Division 7 of the NCDOT *Standard Specifications*, 2012 Edition, is replaced in its entirety by the following:

CONCRETE PAVEMENT FOR LOCAL ROADS AND STREETS

700-1 DESCRIPTION

Perform the work covered by this section, which includes, but is not limited to, the construction of a single course non-reinforced Portland cement concrete pavement on a prepared base, in accordance with the NCDOT *2012 Standard Specifications* as indicated or amended by these Special Provisions, and with the lines, grades, thicknesses and typical sections shown on the plans or as directed.

Concrete pavement will be accepted with respect to strength, thickness and ride quality on a lot by lot basis subject to adjusted unit prices as provided in Sections 700 and 1000 of the NCDOT *2012 Standard Specifications*.

Use any combination of equipment that shall effectively perform the necessary construction operations. Ensure the equipment is at the job site sufficiently ahead of the start of construction operations for the Engineer to examine thoroughly and approve.

Maintain all equipment in a satisfactory operating condition while in use on the work.

Submit for approval a Process Control Plan addressing all operations necessary in the production and placement of concrete pavement a minimum of 30 calendar days prior to placing concrete pavement.

700-2 CONCRETE PRODUCTION EQUIPMENT

Use batch plants, central mix plants and truck mixers that meet Section 1000 of the NCDOT *2012 Standard Specifications*.

700-3 CONCRETE HAULING EQUIPMENT

Transport concrete to the point of placement either in a truck agitator, a truck mixer operating at agitating speed or in non-agitating equipment meeting the provisions below. Bottom or belly dump equipment is prohibited. Provide and secure material covers on the equipment bodies for protection against detrimental environmental conditions.

Prevent the accumulation of hardened concrete in the delivery vehicles. Discharge all flushing water before charging with the next concrete load.

When using non-agitating hauling equipment, provide bodies which are smooth, watertight, metal containers with rounded internal corners equipped with vibrators and gates to discharge the concrete without segregation or damage. Dump truck bodies without rounded internal corners

may be used if an approved washout station is provided with sufficiently high water pressure and volume to remove all accumulated concrete residue between loads. Remove from service any hauling equipment with accumulated residue until such time that the residue is removed. Include the washout station provisions in the Process Control Plan if equipment without rounded internal corners is to be used.

For concrete hauled in a transit mix (ready mix) truck, use Table 1000-2 in the NCDOT *2012 Standard Specifications* to determine the maximum elapsed time. For concrete hauled in other equipment, the elapsed time 60 minutes or less, unless otherwise approved. Define the "elapsed time" as the period from first contact between mixing water and cement until the completion of the entire operation including placing, finishing, micro-surfacing and any necessary corrective work.

Deliver the concrete to the work site in a thoroughly mixed and uniform mass.

If at discharge, the concrete is not thoroughly mixed and homogeneous, the hauling distance, charging sequence, size of load, mixing time or any combination thereof shall be altered to meet these requirements; otherwise, use other equipment capable of delivering a thoroughly mixed and uniform concrete mass.

700-4 PREPARATION OF THE SUBGRADE AND BASE

Prepare the subgrade and base (if included) beneath Portland cement concrete pavement in accordance with the applicable sections of these Specifications and with a grading tolerance of ± ¼" from the established grade on mainline lanes and a grading tolerance of ± ½" in all other areas.

Dampen the surface of the base at the time the concrete is placed. Sprinkle the base when necessary to provide a damp surface. Ensure that no free water or ponding is present at the time of concrete placement. Correct all damaged areas in the subgrade or base before placing concrete.

Do not allow traffic on the underlying subgrade or base other than the necessary local traffic and essential construction equipment as authorized by the Engineer.

If using a slip form paver and unless otherwise approved, use and maintain a braided metal cable stringline reference to control the profile and alignment of the concrete pavement. Monitor the stringline for accuracy and tautness. Set pins at a distance no farther than 50 ft apart. When located on a vertical curve, set pins so no farther than 25 ft apart.

700-5 PLACING CONCRETE

(A) General

The use of a slip form paver to place concrete is preferred, although not required.

Place concrete only in the presence of the Engineer or the Engineer's authorized representative.

Handle concrete so as to prevent segregation and keep free from mud, soil or any other foreign matter.

Where finishing operations must be completed after dark, provide acceptable artificial light in accordance with NCDOT *2012 Standard Specification* Section 1413.

Do not pave when any of the following conditions exist:

(1) A descending air temperature at the location of the concrete paving operation and away from artificial heat reaches 35°F. Paving may resume when the weather forecast is projected to reach a high of 40°F on that day's operation and the morning ambient temperature is above 32°F.

(2) The subgrade or base is frozen.

(3) Aggregates to be used in the mix contain frozen particles.

(4) Air temperature in the shade is 90°F and rising or the concrete temperature is greater than 95°F.

Where additional pavement, aggregate or soil must be placed adjacent to new pavement by machine methods, do not place it until the concrete has attained a compressive strength of at least 2,500 psi.

Construction equipment or hauling equipment will not be allowed over the pavement until the concrete has attained a compressive strength of at least 3,000 psi.

Spread the concrete uniformly over the entire area without segregation. When using a slip form paver, perform the spreading with a mechanical spreader independent of the paver except where hand methods are necessary due to pavement design, equipment breakdown or other emergencies.

(B) Slip Form Paver Method

Use a slip form paver that is an approved self-propelled machine(s) designed to spread, consolidate, screed and float finish the concrete in one complete pass of the machine to provide a smooth, dense and homogeneous pavement with minimal hand finishing. Use slip form pavers equipped with both horizontal and vertical controls. Operate the paver with continuous forward movement and coordinate all operations of mixing, delivering and spreading the concrete to provide uniform progress and minimize stopping and starting of the paver.

