is present, water, oxygen and chemicals (such as deicers and salt spray from marine environments) can enter pavement joints and travel along the dowel-concrete boundary to find points for attacking the steel, resulting in corrosion and possible joint restraint, loss of load transfer and pavement damage (Figure 4-24).

Dowel corrosion has been identified as one of the problems that must be addressed to successfully design and construct "long-life [or high-performance] concrete pavements" (which have been defined as concrete pavements with a design life of 40 or more years with no premature failure and no further required construction activity other than normal maintenance (Tayabji and Lim, 2006). Several manufacturers have developed dowels that are intended to address this need (Figure 4-25). Available products include solid and tubular stainless steel, stainless steel-clad carbon steel dowels, epoxy-coated carbon steel that has been press-fit into a stainless steel tube, zinc alloy-clad carbon steel dowels (both solid and tubular), epoxy-coated galvanized tubular carbon steel, solid and tubular fiber-reinforced polymer (FRP), FRP-encapsulated carbon steel, microcomposite steel, carbon steel with thicker epoxy coating, carbon steel with a special hardened epoxy layer over the ASTM A775 epoxy coating, and more.

These products are all reported to have unit costs that range from "slightly more" to "two to three times more" than those of conventional epoxy-coated carbon steel dowels, but those costs have been deemed worthwhile by many agencies for projects where high volumes of heavy traffic make frequent maintenance and repair operations highly undesirable (e.g., urban freeways and similar routes). Since JPrCP systems are used in similar applications with similar long-life performance expectations, the use of corrosion-resistant or non-corroding dowels should be considered any time the expected JPrCP service life exceeds 20 years.

Extractable Dowels for Utility Cuts and Incremental Reconstruction

It is sometimes beneficial or necessary to add new PCP panels adjacent to panels that were placed intermittently several years before as the existing concrete roadway around the originally placed precast panels continues to deteriorate. It is also reasonable to expect that PCP panels placed over utilities in urban areas may need to be removed and replaced periodically for future utility access. In both cases, top slots and solid conventional (or longer-life) dowels can be used to accomplish the tasks. However, most JPrCP placements in the U.S. to date have used bottom-slot construction and