SUPERSEDED BY EB 15-031 EFFECTIVE 9/28/15	MODIFIED BY EB 02-049 EFFECTIVE 9/12/02 & EI 04-020 EFFECTIVE 9/9/04		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 02-003

Title: **PORTLAND CEMENT CONCRETE (PCC) PAVEMENT**

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- ☒ Main Office (30)
- ☒ Local Govt. (31)
- ☒ Regions/Agencies (32)
- ☒ Surveyors (33)
- ☒ Consultants (34)
- ☒ Contractors (39)
- ☐ _____( )

Approved:

Robert L. Sack, Deputy Chief Engineer, Technical Services (Acting) — Date: 12/28/01

ADMINISTRATIVE INFORMATION: This Engineering Instruction (EI) is effective with projects submitted for the letting of 07/11/02, coinciding with the planned effective date for the proposed *2002 Standard Specifications*. It supersedes Standard Specification Section 502, Portland Cement Concrete Pavement. The EI Design and Construction Guidelines will eventually reside in the Comprehensive Pavement Design Manual and the Construction Inspection Manual, respectively.

PURPOSE: To issue a new standard specification and associated design and construction guidelines.

TECHNICAL INFORMATION:

Design Guidelines:

1. Project Selection. Consider PCC pavements when constructing or reconstructing roads projected to carry high traffic volumes and/or high equivalent single axle loads (ESALs). PCC pavement construction atop rubblized PCC pavement is also governed by the transmitted specification.

2. Thickness Selection. Consult the Comprehensive Pavement Design Manual (CPDM), Chapter 4, for pavement layer thicknesses. Show the layer thicknesses in the plans.

3. Pavement Hardware. The type, size, and spacing of longitudinal joint ties, transverse joint supports (dowels), reinforcing mesh, and reinforcing steel are depicted in the M502 Series Standard Sheets for Portland Cement Concrete Pavements, issued by EB 00-057. There is no need to repeat these details in the plans.

4. Projections Into The Pavement. Whenever possible, move drainage structures, utilities, and other projections into the pavement from travel lanes and into medians, shoulders, sidewalks, or other areas not routinely exposed to traffic. Such projections into the pavement:

   - Reduce the concrete cross section, thereby decreasing structural capacity.
   - Introduce complex joint layouts, irregular slabs, or high-cost heavily reinforced slabs.
   - Require significant effort to properly consolidate the concrete and isolate the structure.
   - Present weakened planes in plastic concrete which may initiate uncontrolled cracking.
   - Interrupt paving.
   - Result in bumps.

   If projections must be placed in travel lanes:

   - Space them such that reasonable transverse joint layouts may be accommodated. In general, space projections such that their midpoints are at least 3.5 m apart longitudinally. This includes projections in different lanes. That is, to accommodate reasonable transverse joint

layouts, assume all projections that occur across multiple lanes occur only in one lane. This one lane then controls transverse joint locations across multiple lanes.

- Center any portion of a projection that protrudes into the permeable base or PCC between longitudinal joints. If centering between longitudinal joints is not possible, locate the structure such that any portion that protrudes into the permeable base or PCC is at least 300 mm from any longitudinal joint. Avoid placing projections in the wheel paths or on longitudinal joints.
- Set the projection to a depth such that at least 100 mm of subbase can be placed between the top masonry surface of the projection and the bottom of the permeable base or the PCC slab isolating the projection.

5. Joint Layout. The need to provide a complete joint layout in the plans varies with project complexity. Generally, it is not practical to provide a complete joint layout in the plans because moving one joint during construction alters the layout significantly. It is recommended that the longitudinal joint locations be included in the plans if there are multiple maintenance and protection of traffic (M&PT) stages. Separate sheets devoted solely to joint layout, showing the longitudinal joint locations and projections within 250 mm of the bottom of the PCC slabs, are helpful to both the Contractor and Engineer when laying out joints at the project.

   It is highly preferable to align longitudinal joints between travel lanes with the final longitudinal pavement markings. The Contractor is required to submit the final joint layout based on construction staging and the locations of projections, tapers, irregular areas, etc. The joint layout is subject to the Engineer's approval. Guidance for joint layout is found in the Standard Sheets.

   For PCC intersections, a proposed joint layout should be included in the plans to provide the Contractor with a reasonable expectation of the work required. Intersection joint layouts are typically complex because of projections and intersecting centerlines. In the plans, reference Note 1 on Standard Sheet M502-17, Utility Isolation and Joint Layout - General Notes, to inform the Contractor that the joint layout is proposed only, and they are responsible for developing the final joint layout. The Field Engineering II Section of the Materials Bureau is available to assist in developing the proposed joint layout.

