National Concrete Pavement Technology Center

Tech Center

# Guide Specifications for Concrete Overlays

September 2015

**(Revised February 2016)**

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Institute for Transportation

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September 2015

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## Mission

The mission of the National Concrete Pavement Technology Center is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, technology transfer, and technology implementation.

## Disclaimer



## Nondiscrimination statement



## Notice of correction on page 10

Section N, including Table 3, on page 10 was revised in February 2016.

# TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

# INTRODUCTION

Resurfacing existing pavements with concrete pavement is a tried and true engineering solution for preserving our nation's infrastructure assets (Fick and Harrington 2014). The purpose of this document is to provide guidance for the development of project specifications that are tailored for concrete overlay projects. The guidance in this document is based on the agency's standard specifications for concrete pavement. If the standard specifications are outdated or rarely used, modifications other than those provided in this document (e.g., aggregate grading, water/cementitious materials ratio less than 0.42, permeability, smoothness incentives, etc.) may be necessary to produce a high quality, long lasting concrete pavement.

## TYPES OF CONCRETE OVERLAYS

Concrete overlays are considered either bonded or unbonded. The distinction between bonded and unbonded is strictly a pavement design issue. Meaning that during the pavement design process, a bonded overlay considers the existing pavement as a structural component and an unbonded overlay treats the existing pavement as merely a high quality subbase.

For further clarification regarding the distinction between bonded and unbonded concrete overlays, consult the *Guide to Concrete Overlays: Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavements,* 3rd edition (Harrington and Fick 2014). Within the bonded and unbonded concrete overlay types are further subcategories depending upon the existing pavement type (asphalt, composite, or concrete) (Figure 1).

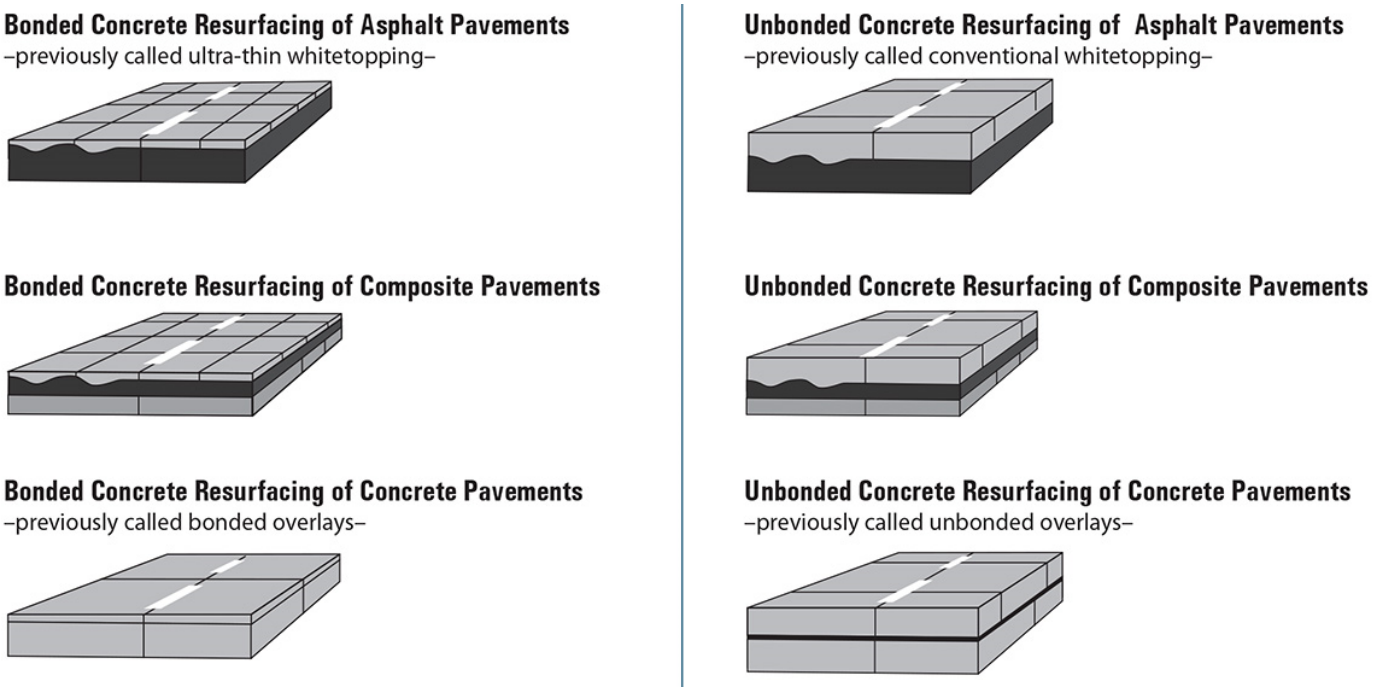


Figure 1. Types of Concrete Overlays

## FORMAT OF THIS DOCUMENT

Recognizing that there is a wide variation (style, order of items, etc.) in standard specifications across the United States, the guidance provided in this document is advisory in nature and not necessarily "specification language". Recommended specification modifications are provided by the appropriate overlay type. Users should modify the guidance as needed to fit within their standard specifications while preserving the intent of the recommendations provided. In many cases, brief explanations formatted as footnotes accompany the suggested guidance. Many of these footnotes include page references for the *Guide to Concrete Overlays: Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavements,* 3rd edition (Harrington and Fick 2014) for those who may desire to have a more detailed understanding of the basis for the specifications guidance.

## ADDITIONAL CONCRETE OVERLAY RESOURCES

The following documents are recommended for obtaining in-depth guidance on the design and construction of concrete overlays.