Provide concrete that has sufficient cohesion to prevent appreciable slumping at the edges of each slab. Longitudinal edge tolerance shall apply to the area within 6" of the edge. Edge slump shall be limited to no more than ¼".

(C) Fixed Form Method

Apply this section to all paving operations where a slip form paver is not being used.
Use forms made of metal and of such section and design that they will adequately support the concrete and construction equipment.

Use forms that have a depth not less than the edge thickness of the pavement to be constructed and not more than 1" greater than the edge thickness of the pavement to be constructed. Use a form which has the base width at least equal to the height of the form.

Use a form in which the top face does not vary from a true plane more than 1/8" in 10 ft and the upstanding leg does not vary more than 1/4".

Use straight forms that have at least 3 pin pockets per 10 ft in length and at least 2 pin pockets per 5 ft in length.

Use form pins that are metal and capable of holding the forms rigidly in place during construction operations. The Engineer may require pinholes in the base to be sealed before placing subsequent pavement.

Connect the form sections by a locking joint that will keep the forms free from vertical and horizontal movement.

Use straight forms 10 ft in length on tangents and on curves having a radius of 200 ft or more. For curves having a radius of between 50 ft and 200 ft use either straight forms 5 ft in length or flexible forms. Use flexible forms for curves having a radius of less than 50 ft.

Clear all forms before they are set. Oil all forms before placing concrete. Check the bearing of the forms and correct all areas of inadequate bearing.

Remove all rejected forms immediately from the project.

Set forms a sufficient distance in advance of the point where the concrete is being placed to provide for a continuous operation in placing the concrete and for proper inspection of line and grade.

All forms used for construction joints shall meet this section except provisions shall be made for inserting dowel bars where required.

700-6 VIBRATING CONCRETE

Uniformly vibrate the concrete after it has been spread. Consolidate the full width and depth of the Portland cement concrete in a single pass.

Vibrators for full width vibration of concrete may be either the surface pan type of the internal type with either immersed tube or multiple spuds. Attach the vibrators to the spreader or the finishing machine, or mount the vibrators on a separate carriage.

Furnish an electronic vibrator monitoring device, displaying the operating frequency of each individual vibrator on the paving equipment. Operate the electronic vibrator monitoring device in areas where the mainline, ramp or loop pavement exceeds 600 ft in length. Record the time, station location, paver track speed and operating frequency of each individual vibrator after every 25 ft of paving or after each 5 minute time interval has elapsed. Provide a report of the vibrator data to the Engineer daily for the first 3 days of paving and weekly thereafter. The Engineer may determine that more frequent submissions are necessary, particularly if equipment is malfunctioning.

Set the internal vibrators to approximately mid slab depth and provide a locking device to avoid contact with any joint, load transfer device, tie bar, subgrade or side form. Provide an operating position locking device so that no part of the vibrating unit can be lowered to the extent that it will come in contact with dowel bars, dowel bar assemblies or tie bars while paving. Set the horizontal spacing of vibrators to the manufacturer's recommendations, but in no case exceed 16" from center to center.

Operate internal and spud vibrators within a frequency range of 3,500 to 8,000 vpm and surface vibrators within a frequency range of 3,500 to 6,500 vpm. Operate vibrators to avoid separation of the mix ingredients. A reduction in vibrator frequency may be required when the forward motion of the paver is reduced to avoid separation of the mix. Either discontinue the use or remove from contact with the concrete, the machine mounted vibrators, whenever the forward motion of the machinery is stopped.

Should the electronic monitoring device fail to operate properly, immediately check the vibrators manually in the presence of the Engineer or Engineer’s representative. If the vibrators are functioning properly, paving may continue. Repair the monitoring device within 3 production days or suspend paving.

700-7 FINISHING

Finish concrete pavement in accordance with Article 710-6. Do not use excessive water for finishing.

700-8 PROTECTION OF PORTLAND CEMENT CONCRTE PAVEMENT

(A) General

Protect the Portland cement concrete pavement from environmental conditions. Remove and replace concrete pavement damaged as a result of environmental conditions. Use protective

covering that will protect the surface of the freshly placed pavement from rain or cold weather readily available each day at the location of each proposed day's operation before beginning work. Store an adequate quantity of these materials at the paving train.

(B) Cold Weather

When the air temperature is projected to drop below 35°F for more than four hours, insulate the Portland cement concrete pavement to prohibit the concrete surface temperature from dropping below 35°F during the curing period.

(C) Hot Weather

When the anticipated daily high temperature is above 90°F, place the concrete at the coolest temperature practical. Control concrete temperatures to assure proper placing, consolidation, finishing, curing and to prevent plastic shrinkage cracking.

(D) Rain

When rain appears imminent, stop all paving operations, and ensure all available personnel protect the surface of the unhardened concrete. Failure to properly protect the concrete pavement may constitute cause for removal and replacement of the damaged pavement.

700-9 CURING

(A) General

Immediately after finishing operations have been completed and surface water has disappeared, cover all exposed surfaces of the pavement by one of the curing methods herein.

Apply the selected curing method to the edges of the pavement immediately after the forms are removed.

Curing is required until the concrete compressive strength has exceeded the required strength in accordance with Article 700-13.

(B) Membrane Curing Compound

After final finish and immediately after the free surface moisture has disappeared, use a minimum application rate of 0.0067 gal/sf when the application equipment is mechanically operated. Provide an inline flow-metering device to ensure the proper application rate is provided. Apply the curing compound such that puddling or ponding does not occur on the fresh concrete surface.

Use mechanically operated application equipment designed to apply a uniformly agitated continuous flow of the curing compound at the prescribed rate to all concrete surfaces.