   When designing a PCC intersection, extend the PCC limits to the point where hot mix asphalt (HMA) rutting and shoving are likely to begin.

6. Slab Geometry. Show the typical slab length and width in the plans. The Standard Sheets depict slab lengths (transverse joint spacings) between 3.5 m - 5.5 m to allow flexibility during construction to accommodate utilities, drainage structures, and other projections into the pavement. For travel lanes, a typical slab length of 5.0 m is recommended for typical 3.6 m or 4.2 m slab widths, resulting in width-to-length ratios of 0.72 and 0.84, respectively.

   Consult the Standard Sheets for slab lengths associated with nontypical slab widths. A recommended maximum slab length at any location is the minimum slab width at that location divided by 0.70. A recommended minimum slab length is the maximum slab width divided by 1.33. Furthermore, if the project is designed without widened outer slabs, tied PCC shoulders, tied gutters, or tied curbs, a combination of shorter slab lengths and/or thicker slabs may be required. Consult the Materials Bureau.

7. Work Zones. Whenever possible, remove traffic from the facility under construction or make work zones as large as possible. Large work zones foster smoother, longer lasting, and less costly pavements by:

   - Allowing the use of high-quality, high-volume paving equipment.

- Minimizing short or irregular placements.
- Enhancing concrete delivery which reduces truck rejection, joint construction, and suboptimal joint configurations.

8. Class F and High-Early-Strength (HES) Concrete. Include an item for Class F concrete if the project is likely to contain short or closure placements that need to be opened to traffic more quickly than a Class C concrete allows. Class F concrete is typically opened to traffic 3 days after placement, while Class C concrete is typically opened 10 days after placement.

   If an even higher early strength concrete is required to expedite construction, select one of the HES pay item numbers. If an HES pay item is selected for a location, the contract documents should also include a work zone closure time frame for that location. The Contractor will design the HES mix based on the assigned closure time frame and the work required. When selecting a work zone closure time frame, consider HES mixes to be capable of developing the strength required for traffic opening 12 hours after placement, however, 18-hour mixes are preferable. Select joint filling items where HES concrete items are specified.

9. Concrete Compressive Strength Determination. Consult the Regional Materials Engineer to determine if compressive strength testing should be performed by the Regional Materials staff, rather than by the Contractor. If the Regional Materials Engineer elects to perform the testing, include the special note attached to this EI in the contract documents. Include the Regional Materials Engineer's address on the special note.

10. Smoothness Requirements. If a high level of smoothness is desired, consult the Materials Bureau for the recommended smoothness level and select one of the profilographed items. Select a Level 1 item for projects with sizable work zones and few or no projections into travel lanes. As a minimum, interstate and expressways should be built to Level 2 smoothness requirements. Deceleration or acceleration lanes tied to the main line pavement should have the same smoothness requirement as the main line pavement. After separation from the pavement, PCC ramps, when selected, can also be constructed using a profilograph item depending on geometrics, speed, and work zone availability.

    Select unprofilographed items for low-speed roads, city streets, intersections, or tied PCC shoulders. The portion of the shoulder placed as part of a widened driving lane should have the same smoothness requirement as the travel lane. Profilographed and unprofilographed work limits can be included in the same project. For example, the "legs" of an intersection built to a grade line can be profilographed, but the transitions between different grade lines, or over the crown of the intersection, can be unprofilographed.

    If a profilographed item is selected, include the corresponding pay item for the Smoothness Adjustment Factor in the contract documents. Quality Unit is the pay unit for the Smoothness Adjustment Factor. The quantity of Quality Units included in the contract documents is 0.05 times the cubic meters of profilographed PCC. The cost per Quality Unit will be determined in consultation with the Materials Bureau. Include the quantity of Quality Units and the established unit bid price in the bid documents.

11. Diamond Grinding Slurry Removal. Include a note or table in the contract documents indicating where diamond grinding slurry must be removed from the project. Slurry must not be deposited on business or residential property or into:

    - Closed drainage systems.
    - Occupied travel lanes.
    - Wetlands, streams, estuaries, or sensitive environmental resources.

- Areas where it will become a public nuisance.