### *Guide to Concrete Overlays: Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavements,* 3rd Edition (Harrington and Fick 2014)

The primary goal of this guide is to fill the knowledge gap about concrete overlays so that pavement owners can confidently include concrete overlays in their toolbox of pavement solutions and make more informed decisions about designing and constructing them. Another goal is to help owner agencies understand and appreciate the versatility of concrete overlay solutions. This is not a complete step-by-step manual, nor does it provide prescriptive formulae or specifications for designing and constructing concrete overlays. Rather, as the title suggests, this booklet provides expert guidance that can supplement practitioners' own professional experience and judgment. In particular, since the 2nd edition was published, this edition enhances original material with updated information on the following topics:

- Evaluating existing pavements to determine if they are good candidates for concrete overlays
- Selecting the appropriate overlay system for specific pavement conditions
- Managing concrete overlay construction work zones under traffic
- Accelerating construction of concrete overlays when appropriate

### *Digital Library of Concrete Overlay Plans and Specifications*

A typical plan set, full plan sets, and special provisions of recent (2010 and later) concrete overlay projects will soon be available online via the National Concrete Pavement Technology Center website. These can serve as a valuable resource for specific design details, maintenance of traffic schemes, materials specifications, and overall examples of what is needed to successfully design and construct a concrete overlay project. The digital library will be organized by overlay type and will be updated as additional projects are completed.

### *Concrete Overlay Field Application Program Final Report: Volume I* (Fick and Harrington 2012)

The National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University conducted a four-year, multi-state concrete overlay construction program to demonstrate and document the concept and benefits of various concrete overlay applications and provide real-world lessons. Teams of CP Tech Center / FHWA experts completed 26 field site visits in 18 states and provided workshops or technical assistance on overlay projects in six additional states. The site visits included four open house demonstration projects. A report with recommendations was prepared for each of the site visits. As a result of the site visits and recommendations, concrete overlays were either constructed or scheduled for construction in nine states, and the teams provided additional advice and assistance as requested during the course of these projects. During the site visits, workshops, project planning, and construction, the teams recognized opportunities to improve concrete overlay projects for a variety of applications, and

the final report includes an overview of these lessons learned. Volume I of this final report outlines the field applications program purpose, activities, and results/lessons learned. Volume II includes copies of all documents prepared during the course of the program.

*Concrete Overlay Field Application Program Iowa Task Report: US 18 Concrete Overlay Construction Under Traffic* (Cable 2012)

The National Concrete Pavement Technology Center, Iowa Department of Transportation, and Federal Highway Administration set out to demonstrate and document the design and construction of portland cement concrete (PCC) overlays on two-lane roadways while maintaining two-way traffic. An 18.82 mile project was selected for 2011 construction in northeast Iowa on US 18 between Fredericksburg and West Union. This report documents planning, design, and construction of the project and lessons learned. The work included the addition of subdrains, full-depth patching, bridge approach replacement, and drainage structural repair and cleaning prior to overlay construction. The paving involved surface preparation by milling to grade and the placement of a 4.5 inch PCC overlay and 4 foot of widening to the existing pavement. In addition, the report makes recommendations on ways to improve the process for future concrete overlays.

## Contract Documents

A contract is a written agreement between the Contracting Authority and Contractor setting forth obligations of the parties thereunder, including but not limited to, performance of the work, furnishing of labor and materials, and basis of payment. The contract documents typically include the following:

- Addendum
- Contract Bond
- Contract Form
- Materials Instructional Memorandums
- Notice to Bidders
- Notice to Proceed
- Plans
- Proposal
- Special Provisions
- Standard Specifications, including General Supplemental Specifications
- Developmental Specifications
- Supplemental Specifications
- Any change orders and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument
- Local Agency Agreements (when applicable)
- DBE Commitment Forms (when applicable)
- Warranty Forms and Bonds (when applicable)

## How to Use the Guide Specifications for Concrete Overlays

Concrete pavement specifications, as with all specifications, are written to the contractor. The engineer provides specific requirements through the specifications for the contractor to complete the project. The following guide specifications for concrete overlays is written for a public agency to use in concrete overlay project development and in developing supplemental specifications or special provisions to their own concrete pavement specifications. It should be remembered that special provisions are a critical component of specifications. Prior to compiling their bids, contractors check the special provisions for each contract and also any supplemental specifications that the contracting authority may have that

modify the standard specifications. These documents supersede the standard specifications and take precedence as the work is pursued.

These guide specifications were developed with the involvement of engineers and construction industry representatives from across the nation. They elected to identify every aspect of typical concrete pavement and those items that are common to all concrete pavements were identified and followed by the statement **"Comply with contract documents."** Those items specific to concrete overlays only, were also identified followed by the specification statement. In this way, the user of the guide specifications can continually refer to the entire listing of concrete pavement items without having to go back to their own specifications in order to obtain an understanding of how the overlays items fit within the spectrum of a concrete specifications.

The guide specifications is set up in a consistent three-part format:
The **Part 1-General** provides a description of the type of work, as well as any specific requirements of the project. It also lists what work activities are included in each bid item and how each item will be measured and paid for.

**Part 2-Products** lists materials and concrete mixtures to be used to accomplish the project. The specifications provide the specific AASHTO or ASTM requirement.

**Part 3-Execution** lists the construction requirements. The construction activities are tailored to concrete pavement products. Some agencies add standard detail drawings to the construction section to further clarify construction or product requirements. These standard details are not included in the guide specifications, but such details can be obtained in the 2014 edition of the CP Tech Center's Guide to Concrete Overlays (Harrington and Fick 2014). If specific testing processes are required, they may be included within the execution requirements.

# PART 1 – GENERAL

## 1.01 SECTION INCLUDES

A. Bonded Concrete Overlays Over Concrete
B. Bonded Concrete Overlays Over Asphalt
C. Unbonded Concrete Overlays Over Concrete
D. Unbonded Concrete Overlays Over Asphalt

## 1.02 SUBMITTALS

**Follow the DOT contract documents for submittals as well as the following:**

A. Mix Design: Two weeks prior to commencing PCC pavement placement, submit a paving mix design for each different source of aggregate to be used for review and approval by the Engineer. Submit mixes or mix design approved by the Department of Transportation (DOT) or an independent testing laboratory.