Hand spraying shall only be permitted for irregular widths or shapes and surfaces exposed by removal of forms unless expressly approved by the Engineer. The rate of application for these areas shall be 0.01 gal/sf applied in such a manner than the concrete surface is uniformly and completely coated such that the underlying concrete is not visible.

Do not expose newly placed concrete for more than 30 minutes before being covered with curing compound. Failure to cover the surfaces of the concrete shall be cause for immediate suspension of the paving operation.

Protect the membrane curing compound film at all times during the curing period and repair any damage immediately. Ensure a sufficient amount of polyethylene film, burlap or other approved material is available to provide for protection of the concrete during rain or when the application equipment fails to apply the curing compound uniformly to all surfaces.

Reapply curing compound to any concrete surfaces that received heavy rainfall within 3 hours after initial application.

(C) Polyethylene Film

Spread the sections of the film in a manner that will not damage the finished pavement surface. Securely tape or provide lap joints for the sections that are at least 12" wide, and take suitable precautions to prevent the circulation of air beneath the film. Cover all exposed surfaces and beyond the edge of the pavement surface.

Use black or dark plastic sheets when the daily high ambient temperature is between 40°F and 60°F. Use white opaque reflective plastic sheet when the daily ambient temperature is above 60°F. Plastic sheets will meet ASTM C171.

Check the film for damage when it is spread and during the curing period. Repair or replace any damaged sections immediately.

(D) Burlap

Spread the sections of burlap in a manner that will not damage the finished pavement surface. Provide lap joints that are at least 6" wide.

Use an amount of burlap that is not less than 12 oz. per running yard based on a 40" width. Use either one layer of Class 4 burlap or 2 layers of Class 1, 2 or 3 burlap in conformance with AASHTO M 182.

Saturate the burlap thoroughly before placing on the concrete and keep thoroughly wet throughout the curing period.

700-10 REMOVING FORMS

Do not remove forms from freshly placed concrete for at least 12 hours after placement and until the concrete has hardened sufficiently to resist spalling, cracking or any other damage.

Repair any honeycombed areas along the sides or edges of the slab by filling with mortar immediately after the forms have been removed. Use mortar consisting of one part cement to 2 parts fine aggregate.

700-11 JOINT CONSTRUCTION

(A) General

Construct all joints in accordance with these Standard Specifications and the details shown on the plans. Saw all transverse joints and seal them with joint sealer in accordance with the dimensions and details shown in the contract. Seal joints in accordance with Article 00-12.

Perform sawing as soon as the concrete has hardened sufficiently without undercutting, spalling and raveling to control random cracking. Complete all saw cutting before 7 hours has elapsed from the time of concrete placement.

Ensure an adequate amount of sawing equipment is available to match the production and concrete paving operations. At least one standby sawing unit is recommended. To estimate the time of sawing, it is recommended to use the latest version of FHWA's High Performance Paving software entitled HIPERPAV. When dowel bars are used at the transverse joints and for longitudinal joints, cut the joint to the design thickness divided by 3. When dowel bars are not used, cut the transverse contraction joints to the design thickness divided by 4.

Saw the concrete pavement as soon as it can support the weight of the equipment and operator without disturbing the final finish. Saw joints in a neat, vertical straight line without chipping, spalling, tearing or disturbing the final finish.

Immediately after sawing the joint to the dimensions shown on the plans, completely remove the resulting slurry from the joint without damaging the adjacent concrete.

Immediately reapply curing membrane to areas damaged by the sawing operation.

Deviations from the method of joint construction specified in the contract requires prior approval in writing. Such approval is conditional and is subject to obtaining satisfactory results.

The Engineer may order any concrete pavement or shoulder where uncontrolled cracking has occurred before final acceptance to be removed and replaced at no cost to the Department. Where permitted, the Contractor may be allowed to repair the cracking in a manner acceptable to the Engineer.

Before placing either concrete pavement or concrete shoulders adjacent to a previously placed pavement, cover the transverse joint opening on the edge of the existing slab to prevent intrusion of grout into the opening.

(B) Transverse Contraction Joints

Construct transverse contraction joints in accordance with the details, dimensions and intervals as shown on the plans.

(C) Longitudinal Contraction Joints

Construct longitudinal contraction joints in all pavements wider than 16 ft in accordance with the details and dimensions shown on the plans.

(D) Transverse Construction Joints

(1) General

Construct transverse construction joints by use of an approved form at the end of each day's operations (planned joint) or whenever the placing of concrete is suspended for more than 30 minutes (emergency joint).

(2) Planned Transverse Construction Joints

Locate this type of joint at the same spacing required for contraction joints. Use dowel bars of the size and spacing shown on the plans.

(3) Emergency Transverse Construction Joints

Use this type of joint when the placing of concrete is suspended for more than 30 minutes. Use tie bars of the size and spacing shown on the plans.

Do not change the spacing of contraction joints due to emergency construction joints.

Locate the emergency construction joints at least 6 ft from any contraction joint or planned construction joint.

(E) Longitudinal Construction Joints

Construct longitudinal construction joints using tie bars in accordance with the details shown on the plans.

(F) Transverse Expansion Joints

Construct transverse expansion joints in accordance with the details shown on the plans utilizing an approved joint assembly.

(G) Verification of Dowel Bar Alignment

If an approved dowel joint assembly and anchoring method is used, verification of dowel bar alignment using a pachometer or similar device is required.

If dowels are placed by means of an automated dowel bar insertion device, then verify dowel bar alignment in accordance with a magnetic imaging device as described below.

Provide a calibrated magnetic imaging device that will document dowel bar location and alignment. Calibrate the magnetic imaging device to the type and size dowel bar used in the work. Use this device as a process control and make necessary adjustment to ensure the dowels are placed in the correct location.