12. Shoulder Type Selection. Use tied PCC shoulders or tied PCC curbs and/or gutters if the outer slabs cannot be widened 600 mm beyond the travel lane width as depicted in the Standard Sheets. If the outer slabs can be widened 600 mm, there are advantages to using full-depth HMA shoulders. HMA shoulders:

    - Are typically less costly for initial construction.
    - Result in less full depth PCC removal and replacement costs on future Concrete Pavement Restoration (CPR) projects.
    - Will not crack due to poor width-to-length ratios (e.g., 1.2 m wide inside PCC shoulders with 5.0 m lengths result in a very slender 0.24 ratio).
    - Can simplify construction, particularly when projections are in the shoulder.

    Tied PCC shoulders used to maintain traffic during construction should be constructed with transverse joint supports.

13. Ramp Type Selection. After a ramp diverges from the main line pavement, treat it as a separate design. Consider the anticipated traffic volume and geometrics when deciding between full-depth PCC or HMA ramps.

14. Joint Sealing or Joint Filling. Select an item to either seal pavement joints or fill pavement joints. At this time, the issue of whether to use a high quality joint sealant (neoprene compression or silicone sealant) or a lower quality joint filler (ASTM 3405) is debated nationwide. A body of research is gaining acceptance that indicates the cost of initially sealing joints and maintaining a high quality seal over the pavement service life is unjustified.

    Historically, NYSDOT has sealed pavement joints. However, considering NYSDOT's new pavement design which incorporates a permeable base and short slab lengths, the recent trend has been to fill joints. Joint filling performance will be monitored. A thorough discussion regarding the advantages and disadvantages of sealing or filling is beyond the scope of this instruction, however, the following conclusions have been made regarding joint sealing and filling:

    - A properly sealed joint will better keep water and debris out of the joint.
    - Sealing is more expensive than filling.
    - Upon material failure, a filled joint will collect less debris because it is narrower.
    - A filled joint is quieter because it is narrower.
    - A filled joint can be widened and sealed at a later date.
    - When a previously sealed joint is resealed, noise from "tire slapping" increases.
    - Filling joints expedites construction.
    - If a Region is unlikely to close a heavily trafficked road to reseal, select filling.
    - Select filling wherever an HES item is specified.

    Consult the Materials Bureau for guidance.

Construction Guidelines:

1. Equipment. Ensure that the equipment conforms to the specification, has no obvious defects, and is not leaking. Consult the Materials Bureau if assistance is needed to determine equipment conformance.

2. High-Early-Strength (HES) Concrete. If an HES concrete is specified, the mix design is the Contractor's responsibility. Transmit the proposed mix to the Regional Materials Engineer (RME) and the Director, Materials Bureau before trial batch production. The Contractor is also responsible for casting, curing, and transporting concrete cylinders used to determine the compressive strengths of both the trial batch concrete and the project concrete. Ensure the RME and Materials Bureau personnel attend trial batch production. Ensure the trial batch concrete has the same slump required by the Contractor to place the project's concrete.

   Unless otherwise noted in the contract documents, the Contractor is also responsible for all compressive strength testing. All testing and testing facilities must be approved by the Regional Materials Engineer. Three cylinder pairs, six total, are needed for one strength determination. It should be brought to the Contractor's attention that an adequate number of cylinders should be prepared in the event that the initial testing identifies inadequate concrete strength.

2. Profilograph. The Contractor is responsible for profilograph operations and trace development. The Materials Bureau should be consulted for equipment approval.

3. Joint Layout. Final joint layout is the Contractor's responsibility. The Contractor must submit a joint layout to the Engineer for approval at least 10 days before paving begins. To date, Engineers have typically consulted with the Materials Bureau. Longitudinal joint locations should typically be in the plans. It is highly desirable to align longitudinal joints with the final longitudinal pavement markings.

   If there are projections into the pavement in adjacent lanes placed in different stages, it is essential to locate joints in the initial placement such that their layout properly accommodates the projections in the subsequent placements. When developing joint layouts for past projects, it has been helpful to assume that all projections occurring across multiple lanes occur in the initial placement width. This initial placement then controls transverse joint locations across the full pavement width. If a reasonable joint layout cannot be accommodated for the placement assumed to contain all projections, refer to the Standard Sheets for multiple utility isolation and consult the Materials Bureau.

4. Consolidation. In general, hand vibration (using vibrators not attached to the paving equipment) has been poor. If the Contractor is employing hand vibrators to consolidate the PCC, a review of good vibrating practices should be discussed at the prepaving meeting. The Materials Bureau is available to discuss these practices, as well as equipment requirements in general, at the prepaving meeting.