B. Materials: Submit data on proposed admixtures, fibers, curing compounds, HMA mix design, geotextile interlayer, expansion joints, joint fillers and sealers, and grout. See Table 1.

C. Equipment: Submit list of proposed paving equipment, conveyors, placers, spreaders, and other major equipment.

D. Samples and Testing: Submit all field sampling and testing according to DOT requirements and include the following as shown in Table 1.

E. Submit a Quality Control Plan in accordance with the contract documents[1].

**Table 1. Material Testing**

| Material or Construction Item | Tests |
|---|---|
| Fine Aggregates | Gradation |
| | Moisture |
| | Specific Gravity |
| | Quality |
| Coarse Aggregates | Gradation |
| | Moisture |
| | Specific Gravity |
| | Quality |
| Portland Cement | Quality |
| Fly Ash | Quality |
| GGBFS | Quality |
| Air Entrainment | Quality |
| Water Reducer | Quality |
| Accelerator | Quality |
| Curing Compound | Quality |
| Joint Sealer | Quality |
| Epoxy Dowel Bars and Assemblies | Quality |
| Tie Bars | Quality |
| Plastic Concrete | Air Content |
| | Slump |
| | Cylinders 6in. |
| | Beams |
| | Thickness |
| Hardened Concrete | Smoothness |
| | Thickness[2] |
| | Strength |
| Synthetic Fibers | Mass per unit area |
| | Thickness under load |
| | Tensile Strength |
| Maturity Curves | Maturity readings |
| HMA Separation Layer | Material/Quality |
| Geotextile Separation Layer | Material/Quality |

[1] A Quality Control (QC) Plan is defined as a project-specific document prepared by the contractor that identifies all QC personnel and procedures that will be used to maintain all production and placement processes "in control" and meet the agency specification requirements. In simple terms, it requires the contractor to face issues before problems show up and maintain control of the project. Also, a Quality Control Plan is intended to provide a proactive roadmap for all contractor members on a construction project to tangibly apply the "Zero Defects" philosophy and prevent problems or "deficiencies" from occurring in the first place. A contractor QC system begins with the proper QC organization and a well written Quality Control Plan. It includes sampling, testing, and inspection. QC must address activities at contractor manufacturing, fabrication, and production facilities as well as at field placement locations. It also requires maintaining good records.
See FHWA "Field Reference Manual for Quality Concrete Pavements." Publication No. FHWA-HIF-13-059 September 12, 2012. Appendix A of this document provides a list of items to be considered in developing a Quality Control Plan for concrete overlays. The level of detail required in a Quality Control Plan depends on the size and complexity of the project.

[2] It is strongly recommended that concrete overlay has two pay items, i.e., one in cubic yards for the material delivered and the second one in square yards for placement. This allows the contractor to maintain a specified minimum thickness even with irregularities in the existing pavement surfaces such as variable cross slopes, undulating profiles, rutting, etc.

## 1.03 SCHEDULING AND CONFLICTS

A. Construction Sequence:
   1. Prior to commencing construction, submit a plan including anticipated dates for traffic closures and opening, construction sequence, and schedule.
   2. Submit a detailed description of the sequence of operations for concrete delivery, placement, and finishing.

B. Traffic Control Plan: Develop a traffic control plan based on the Manual on Uniform Traffic Control Devices (MUTCD). Review traffic control plans that are provided in the contract documents and use traffic control devices complying with the MUTCD.

C. Conflict Avoidance: Expose possible conflicts in advance of construction. Verify elevations and locations of each clearance for proposed construction. Complete elements of work that can affect line and grade in advance of construction unless noted on plans.

D. Opening to Traffic: Comply with contract documents.

E. Use of Shoulders: Comply with contract documents.[3]

F. Limitations of Operation:
   1. Concrete Placement: For temperatures below 55°F, comply with contract documents.
   2. Open Strength: Comply with contract documents.
   3. Edge Loading Prior to Opening: Comply with contract documents.

## 1.04 SUBSTITUTIONS

Comply with contract documents.

## 1.05 DELIVERY, STORAGE, HANDLING, AND SALVAGING

A. Aggregate Storage: Comply with contract documents.

B. Cement and Fly Ash: Comply with contract documents.

C. Admixtures: Store in suitable weather tight enclosures that will preserve quality, and comply with DOT contract documents.

D. Reinforcing Steel: Store off ground on timbers or other supports, and comply with DOT Contract documents.

[3] If the engineer approves the use of shoulders for construction activities by the contractor, they shall be repaired at no additional cost.

## 1.06 MEASUREMENT AND PAYMENT

A. PCC Overlay, Furnish Only:
   1. Measurement: Measurement will be in cubic yards of PCC furnished, including concrete placed in widening sections, partial depth patches, and irregular sections.
   2. Payment: Payment will be at the unit price per cubic yard of PCC furnished.
   3. Includes: Unit price includes, but is not limited to, furnishing the concrete mixture and delivery of concrete to the project site.

B. PCC Overlay, Place Only:
   1. Measurement: Measurement will be in square yards based on the area shown in the contract documents. Area will be computed from the longitudinal surface and nominal width, including widening sections, partial depth patches, and irregular sections. The area of manholes, intakes, or other fixtures will not be deducted from the measured overlay area.
   2. Payment: Payment will be at the unit price per square yard.
   3. Includes: Unit price includes, furnishing all materials, labor, and equipment necessary for placement of integral curb; sawing, cleaning, and sealing joints; finishing and texturing; standard surface curing; placement of tie bars and dowel bars[4]; boxouts for fixtures; pavement protection; and pavement smoothness testing.

C. Surface Preparation for Bonded PCC Overlay:
   1. Measurement: Measurement will be in square yards based on the area shown in the contract documents. Area will be computed from the longitudinal surface and nominal width of the existing pavement.
   2. Payment: Payment will be at the unit price per square yard.
   3. Includes: Unit price includes, but is not limited to, sandblasting, shot blasting, and surface cleaning.