Scan at least 25% of the joints in the initial placement or 1.0 mile of pavement, whichever is greater, at random intervals, as selected by the Engineer, throughout the pavement each time the paving train is mobilized. Mark scanned joints on the pavement. Perform all scans in the presence of the Engineer or Engineer's representative and provide the raw scan data.

Scan all joints in this initial placement if the dowel bars exhibit longitudinal translation (side shift), horizontal translation, vertical translation (depth), horizontal skew or vertical tilt, and total misalignment above the allowable tolerances defined below. In addition, continue scanning no less than 25% of the joints until it is established that the dowel bar inserter is consistently placing the dowel bars at the correct location and meeting the tolerances defined in Table 700-1 of the NCDOT *2012 Standard Specifications*. Once the Engineer determines that consistency is established, the contractor may reduce the percentage of scanned joints to no less than 10%. Any time inconsistency in the placement of the dowel bars becomes evident, additional scanning may be required up to 100% of the joints.

If consistency of the proper dowel bar alignment cannot be established within a reasonable time frame, the Engineer will have the option of suspending the paving operation.

Provide a report of the scanned joints within 48 hours of completing the day's production. The report should include the station and lane of the joint scanned, as well as the horizontal location, depth, longitudinal translation (side shift), horizontal skew and vertical tilt, of each dowel bar in the joint. If a dowel bar inserter is used, the joint score described below should also be provided in the report. Longitudinal translation (side shift) is defined as the position of the center of the dowel bar in relation to the sawed joint. The maximum allowable longitudinal translation (side shift) is 2".

Horizontal translation is defined as difference in the actual dowel bar location from its theoretical position as detailed in the standard details. The maximum allowable horizontal translation is 2".

Vertical translation (depth) is the difference in the actual dowel bar location from the theoretical midpoint of the slab. The maximum allowable vertical translation is 1/2" higher than the theoretical midpoint and 1" lower than the theoretical midpoint.

Dowel bar misalignment, either vertical tilt or horizontal skew is defined as the difference in position of the dowel bar ends with respect to each other. Vertical tilt is measured in the vertical axis whereas horizontal skew is measured in the horizontal axis.

Determine a joint score for each joint scanned. The joint score is a measure of the combined effects from the dowel's horizontal skew or vertical tilt. The joint score is determined by summing the product of the weight shown in the Table 700-1 and the number of bars in each misalignment category and adding one. The vertical tilt and horizontal skew should be evaluated and the total misalignment shall be used in determining the joint score.

TABLE 700-1
TOLERANCE FOR DOWEL BAR ALIGNMENT[A]

Misalignment Category, inches	Weight
$0 \leq \mathbf{d} \leq 0.6$	0
$0.6 < \mathbf{d} \leq 0.8$	2
$0.8 < \mathbf{d} \leq 1.00$	4
$1.00 < \mathbf{d} \leq 1.50$	5
$1.50 \leq \mathbf{d}$	10

A. Where **d** is the individual dowel bar misalignment

A joint that has a joint score of 12 or greater will be considered locked.

When a locked joint as defined above is discovered, scan the 2 joints immediately adjacent to the locked joint. If either of the adjacent joints are deemed to be locked, provide a written proposal to address the dowel misalignment for each locked joint. No corrective action should be performed without written approval.

700-12 SEALING JOINTS

(A) General

Seal all joints with an approved low modulus silicone sealant in the presence of the Engineer.

Install backer rod and sealant in accordance with the details shown in the plans and the manufacturer's recommendations.

Any failure of the joint material will be cause for rejection. Repair the failed joint material as approved by the Engineer.

When requested, have a representative of the silicone sealant manufacturer present on the project during the sealing operation.

(B) Age of Pavement

Do not seal the joints until the concrete is at least 14 calendar days old.

Do not perform final sawing and sealing of concrete pavement joints until after surface testing, correction of surface deficiencies and all adjacent earth and paved shoulder construction has been completed.

(C) Temperature

Do not place joint sealant when the air temperature near the joint is less than 45°F or is 45°F and falling.

(D) Sealing the Joint

Immediately after sawing the joint to the dimensions as shown on the plans, completely remove the resulting slurry from the joint by flushing with a jet of water under pressure.

Use sand blasting to clean joint faces before applying sealant. Make as many passes with a sand blaster as are necessary to provide a clean joint wall.

Blow all joints clear of deleterious materials with air using a nozzle pressure of at least 90 psi before installing the backer rod. Use rotary screw compressors for this purpose that are equipped with traps capable of removing water and oil from the air. Maintain the traps in accordance with manufacturer's instructions.

Apply sealer only on thoroughly clean and dry joints. Place the sealer to closely conform to dimensions shown on the plans. Any unreasonable deviation will be cause for rejection.

(E) Cleaning Pavement

After a joint has been sealed, remove surplus joint sealer on the pavement as soon as possible.

700-13 USE OF NEW PAVEMENT OR SHOULDER

Traffic or other heavy equipment will not be allowed on the concrete pavement or shoulder until the estimated compressive strength of the concrete has reached a compressive strength of 3,000 psi, as estimated from field cured 6”x12” cylinder specimens prepared and cured in accordance with AASHTO T 23 and tested in accordance with AASHTO T 22, unless otherwise specified in the contract documents or directed in writing by the Engineer.

Alternatively, in lieu of field cured specimens the Contractor may elect to estimate the compressive strength of the pavement using the maturity method. In this case, follow the requirements below.

Furnish thermocouples or thermistors and digital data logging maturity meters that automatically compute and display the maturity index in terms of a temperature-time factor (TTF). The

maturity meters must be capable of storing at least 28 days worth of data and exporting data into an Excel® spreadsheet. Install meters at least every 2 lots near the concrete surface. Submit the proposed equipment to the Engineer for approval.
When establishing a strength-maturity relationship, perform compressive tests at ages 1, 3, 7, 14 and 28 days in accordance with AASHTO T 22.