5. Untied Longitudinal Joints With Shear Key. These joints are used at projections into the pavement and where nonparallel centerlines converge, such as ramps and intersections. Because these joints do not transfer any load through longitudinal joint ties, a larger key way is required. Refer to the Standard Sheets for construction details. Transverse joints may be misaligned when they intersect an untied longitudinal joint. Untied longitudinal joints use should be minimized and clearly indicated in the Contractor submitted joint layouts.

6. Diamond Grinding Slurry Removal. Slurry must not be deposited on business or residential property or into:

   - Closed drainage systems.
   - Occupied travel lanes.
   - Wetlands, streams, estuaries, or sensitive environmental resources.
   - Areas where it will become a public nuisance.

IMPLEMENTATION: Designers may specify PCC pavements by showing it on plan sheets and including the appropriate items listed at the end of the specification.

Disapproved statewide special specifications are:

- Item 18502.03, Cement Treated Permeable Base Course.
- Item 15502.04, Profilograph.
- Item 15502.0401, Cement Concrete Pavement, Reinforced, Class C Profilographed.
- Item 15502.0601, Cement Concrete Pavement, Unreinforced, Class C Profilographed.
- Item 15502.0402, Cement Concrete Pavement, Reinforced, Class C Profilographed.
- Item 15502.0602, Cement Concrete Pavement, Unreinforced, Class C Profilographed.
- Item 18502.4402, Sawing and Sealing Pavement and Shoulder Joints in New PCC Pavements.

This EI also disapproves all Regional 502 Special Specifications. Regions should submit a list of essential Regional 502 Special Specifications to the Field Engineering II Section of the Materials Bureau as soon as possible for a review of technical content, conformance to new issuances, and statewide applicability. The Materials Bureau will reissue submitted specifications with "18" prefixes by either Engineering Bulletin or Engineering Instruction depending on the complexity and previous use of the item in question.

TRANSMITTED ITEMS: To save printing expense, the full text of Section 502, Portland Cement Concrete Pavement, will be contained in advance copies of the *2002 Standard Specifications* to be made available to designers. Full text is also available on the IntraDOT site in the Design Quality Assurance Bureau's Specification and Standards page and with the electronic version of this EI on our web site at www.dot.state.ny.us, "Site Index", "E", "Engineering Directives...", "EI Index", "EIs Issued in 2002".

Attached to this EI is a special note to be inserted into the contract documents by the Regions, that is used when the Regional Materials Engineer elects to perform concrete compressive strength testing.

BACKGROUND: Standard Specification Section 502, Portland Cement Concrete Pavement, issued on January 2, 1995, is largely unchanged from the one issued on January 2, 1973. Several aspects of this specification have become obsolete or inappropriate over time. However, the relative scarcity of new PCC pavement construction from 1973 to 1995 made revisions unjustified. The October 1994 issuance of the Thickness Design Manual for New and Reconstructed Pavements further diverged existing standards from actual construction requirements.

The American Concrete Pavement Association (ACPA) was also aware of the discrepancies between existing Department standards and actual construction practices. They asserted that inadequate standards led to inadequate pavements and kept the Department from initiating and constructing PCC pavement projects. To address these concerns, a joint NYSDOT-ACPA Task Force was formed at ACPA's request. Section 502 issued by this EI and EB 00-057, Portland Cement Concrete (PCC) Pavement Standard Sheets, are Task Force products that incorporate state of the practice techniques initiated in recent PCC pavement construction.

CONTACT: The Field Engineering II Section of the Materials Bureau is available to assist Regional Design and Construction at (518) 457-4582.

SPECIAL NOTE

Concrete Compressive Strength Testing

For this project, all compressive strength testing will be performed by the Regional Materials Engineer at the Regional Materials Laboratory located at:

Address:

The Contractor is responsible for properly casting the appropriate number of cylinders, curing the cylinders, and delivering the cylinders, along with the corresponding Concrete Cylinder Reports completed by the Engineer, to the Regional Materials Laboratory.

Provide the Engineer a written interim testing schedule prior to any concrete placement requiring compressive strength testing. The Engineer will finalize the testing schedule based on the time the placement is completed and/or the opening to traffic requirements of the project. The Engineer and the Regional Materials Engineer will coordinate testing at the designated times. Once the required strength has been achieved, additional testing will be made at the Regional Materials Engineer's sole discretion.