D. Surface Preparation for Unbonded PCC Overlay:
   1. Measurement: Measurement will be in square yards based on the area shown in the contract documents. Area will be computed from the longitudinal surface and nominal width of the existing pavement.
   2. Payment: Payment will be at the unit price per square yard.
   3. Includes: Unit price includes all surface preparation required by the contract documents.

E. Mill Existing Surface:
   1. Measurement: Measurement will be in square yards based on the area shown in the contract documents. Area will be computed from longitudinal surface and nominal width of the existing pavement.
   2. Payment: Payment will be made at the unit price per square yard.
   3. Includes: Unit price includes, but is not limited to, milling existing pavement surface to the depth specified, removal and disposal of millings, and cleaning of the pavement surface.

F. HMA Separation Layer for Unbonded PCC Overlay:
   1. Measurement: Measurement will be in square yards based on the area shown in the contract documents. Area will be computed from the longitudinal surface and nominal width of the existing pavement.

[4] Some states pay for each tie and dowel bars used as separate item.

2. Payment: Payment will be at the unit price per square yard.
3. Includes: Unit price includes, but is not limited to, cleaning surface, furnishing and placing the HMA mixture, and the cost of the asphalt binder.

G. Geotextile Separation Interlayer:
1. Measurement: Measurement will be in square yards based on the area shown in the contract documents. Area will be computed from the longitudinal surface and nominal width of the existing pavement.
2. Payment: Payment will be at the unit price per square yard.
3. Includes: Unit price includes, but is not limited to, cleaning surface and furnishing, placing, and securing the geotextile fabric separation layer.

H. Enhanced Curing:
1. Measurement: Measurement will be in square yards based on the area shown in the contract documents. Area will be computed from the longitudinal surface and nominal width, including widening sections.
2. Payment: Payment will be at the unit price per square yard.
3. Includes: Unit price includes, but is not limited to, handling, supplying, and applying enhanced curing compound at the rate specified.

I. Deficiencies: Comply with contract documents[5].
1. Air Content
2. Pavement Smoothness
3. Thickness

J. Fixture Adjustment[6]: Comply with contract documents.

K. PCC Pavement Samples and Testing: Comply with contract documents.

L. Pavement Removal: Comply with contract documents.

M. Pavement Repair and Rehabilitation: Comply with contract documents.

[5] These are typical minimums. Some states may have others such as strength, permeability, etc.
[6] Fixture adjustments are covered in state specifications for adjustments to sanitary sewer/storm sewer manholes, intake boxouts, water values, fire hydrants, and other appurtenances such as signal loops.

# PART 2 – PRODUCTS

## 2.01 MATERIALS

A. Cement: Comply with contract documents.

B. Supplementary Cementitious Materials (SCM): Comply with contract documents.

C. Fine Aggregate: Comply with contract documents.

D. Coarse Aggregate: Comply with contract documents, and the following:
   1. The nominal maximum size of the coarse aggregate shall be no greater than one-third of the concrete overlay thickness.
   2. Use aggregates for bonded overlays of concrete pavement that will produce a concrete mixture having a coefficient of thermal expansion (CTE) equal to or less than the CTE of the existing concrete pavement.[7]

E. Fiber Reinforcement[8]:
   1. Provide macro synthetic fibers complying with ASTM C 1116, Type III
   2. Incorporate at a dosage of *specify*[9] pound per cubic yard
   3. ASTM C1609 Residual Strength Method

F. Water: Comply with contract documents.

G. Admixtures: Comply with contract documents.

H. Reinforcing Steel, Tie Bars, Load Transfer Dowels, and Embedded Items: Comply with contract documents.

I. Expansion Joint: Comply with contract documents.

J. Joint Fillers and Sealers: Comply with contract documents.

K. Curing Compound: Comply with contract documents; for concrete overlays ≤ 6 inches thick[10], provide curing compound complying with ASTM C 309, Type, 2, Class B with 100% of resin consisting of poly-alpha methylstyrene (PAMS) meeting the requirements of Table 2.

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[7] To minimize stresses caused by differential thermal movement, the CTE of the concrete overlay mixture should be similar to but not exceed the CTE of the existing concrete pavement (Harrington and Fick 2014, p. 76).

[8] Fiber reinforcement is an option and not a requirement. Fiber reinforcement is typically used in concrete overlays 4 inches or less.

[9] Insert the desired dosage rate. Typical dosage rates are from 3 lb/yd$^3$ to 7.5 lb/yd$^3$, tests and demonstrated ranges are used for practical highway applications using ASTM C 1609 or use specified residual strength see (ASTM C 1609). (Harrington and Fick 2014, pp. 77–78 and 113–115)

[10] Thinner concrete overlays have a higher ratio of surface area to volume and are more sensitive to the detrimental effects of surface evaporation. Curing compound with PAMS resin has proven to be an effective curing compound.

Table 2. Material Requirements for Poly-Alpha Methylstyrene Curing Compound

| Properties | Range |
|---|---|
| Total solids, % by weight of compound | ≥ 42 |
| % reflectance in 72 hr (ASTM E 1347) | ≥ 65 |
| Loss of water, kg/m$^2$ in 24 hr (ASTM C 156) | ≤ 0.15 |
| Loss of water, kg/m$^2$ in 72 hr (ASTM C 156) | ≤ 0.40 |
| V.O.C. Content, g/L | ≤ 350 |

L. Grout for Embedded Items: Comply with contract documents.

M. Hot Mix Asphalt as Separation Layer for Unbonded Overlay[11]: Comply with contract documents.[12]

N. Geotextile Fabric as Separation Layer for Unbonded Overlay: Based on the contract document's specified mass per unit area, provide a geotextile fabric meeting the requirements in Table 3. [**Note: This section, including Table 3, was revised in February 2016.**)