Use the TTF maturity function to compute the maturity index from the measured temperature history of the concrete. Set the datum temperature at – 10^{o}C to calculate the TTF in Equation 1 of ASTM C1074.

Establish and submit a strength-maturity relationship in conjunction with each concrete pavement mix design. Determine the TTF corresponding to the strength-maturity relationship at 3,000 psi, TTF. Any changes to plant operations, material sources or mix proportions will affect the strength-maturity relationship. If any changes occur during production, develop a new strength-maturity relationship unless otherwise directed.

No permanent traffic will be allowed on the pavement until construction of the joints, including all sawing, sealing and curing that is required, has been completed.

Take particular care to protect the exposed pavement edges and ends.

700-14 CONTRACTOR'S RESPONSIBILITY FOR PROCESS CONTROL

Perform process control sampling and testing of concrete materials and operations in accordance with Article 1000-3. The Contractor's roadway foreman and all personnel involved in the batching, sampling, testing and acceptance of Portland cement concrete pavement shall be certified as Portland cement concrete pavement technicians by NCDOT.

700-15 ACCEPTANCE TESTS FOR CONCRETE

(A) Responsibility

The Engineer will conduct acceptance sampling and testing of concrete. Provide access to all materials to be sampled and tested. The following tests will be performed on both concrete pavement and concrete shoulders to determine acceptance.

(B) Lot Definition

A lot for acceptance purposes is defined and described in Article 10-4.

(C) Air Content

The air content of the concrete will be determined on the roadway at a frequency established by the Engineer and in accordance with Subarticle 1000-3(B) of the NCDOT *2012 Standard Specifications*. The sample taken for determination of air content will be obtained immediately after the concrete has been discharged on the road.

Concrete failing to meet specification requirements for air content will be subject to rejection.

(D) Slump

The slump of the concrete will be determined in accordance with AASHTO T 119 at a frequency established by the Engineer. The sample taken for determination of slump will be obtained immediately after the concrete has been discharged on the road.

When the slump of the concrete is questionable by visual observation, do not place the concrete on the road until tested for slump by the Engineer.

Concrete failing to meet specification requirements for slump will be subject to rejection.

(E) Compressive Strength

Determine the compressive strength of concrete using one set of two 6" x 12" cylinders at 28 calendar days. Test samples will be made by the Engineer from the concrete as it comes from the mixer. The samples will be made and cured in accordance with AASHTO T 23. Test specimens will be tested by the Engineer in accordance with AASHTO T 22.

(F) Thickness

The thickness of the pavement will be determined by measurement of cores in accordance with AASHTO T 148.

Take 4" diameter cores in the presence of the Engineer. The Engineer will take immediate possession of the cores. Take the cores when the concrete has attained a compressive strength of at least 2,500 psi and at least 72 hours have elapsed since placement of the pavement. If the concrete has not attained a compressive strength of at least 2,500 psi, the gross vehicle weight rating of vehicles supporting the coring operation may not exceed 7,000 lb. Take cores no later than 30 days after the pavement has been placed. The core locations for each lot will be selected at random by the Engineer.

Patch all core holes within 72 hours of taking the core, using an approved nonshrink grout compatible with the pavement or shoulder concrete.

(G) Surface Smoothness

Perform acceptance testing for surface smoothness on concrete pavements using a 10-foot stationary straightedge furnished by the Contractor. Apply the straightedge parallel to the centerline of the surface. Do not exceed 1/8” variation of the surface being tested from the edge of the straightedge between any two contact points. Correct areas found to exceed this tolerance by grinding the pavement or as approved by the Engineer.

700-16 MEASUREMENT AND PAYMENT

Remove and repair defects and damage to underlying asphalt course, Portland cement concrete and joints at no cost to the Department.

SECTION 710
CONCRETE PAVEMENT

710-1 DESCRIPTION

Perform the work covered by this section, including, but not limited to, designing the concrete mix; furnishing and placing concrete; furnishing of all admixtures and additives; constructing all joints and furnishing joint materials; marking the pavement; curing the pavement and furnishing all curing materials; furnishing concrete necessary for making test beams and cylinders; performing maturity testing; coring and patching the pavement; calibrating and checking the operation of batching equipment; taking actions necessary to prevent or to repair cracking; sawing and sealing joints; verifying dowel bar alignment; removing and replacing of defective pavement; and constructing Portland cement concrete pavement in accordance with these Standard Specifications and with the lines, grades and dimensions shown on the plans.

710-2 MATERIALS

Refer to Division 10 of the NCDOT *2012 Standard Specifications,* as amended herein.

Item	**Section**
Curing Agents	1026
Dowels and Tie Bars	1070-6
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete	1000
Water	1024-4

710-3 COMPOSITION OF CONCRETE

Design the concrete mix in accordance with Section 1000 of the NCDOT *2012 Standard Specifications,* as amended herein.

Before placement, produce a trial batch through the plant. The Engineer will make compressive and flexural samples from the trial batch for testing at 1, 3, 7, 14 and 28 days of age. Until the trial batch meets 550 psi or 650 psi flexural strength, as specified, and 3,500 psi or 4,500 psi compressive strength, as specified, the Engineer will make acceptance samples for flexural and compressive tests for mix placed. If the trial batch test results meet strength requirements, flexural samples representing placed concrete will be discarded, and compressive samples will be used for acceptance. If the trial batch does not meet strength requirements, flexural samples will be used for acceptance until plant produced mix meets strength requirements.

If any major change as defined in Section 1000 is made to the mix design, this process shall be initiated again.

710-4 ACCEPTANCE OF CONCRETE

The Department will test the concrete pavement for acceptance with respect to compressive strength and thickness on a lot by lot basis in accordance with Article 00-15 and the requirements herein.