Table 3. Geotextile Separation Layer Material Requirements

| Property | Requirements | Test Procedure |
|---|---|---|
| Geotextile Type | Nonwoven, needle-punched, no thermal treatment to include calendaring† | EN 13249, Annex F (Certification) |
| Color | Uniform/nominally same color fibers | (Visual Inspection) |
| Weight (mass per unit area)[13] | ≥ 450 g/m$^2$ (13.3 oz/yd$^2$)<br>≥ 500 g/m$^2$ (14.7 oz/yd$^2$)<br>≤ 550 g/m$^2$ (16.2 oz/yd$^2$) | ISO 9864 (ASTM D 5261) |
| Thickness under load (pressure) | [a] At 2 kPa (0.29 psi): ≥ 3.0 mm (0.12 in.)<br>[b] At 20 kPa (2.9 psi): ≥ 2.5 mm (0.10 in.)<br>[c] At 200 kPa (29 psi): ≥ 0.10 mm (0.04 in.) | ISO 9863-1 (ASTM D 5199) |
| Wide-width tensile strength | ≥ 10 kN/m (685 lb/ft) | ISO 10319 (ASTM D 4595) |
| Wide-width maximum elongation | ≤ 130 percent | ISO 10319 (ASTM D 4595) |
| Water permeability in normal direction under load (pressure) | ≥ 1 x 10$^{-4}$ m/s (3.3 x 10$^{-4}$ ft/s) at 20 kPa (2.9 psi) | DIN 60500-4 (modified ASTM D 5493) |
| In-plane water permeability (transmissivity) under load (pressure) | [a] ≥ 5 x 10$^{-4}$ m/s (1.6 x 10$^{-3}$ ft/s) at 20 kPa (2.9 psi)<br>[b] ≥ 2 x 10$^{-4}$ m/s (6.6 x 10$^{-4}$ ft/s) at 200 kPa (2.9 psi) | ISO 12958 (ASTM D 6574)<br>or<br>ISO 12958 (modified ASTM D 4716) |
| Weather resistance | Retained strength ≥ 60 percent (70% average) | EN 12224 (ASTM D 4355 @ 500 hr exposure for grey, white, or black material only) |
| Alkali resistance | ≥ 96 percent polyproplene/polyethylene | EN 13249, Annex B (Certification) |

† Calendering is a process that passes the geotextile through one or more heated rollers during the manufacturing process. The surface of the geotextile is modified during this process. Calendering may reduce the absorption properties of the geotextile on the calendered side.

[11] Separation layers should be measured and paid for as unique pay items; pertinent items are included for clarity. Modifications should be made to individual specifications either for hot mixed asphalt or geotextile fabric.

[12] Unbonded overlay projects with high truck traffic and poor drainage characteristics have shown early distresses from a loss of support due to stripping of dense graded asphalt separation layers (Harrington and Fick 2014, pp. 48, 59–61, and 78). Provide positive drainage for the asphalt separation layer. Also specifiers should consult with local aggregate suppliers to develop an economical gradation that can provide adequate drainage characteristics. The separation layer should always be daylighted to the edge of the shoulder or a subdrain system installed. Antistrip additives can be incorporated into the asphalt mix. Lime has been found to be more effective than liquid anti-stripping additives. To help with reducing surface water intrusion into the asphalt separation layers some states have sealed concrete overlay joints and at the shoulder.

[13] The contract documents need to specify the weight of the fabric (mass per unit area). Recommended for unbonded overlays ≤ 4 inches thick = 13.3 oz/yd$^2$, 130 mils thick; for unbonded overlays ≥ 5 inches thick = 14.7 oz/yd$^2$, 170 mils thick. The 16.2 oz/yd$^2$ is typically not used except for very thick overlays. Check with the manufacturer for specifics before using.

### 2.02 CONCRETE MIX

Comply with contract documents; when fiber reinforcement has been specified, adjust batching and mixing procedures as necessary to homogeneously distribute the fiber reinforcement.[14]

# PART 3 – EXECUTION

### 3.01 EQUIPMENT

A. Weighing, Batching, and Mixing Equipment: Comply with contract documents.

B. Concrete Placement Equipment:
   1. Consolidating and Finishing Equipment: Comply with contract documents.
   2. Vibrators for Machine Paving: Comply with contract documents.
   3. Vibrators for Hand Placement: Comply with contract documents.
   4. Hand Finishing Equipment: Comply with contract documents.
   5. Forms: Comply with contract documents.
   6. Curing Equipment: Comply with contract documents.
   7. Concrete Saws:
      a. Comply with contract documents.
      b. When joint spacing is less than typical due to reduced pavement thickness, add the following[15]:
         The number of saws required should be estimated. Prior to construction, this estimate is to be based on the placement production rate and the sawing production rate. Before paving begins, provide an adequate number of saws and blades on-site based on the estimate.
   8. Joint Sealing Equipment Comply with contract documents.
   9. Milling Equipment: Comply with contract documents.
   10. Shot Blasting Equipment: Provide shot blasting equipment capable of collecting used shot and waste material. Use of recycled shot material is allowed.

### 3.02 PAVEMENT CONSTRUCTION

A. Pre and Post Construction: Comply with contract documents.
B. Overlay transition areas at the beginning and end of project limits and at bridges; comply with contract documents.
C. Temperature Limitations:
   1. Air Temperature: Do not place overlay concrete when air or existing pavement surface is below 40°F.
   2. Pavement Temperature: If the surface of the HMA is above 110°F, apply water mist to the surface of the HMA ahead of the paving operation in order to cool the surface. Apply water mist far enough in advance of the paving operation so that the surface will cool from evaporation before concrete is placed. Ensure no standing water remains on the surface at the time the overlay is placed.

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[14] Fibers should be mixed thoroughly to prevent clumping and balling within the fresh concrete (Harrington and Fick 2014, p. 114).

[15] The contractor should demonstrate that the sawing operation is capable of sawing the concrete overlay in a timely manner (Harrington and Fick 2014, p. 105).

D. Bonded Surface Preparation:
   1. Over PCC:
      a. Remove all dirt, oil, and other foreign materials, as well as any laitance or loose material from the surface against which new concrete is to be placed, including all pavement markings and raised pavement markings.
      b. When required to mill the existing surface to the required depth and cross slope as shown in the plans, shotblast or waterblast the milled surface. Complete patching with concrete patches after milling, as shown in the plans[16].
      c. Sweep the prepared surface and blow clean with dry oil free compressed air directly ahead of the paving operation. Keep air blasting operations as close to overlay operations as possible to prevent any resettlement of debris onto previously cleaned area. If material is subsequently tracked onto the surface, the surface must be re-cleaned.
   2. Over HMA:
      a. When required, mill the existing surface to the required depth and cross slope as shown in the plans[17].
      b. Sweep and air blast surface to remove any loose dirt or debris. Keep air blasting operations as close to overlay operations as possible to prevent any resettlement of debris onto previously cleaned area. If material is subsequently tracked onto the surface, the surface must be re-cleaned.

E. Unbonded Surface Preparation: Clean the existing pavement surface immediately prior to paving to remove dirt or debris.
   1. Over PCC:
      a. Do not scarify the existing PCC surface if an HMA stress relief course will be constructed.
      b. When placing a geotextile on milled surface, limit ridges on milled surfaces to 1/4 inch maximum height.
   2. Over HMA:
      a. Trim high spots in an existing asphalt surface as specified in the contract documents.
      b. Remove all loose asphalt material after milling.

F. Existing Pavement Loading:

[16] Whether a concrete patch is placed separately or poured at the same time as the overlay (i.e., in one paving operation), the result is a spot section of thicker concrete. This thicker section of concrete will move differently from the adjacent asphalt, so no single overlay panel should be over both asphalt pavement and the concrete patch. This will require adjusting the normal jointing pattern of the overlay so the section over the concrete patch is isolated.

[17] Most surface distresses can be removed through milling. Milling may be used where surface distortions are 2 in. or greater. The amount of asphalt removed depends on the types and severity of distresses and the thickness of the asphalt. Milling can be used to remove gross irregularities that would cause quantity overruns in the volume of concrete needed for the overlay; it is not necessary to obtain a perfect cross section or to completely remove ruts. If a stripped (loose) layer of asphalt is encountered, it must be completely removed to provide a sound structural layer for bonding. The minimum thickness of structurally sound asphalt required for bonding is 3 inches. Construction traffic, specifically, trucks loaded with concrete, can cause significant damage to the remaining asphalt pavement. An adequate layer of asphalt is required to prevent delamination, thus ensuring that the asphalt will function as a load-carrying portion of the composite section (not as a separation layer of shear plane, as in an unbonded overlay). Some construction traffic, however, can be placed on the milled surface to identify any loose material (i.e., partial lifts, deteriorated asphalt, isolated areas of stripping, etc.) remaining after the milling operation. All unsound areas should be removed prior to performing any further operations.

1. Travel of concrete delivery trucks on the existing pavement must be approved by the Engineer. In such cases, cleaning and water misting of the existing pavement must be limited to just ahead of the paving machine.
2. Do not allow loads in excess of the legal axle load on the existing pavement.
3. Partially loaded trucks may be required to prevent damage[18].

G. Paving Suspended:
   1. Suspend the paving operation where stability of the underlying pavement section has been lost.
   2. Do not place concrete on an underlying pavement that has become unstable.

H. Surface Fixture Adjustment: Comply with contract documents.

I. Setting of Forms: Comply with contract documents.

J. Bar and Reinforcement Placement:
   1. Tie Bars: Comply with contract documents.
      a. Widening units equal or greater in thickness than overlays
         (1) Maximum No. 4 bars to be used when tie bars are required.
         (2) Unless otherwise specified, epoxy tie bars to existing pavement when overlay thickness is 4 1/2 inches or less.
   2. Dowel Bar: Comply with contract documents[19].
   3. Provide a Quality Control Plan for Anchoring Dowel Basket Assemblies[20]
      a. At least 7 days prior to the beginning of concrete paving, provide a Quality Control Plan in writing to the Engineer for acceptance that provides a method for keeping the dowel basket assemblies anchored to the subgrade, the existing concrete, or into the asphalt or bond breaker layer and into the underlying concrete. At a minimum, include the following in the Quality Control Plan:
         (1) Proposed type and number of fasteners
         (2) Proposed installation equipment
         (3) Dowel basket assembly anchoring plan, stating if basket assemblies are anchored prior to or during concrete placement, one lane at a time.
         (4) Action plan if mis-aligned baskets are identified during concrete pavement placement
      b. The Engineer will suspend paving operations if the Contractor fails to comply with their Quality Control Plan.
   4. Bar Mats for Reinforced Pavement: Comply with contract documents.

K. Concrete Pavement Placement: Comply with contract documents.
   1. Ensure the prepared surface is close to but no wetter than Saturated Surface Dray (SSD) and no standing water exists.

[18] If the existing pavement has been milled to meet vertical restrictions and the remaining pavement before placement of the overlay is relatively thin, (min. 3" of HMA) then the amount of trucks hauling over the existing pavement must be analyzed to prevent damage to the pavement.
[19] Dowel joints are used for 7" thick or greater unbonded overlays with measureable truck traffic.
[20] Some unbonded overlays placed on HMA interlayers (especially variable thickness) have experienced movement of the dowel baskets during the slipform paving process. Necessary precautions and inspection should be undertaken to monitor basket placement (Harrington and Fick 2014, pp. 104–105).

2. Submit a plan for placement of bonded overlay when the ambient air temperature is below 65°F and dropping.[21]

L. Integral Curbs: Comply with contract documents.

M. Finishing:
   1. Grade and Crown: Comply with contract documents.
   2. Watering the Surface: Comply with contract documents.
   3. Floats: Comply with contract documents.
   4. Straightedging: Comply with contract documents.
   5. Surface Texture: Comply with contract documents.
   6. Edge Finish: Comply with contract documents.