For all concrete pavement, including mainline, shoulders, ramps, tapers, intersections, entrances, crossovers and irregular areas not otherwise defined, produce a lot consisting of 1,333.3 sy or fraction thereof placed within 28 calendar days. From each lot, the Engineer will make at least one set of two 6" x 12" cylinders from a randomly selected batch of concrete. The average compression strength of the 2 cylinders is considered one test. If the Engineer makes and tests additional sets of cylinders for a lot, all sets will be averaged with the original set to determine the strength. In the case of low strength, the Engineer will perform an investigation.

710-5 CONSTRUCTION METHODS

Construct concrete pavement in accordance with Section 700.

710-6 FINISHING

Screed and float finish the concrete to the required cross section that minimizes or eliminates hand finishing. Additional water for finishing will not be allowed. Hand finishing will not be permitted except under the following conditions:

(A) Narrow widths or irregular areas, where operation of mechanical equipment is impractical.

(B) If a breakdown of mechanical equipment occurs, hand methods may be used to finish only that concrete deposited on the base before the breakdown.

(C) Abnormal circumstances of short duration subject to approval.

Produce a final finish on the pavement surface true to grade and uniform in appearance and free of irregular, rough or porous areas.

Following the finishing of the pavement by screeding, floating and checking with straightedges, further finish the surface of the pavement by burlap dragging or other acceptable method to produce a uniform surface texture. Pull the burlap drag in a longitudinal direction. For segments zoned for speeds of 45 mph or less, the Contractor may elect to use a heavy turf, carpet, burlap or broom finish or a tined finish. For segments zoned for speeds greater than 45 mph, a tined finish is required.

For tined finishes, produce the final surface finish on all mainline pavement, auxiliary lanes, and ramps by mechanical equipment for longitudinally tined grooves while the concrete is plastic.

The tining shall be done with a mechanical device such as a wire comb. The comb shall have a single row of tines. Each shall have a nominal width of 5/64 inch to 1/8 inch. The nominal spacing of the tines shall be 3/4 ± 1/8 inch center-to-center. The nominal depth of tined groove in the plastic concrete shall be 1/8 ± 1/32 inch.

Longitudinal tining shall be accomplished by equipment with automated horizontal and vertical controls to ensure straight, uniform depth tined grooves. The texture geometry shall be the same as imparted throughout the length of the tining comb. A 2-inch to 3-inch wide strip of pavement surface shall be protected from tining for the length of and centered about longitudinal joints.

The tining operation shall be done so that the desired surface texture will be achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets. Where abutting pavement is to be placed, the tining shall extend as close to the edge as possible without damaging the edge. If abutting pavement is not to be placed, the 6-inch area nearest the edge or one foot from the face of the curb shall not be tined. Hand-operated tining equipment that produces an equivalent texture may be used only on small or irregularly shaped areas. Tines shall be thoroughly cleaned at the end of each day's use and damaged or worn tines replaced.

When surface corrections for pavement smoothness are made in the hardened concrete, no additional texturing is required.

After final finishing, hand finishing may be required on the edges of pavement and joints whenever irregularities in surface texture or alignment occur. Care should be taken in hand finishing pavement edges to avoid ridges or high places that will prevent water from draining out of the transverse grooves.

The use of excessive water during the finishing operations will not be permitted. Provide a textured surface with an average texture depth of 0.8 mm as tested in accordance with ASTM E965 with no single test having a texture depth of 0.5 mm or less. The Engineer will perform 4 randomly located tests in accordance with ASTM E965 within the initial pavement lot of each mobilization. A "lot" is defined in Article 710-4. If the average of the 4 tests does not meet the above criteria, make appropriate changes to the surface texture operations and test the next lot as detailed above. Once the surface texture process is established to meet minimum texture requirements, maintain consistency within the operation to provide the above minimum texture depth. Perform additional sand patch tests in accordance with ASTM E965 when directed.

If the surface texture becomes damaged or reduced by rain or any other action, reestablish or restore surface texture by an approved method.

710-8 PAVEMENT MARKING

If indicated on the plans or in the contract documents, emboss the location of station numbers and drainage outlets in the plastic concrete as described below. Otherwise, such markings are not required.

Mark the pavement at locations as shown on the plans with station numbers. Mark the pavement by pressing beveled-face metal dies between 4" and 6" high into the plastic concrete.

At locations where shoulder drain outlets are placed, mark the edge of pavement nearest the outlet with the letters “OL”. Use the same marking procedure as for station numbers.

710-9 THICKNESS TOLERANCES

A lot for thickness acceptance testing is defined in Article 710-4.

To establish an adjusted unit price, if appropriate, for mainline pavement, take one 4" diameter core from each lot at a random location as directed. Other areas such as intersections, entrances, crossovers and ramps will each be considered as one lot and the thickness of each of these lots will be determined separately. Small irregular areas may be included as part of another lot. Take one core for each 1,333.3 sy of pavement or fraction thereof in the lot.

When the measurement of any core, original core or additional cores taken to calculate the average, is less than the plan thickness by more than 10% of the plan thickness, the extent of the removal area due to thickness deficiency will be determined by taking additional exploratory cores at approximately 10 ft intervals parallel to the center line in each direction from the deficient core until an exploratory core is found in each direction which is within 10% of the plan thickness. The pavement between these exploratory cores will be removed full lane width wide and replaced with concrete of the thickness shown on the plans. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price.

When the measurement of the core from a lot is deficient by 0.2" or less from the plan thickness, no pay reduction will be made for thickness. When such measurement is deficient by more than 0.2" from the plan thickness, take 2 additional cores at random locations within the lot and calculate the average thickness of the lot from the 3 cores. In determining the average thickness of the pavement lot, the Engineer will use all 3 core measurements. Individual core measurements which are greater than the plan thickness + 0.2" will be considered as the plan thickness + 0.2". Individual cores which are less than the plan thickness – 10% of the plan thickness will be considered as the plan thickness –10% of the plan thickness. If the average measurement of the 3 cores is within 0.2" from the plan thickness, full payment will be made. If the average measurement of the 3 cores is deficient by more than 0.2" from the plan thickness, an adjusted unit price in accordance with Subarticle 710-10(B) will be paid for the lot represented. Areas found deficient in thickness by more than 10% of the plan thickness, whichever is less, shall be removed and replaced with concrete of the thickness shown on the plans. Any full lane or full shoulder width repairs to the concrete pavement shall be performed in accordance with the North Carolina Department of Transportation Partial and Full Depth Repair Manual and not be less than 1/2 of the slab length.

Patch all core holes within 72 hours of taking the core, using an NCDOT approved nonshrink grout compatible with the pavement concrete.

710-10 MEASUREMENT AND PAYMENT

(A) General

The quantity of Portland cement concrete pavement to be paid will be the actual number of square yards of concrete pavement completed and accepted. In measuring this quantity, the width of the pavement will be as called for on the plans or as directed. The length will be the actual length constructed, measured along the centerline of the pavement.

Separate measurement will be made of pavement that is deficient in thickness by more than 0.2" and of pavement that is deficient in compressive strength.

The quantities of Portland cement concrete pavement will be paid at the contract unit price per square yard for *__" Portland Cement Concrete Pavement, Through Lanes, (with dowels), __" Portland Cement Concrete Pavement, Ramps, (with dowels)* or *__" Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* at such contract unit prices adjusted in accordance with the requirements shown below. No unit price adjustments on lots will be made until a final determination of the lot strength and depth is made. Pavement will be classified as through lane, ramp or miscellaneous pavement in accordance with the classification shown on the plans.

Payment for all work of surface testing will be incidental to the contract unit price for *__" Portland Cement Concrete Pavement, Through Lanes, (with dowels), __"* or *__" Portland Cement Concrete Pavement, Miscellaneous, (without dowels)*.

(B) Pavement Deficient In Thickness

The quantities of Portland cement concrete pavement which are deficient in thickness by more than 0.2" but not deficient by more than 10% of the plan thickness, measured as provided in Article 710-10, will be paid at an adjusted contract unit price per square yard for *__" Portland Cement Concrete Pavement, Through Lanes, (with dowels), __" Portland Cement Concrete Pavement, Ramps, (with dowels)* or *__" Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* completed in place and accepted.

The adjusted contract unit price is determined by the following formula, except no pay over 100% will be allowed:

Pay Factor (%) = 110 – [50 x (*Plan Thickness – Average Core Thickness*)]

Exploratory cores for deficient thickness will not be used in averages for adjusted unit price. Where pavement deficient by more than 10% of plan thickness is removed and replaced with pavement of conforming thickness, the replacement pavement will be paid at the contract unit price per square yard for *__" Portland Cement Concrete Pavement, Through Lanes, (with dowels), __" Portland Cement Concrete Pavement, Ramps, (with dowels)* or *__" Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* which price and payment will be full compensation for all work of placement, removal, restoration of subgrade and base and replacement.

(C) Concrete Pavement Varying in Strength

One of the following formulas will be used to calculate the concrete pavement pay factor.

(1) Compressive Strength

The pay factor for pavement achieving the specified design compressive strength, as shown on the plans, in 28 days or greater is 100%. The pay factor for pavement achieving a compressive strength in 28 days between the specified compressive strength and the specified compressive strength minus 1000 psi is determined by the following formulas:

Pay Factor (%) = 100.0 – [0.05 x (*Design Comprehensive Strength – Measured Comprehensive Strength*)]
(pay factor rounded to nearest 0.1%)

The quantities of Portland cement concrete pavement that meet these criteria, will be paid at an adjusted unit price per square yard for *__" Portland Cement Concrete Pavement, Through Lanes, (with dowels), __" Portland Cement Concrete Pavement, Ramps, (with dowels)* or *__" Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* completed in place and accepted. The adjusted contract unit price will be determined by multiplying the contract unit price by the pay factor level determined for the average strength of concrete in each lot and will be applicable to the total square yards of concrete in each lot.

Any pavement that is deficient by more than 1,000 psi of the specified design compressive strength is subject to removal. If allowed to remain in place, the pavement will be accepted at a reduced unit price based on a pay factor level of 50% as provided in Article 105-3 of the NCDOT *2012 Standard Specifications*.

Where pavement deficient in strength is removed and replaced, the replacement pavement, if acceptable, will be paid at the contract unit price for *__" Portland Cement Concrete Pavement, Through Lanes, (with dowels), __" Portland Cement Concrete Pavement, Ramps, (with dowels)* or *__" Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* which price and payment will be full compensation for all work including placement, removal, restoration of subgrade and base and replacement.

(D) Multiple Adjustments in Price

Pavement found deficient in both thickness and strength will be evaluated by the Engineer to determine if it may be permitted to remain in place. Pavement permitted to remain in place will be paid at a reduced price determined by successively multiplying the contract price by the appropriate factor indicated for each deficiency.

(E) Compensation

Payment at the contract unit prices for __" *Portland Cement Concrete Pavement, Through Lanes, (with dowels)* and __" *Portland Cement Concrete Pavement, Ramps, (with dowels)* and __" *Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* will be full compensation for all work covered by this section.