N. Surface Curing:
   1. Apply liquid curing compound in a fine spray to form a continuous, uniform film on the horizontal surface and vertical edges of pavement, curbs, and back of curbs immediately after surface moisture has disappeared, but no later than 30 minutes after final texture. With approval of the Engineer, the timing of cure application may be adjusted due to varying weather conditions and concrete mix properties to ensure acceptable macrotexture is achieved[22].
   2. Apply compound with power sprayer; rate of application not less than the manufacturer's recommendation[23].
   3. Ensure liquid curing materials are well agitated in the supply drum or tank immediately before transfer to the sprayer. Keep curing materials well agitated during application.
   4. Hand operated sprayers may be used for small and irregular areas.
   5. If forms are used, apply to pavement edges and back of curbs no later than 30 minutes after forms are removed.
   6. If, due to other operations, the coating is damaged within 72 hours after being applied, immediately re-coat the affected areas. When pavement is opened to traffic prior to 72 hours after application of the curing coating, a re-coating will not be required.

[21] When a bonded concrete overlay is placed in cooler weather, the day/night temperature differential will cause movement in the existing pavement; it will expand during the day and contract at night. To prevent cracking in the overlay, the overlay must reach saw strength before the underlying pavement's nighttime contraction. Specifying a minimum overlay mix temperature of 65°F has proven to be helpful in mitigating this set-time issue. In addition, when a concrete overlay is placed in cooler weather, the concrete can set from the bottom up, delaying the sawing window. Temporarily covering the overlay with plastic after paving helps the concrete to set properly, allowing for timely sawing.

[22] Approved mitigation measures should be followed when there is a risk of surface evaporation before curing compound can be applied (Harrington and Fick 2014, p. 105).

[23] Curing of thinner overlays (≤7 inches) is critical due to high surface area to volume ratio. The application rate of curing compound may need to be increased and applied in two coats (Harrington and Fick 2014, p. 105) to prevent detrimental effects of surface evaporation.

O. Construction of Joints: Comply with contract documents[24].

P. Saw Joints: Comply with contract documents.

1. For all concrete overlays: Submit a plan for the Engineer's approval, which includes the following:
   a. Method(s) for assuring adequate saw cut depth in areas of variable concrete overlay thickness.
   b. Anticipated production rate of concrete overlay placement.
   c. Estimated number of saws necessary to prevent random cracking.
   d. Appropriate corrective actions should random cracking occur[25].

2. Bonded Overlay Over Existing Concrete Pavement: Submit a plan for the Engineer's approval, which includes the following:
   a. Marking of all existing joint locations to ensure that joints in the overlay will be placed directly over all existing joints in the underlying concrete pavement.
   b. Transverse Joints:
      1) Saw transverse contraction joints directly over the existing concrete joint the full depth of the overlay plus 1/2 inch (including accommodating variable thickness of the bonded concrete overlay)

24

| Joints spacing for concrete overlays is very important and requires special consideration for each type: | Bonded over Concrete | Bonded over Asphalt for Composite | Unbonded over Concrete | Unbonded over Asphalt or Composite |
|---|---|---|---|---|
| Joints are to be matched with underlying concrete to prevent reflective cracking. | X | | | |
| Intermediate joints are encouraged when the existing longitudinal and transverse joint spacing (in feet) is greater than 2 times the overlay thickness in inches. See page 36 of the 2014 Guide to Concrete Overlays. | X | | | |
| When feasible, it is a good policy to mismatch joints and/or cracks to maximize load transfer from the underlying pavement. Some states that have not intentionally mismatched joints, however, have not experienced any adverse effects. | | | X | X |
| The recommended joint pattern for bonded overlays of asphalt should not exceed 1.5 times the overlay thickness in inches. | | X | | |
| For overlays less than or equal to 6 inches thick, the slab dimensions (in feet) should not exceed 1.5 times the overlay thickness in inches (e.g., 4 in. x 1.5 ft/in. = 6 ft). | | | X | X |
| For overlays greater than 6 inches, the slab dimensions (in feet) should not exceed 2.0 times the overlay thickness in inches, not to exceed 15 ft. | | | X | X |
| Because of the potential for higher curling and warping stress from a rigid underlying pavement, shorter than normal spacing is typical (see pages 40, 44 and 49 of the 2014 Guide to Concrete Overlays). | | | X | X |

25 For a given concrete plant production rate, thinner overlays (≤ 7 inches) typically result in a higher placement rate ($yd^2$/hour). When coupled with smaller slab dimensions, which require more sawed joints per square yard, the number of saws necessary to prevent random cracking is increased substantially. Contractors need to be prepared for this with adequate sawing equipment and/or adjust the concrete overlay placement rate to match their joint sawing capacity (Harrington and Fick 2014, pp. 65 and 105).

2) Ensure the width of the sawed transverse joints in the bonded concrete overlay exceeds the width of the crack opening in the underlying joints[26].

c. Longitudinal Joints: Saw directly over existing joints full depth.

3. Bonded Overlay Over Existing Asphalt or Composite Pavement:
   a. Transverse Joint: Saw to depth of 1/3 of the overlay thickness or no less than 1 1/4 inches with an early entry saw.
   b. Longitudinal Joints: Saw to a depth of 1/3 of the overlay thickness.
   c. Expansion Joints: Expansion joints in the existing concrete pavement should be matched in the bonded overlay.

4. Unbonded Overlays Over Concrete, Composite, or Asphalt Pavement:
   a. Transverse Joints: Saw to depth of 1/3 of the overlay thickness or no less than 1 1/4 inches with an early entry saw.
   b. Longitudinal Joints: Saw to depth of 1/3 of the overlay thickness.
   c. Expansion Joints: Expansion joints in the existing concrete pavement should be matched in the unbonded overlay.

Q. Joint Sealing: Comply with contract documents

R. Pavement Backfill: Comply with contract documents

S. Form Removal: Comply with contract documents

## 3.03 PAVEMENT PROTECTION

A. Weather Conditions:
   1. Cold Weather: Comply with contract documents.
   2. Hot Weather: Comply with contract documents.
   3. Rain Protection: Comply with contract documents.

B. Protection from Traffic: Comply with contract documents.
   1. End of Day's Run: Comply with contract documents.
   2. Repair of Damages: Comply with contract documents.

## 3.04 OPENING PAVEMENT TO TRAFFIC

Comply with contract documents.

## 3.05 TRANSPORTATION RESTRICTIONS

Comply with contract documents.

## 3.06 QUALITY CONTROL

Comply with contract documents.

[26] Joints in a bonded concrete overlay of existing concrete pavement must align with the underlying joints (Harrington and Fick 2014, pp. 35 and 58).

# REFERENCES

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# APPENDIX A
# Contractor Quality Control Plan (QC)

A quality control (QC) plan for concrete overlays is a document prepared by the prime contractor and subcontractors to ensure that the quality of the project is controlled within the specification requirements. The QC plan is a project specific document which should be used to maintain all production and placement processes in accordance with the contract documents. Requiring the contractor to think about the project and build it on paper before the project commences is beneficial. In addition, it establishes an understanding between the contractor and the highway agency of how the project will be managed and constructed. The following list includes items to be considered in developing a quality control plan for concrete overlays. It should be noted that some items may not apply to all concrete overlay projects.

## I. General

1. Cite all applicable standard specifications, special provisions, and drawings.
2. Identify the chain of command in the decision making and construction processes. Include phone numbers and e-mail addresses of key personnel such as contractor and agency representatives, traffic control manager, material suppliers, utility location representatives and QC manager
3. Work schedule breakdown by major task, starting date, and expected duration
4. Field office and lab location
5. Subcontract documentation
6. Material source and quality certifications including batch plant
7. Material testing lab and technician certifications
8. Submittal of concrete mix design
9. Water sources and testing
10. Traffic control plan for each phase of the work
11. Haul road and access point locations and durations
12. Construction survey (line and grade control)
    a. Method – contract or owner
    b. Type and amount of available information
    c. Stringline or stringless construction
    d. Development of the profile grade and concrete quantity by whom and when. Is there an approval process and timeline before construction?
    e. Reestablishment of land corners and centerline control points
13. Public information notification process to be used during construction
14. Utility concerns locations within the project limits, key personnel for location contact, and expected plans for relocation where necessary
15. Local jurisdiction coordination with local road projects or city/county special activities (e.g., festivals)
16. Identify and address potential areas of conflict

## II. Testing and Sampling

1. Delineation of contractor responsibilities for testing and sampling
2. Aggregate durability, soundness, abrasion, and gradation test data and requirements
3. Reinforcing steel and dowel bar submittals
4. Materials sampling and testing procedures
5. Development and use of control charts
6. Concrete mixture designs and water-cementitious ratio effects on strength
7. Concrete sampling, fabrication, curing, and testing procedures including maturity curve development, readings, and delivery of results
8. Documentation of test results and deviations
9. Actions to be taken if specification requirements are not met
10. Pavement smoothness (ride) testing and timing
11. Treatment of premature cracking and spalling (resolution procedures for expected and unexpected delay)
12. Hold points for agency assurance testing and/or inspection at critical junctures of production

## III. Concrete Placement Activities

1. Production activities
    a. Sieve analysis of aggregates
    b. Identification of central mix or ready mix supply source
    c. Mix proportioning
    d. Stockpile management plan and aggregate stockpile moisture
    e. Compare verification batch to mix design properties (slump, unit weight, air content, microwave water content)
    f. Anticipated plant production rates
    g. Consideration of alternative mixes to meet weather changes
    h. Identify washout areas and procedures for trucks

2. Concrete paving (placement, finishing, texturing and curing)
    a. On site weather monitoring - identify the responsible party and provide details regarding conditions that will influence the decisions to cancel and/or suspend scheduled concrete placements
    b. Placement and filler lane scheduling
    c. Base preparation (patching, milling, recycling)
    d. Method(s) for keeping the dowel bar basket assemblies anchored to the existing concrete or asphalt or bond breaker
        1.) Proposed type and number of fasteners and installation equipment
        2.) Dowel basket assembly anchoring plan
        3.) Action plan if misalignment baskets are identified
    e. Maximum allowable concrete haul times
    f. Placement procedures (equipment and methods)
    g. Estimated mix temperature at the time of placement
    h. Thickness verification during placement
    i. Estimated time from placement to time that allows for joint sawing
    j. Hot/cold weather specifications and precautions
        1.) Changes in mix for weather or material changes
        2.) Identification of method and materials to be used to protect the concrete in case of changes in weather (rain, snow, or hot/cold)
    k. Temperature control of existing ACC surfaces
    l. Vibrator testing/consolidation issues
    m. Curing and texturing equipment, rates, and construction procedures
    n. Straight edge and edge slump tolerances
    o. Plastic shrinkage cracking, edge slump, joint spalling, and full-depth cracking treatments[1]

3. Joint development (longitudinal and transverse)
    a. Contractor saw cutting QC plan (number, type, and method of sawing) – describe in detail how the number of saws available was arrived at relative to the planned production rate for paving ($yd^2$/hour)
    b. Backup saw availability (number, personnel, and location to project)
    c. Rain conditions and skip sawing procedures
    d. Saw cutting sequence
    e. Joint sealant material certification submittals
    f. Removal and flushing of joint sawing residue
    g. Joint sealant and concrete curing time requirements and methods
    h. Joint sand blasting, reservoir cleanliness, and moisture condition requirements before sealing
    i. Joint sealant surface depth tolerances, sealant pump, water truck, and saw cutting equipment.

[1] See Harrington and Fick 2014 for steps to prevent, minimize, and repair.