(F) Pay Items

Payment will be made under:

Pay Item	**Pay Unit**
__" Portland Cement Concrete Pavement, Through Lanes (with dowels)	Square Yard
__" Portland Cement Concrete Pavement, Ramps (with dowels)	Square Yard
__" Portland Cement Concrete Pavement, Miscellaneous (without dowels)	Square Yard

Article 1001-3 of the NCDOT *Standard Specifications*, 2012 Edition, is replaced in its entirety by the following:

1001-3 PORTLAND CEMENT CONCRETE FOR PAVEMENT

(A) Composition and Design

Submit concrete paving mix design in terms of saturated surface dry weights on NCDOT Materials and Tests Form 312U for approval at least 30 days before proposed use. Use a mix that contains at least 526 lb of cement per cubic yard, a maximum water cement ratio of 0.559, an air content in the range of 4.5% to 5.5% and a maximum slump of 1.5" for slip form paving and 3.0" for fixed form and hand paving. If the plans specify a compressive strength of 4,500 psi, provide a mix that will achieve a minimum flexural strength of 650 psi at 28 days and a minimum compressive strength of 4,500 psi at 28 days. If the plans specify a compressive strength of 3,500 psi, provide a mix that will achieve a minimum flexural strength of 550 psi at 28 days and a minimum compressive strength of 3,500 psi at 28 days.

The cement content of the mix design may be reduced by no more than 30% and replaced with fly ash at a minimum rate of 1.0 lb of fly ash to each pound of cement replaced.

The cement content of the mix design may be reduced by no more than 50% and replaced with blast furnace slag pound for pound.

Include in the mix design the source of aggregates, cement, fly ash, slag, water and admixtures; the gradation and specific gravity of the aggregates; the fineness modulus of the fine aggregate; and the dry rodded unit weight and size of the coarse aggregate. Submit test results showing that the mix design conforms to the criteria, including the 1, 3, 7, 14 and 28-day strengths of the average of two 6" x 6" x 20" beams and the average of two 6" x 12" cylinders for each age made and tested in accordance with AASHTO R 39, T22 and T97. Design the mix to produce an average strength sufficient to indicate that a minimum strength of 550 or 650 psi in flexure, as specified, and 3,500 or 4,500 psi in compression, as specified, will be achieved in the field within 28 days.

If any change is made to the mix design, submit a new mix design. If any major change is made to the mix design, also submit new test results showing the mix design conforms to the criteria. Define a major change to the mix design as:

(1) A source change in coarse aggregate, fine aggregate or cement.

(2) A pozzolan class or type change (e.g., Class F fly ash to Class C fly ash.)

(3) A quantitative change in coarse aggregate (applies to an increase or decrease greater than 5%), fine aggregate (applies to an increase or decrease greater than 5%), water (applies to an increase only), cement (applies to a decrease only), or pozzolan (applies to a decrease only).

Where concrete with a higher slump for hand methods of placing and finishing is necessary, submit an adjusted mix design for approval to provide a maximum slump of 3" and to maintain the water-cementitious material ratio established by the original mix design.

(B) Air Entrainment

Entrain air in the concrete by the use of an approved air entraining agent dispensed with the mixing water, unless prohibited.

Provide an air content of 5.0% ± 1.5% in the freshly mixed concrete. The air content will be determined in accordance with AASHTO T 121, T152 or T196. At the option of the Engineer, the air content may be measured by the Chace indicator, AASHTO T 199, in which case sufficient tests will be made to establish correlation with the test methods of AASHTO T 121, T152 or T196. Concrete will not be rejected based on tests made in accordance with AASHTO T 199.

(C) Slump

Provide concrete with a maximum slump of 1.5" where placed using slip form paving methods and no more than 3" where placed using fixed form or hand methods. The sample taken for determination of slump will be obtained immediately after the concrete has been discharged onto the road.

(D) Set Retarding Admixture and Water Reducing Admixture

With permission, the Contractor may use an approved set retarding admixture, an approved water reducing admixture or both to facilitate placing and finishing. Use a quantity of set retarding admixture or water reducing admixture within the range shown on the current list of approved admixtures maintained by the NCDOT Materials and Tests Unit.

(E) Contractor's Responsibility for Process Control

Before or at the preconstruction conference, submit a plan detailing the process control and the type and frequency of testing and inspection necessary to produce concrete that meets the Specifications. During all batching and delivery operations assign an NCDOT Certified Concrete Batch Technician on site whose sole duty is to supervise the production and control of the concrete. This duty includes the following:

(1) Tests and inspections necessary to maintain the stockpiles of aggregates in an unsegregated and uncontaminated condition.

(2) Calibration of admixture dispensing systems, weighing systems and water gauges.

(3) Tests and adjustments of mix proportions for moisture content of aggregates.

(4) Mixer performance tests before reducing mixing time of central mix plant to less than 90 seconds and at other times when deemed necessary by the Engineer.

(5) Verifying the actual mixing time of the concrete after all materials are introduced into the mixer at the beginning of paving operations and at least once each month.

(6) Testing all vibrators.

(7) Tests necessary to document the slump and air content of the mix produced. Determine air content at least twice each day.

(8) Tests for depth of the pavement in the plastic state.

(9) Furnishing data to verify that the approved theoretical cement content has been met at intervals not to exceed 50,000 sy of pavement.

(10) Signing all plant reports, batch tickets and delivery tickets.

NCDOT certifies technicians who satisfactorily complete examinations prepared and administered by the Division of Highways.

Perform all test procedures in compliance with the appropriate articles of Section 1000 of the NCDOT *2012 Standard Specifications* as amended herein.

Tests may be witnessed by the Engineer. Document the results of all tests and inspections and make a copy available to the Engineer upon request. Take prompt action to correct conditions that have resulted in or could result in the submission of materials, products, or completed construction that do not conform to the NCDOT *2012 Standard Specifications*.

(F) Contractor Not Relieved of Responsibility for End Result

The Contractor will not be relieved of his obligation to produce a uniform pavement meeting Specifications by reason of:

(1) The acceptance or approval by the Engineer of the concrete mix design or any adjustments;

(2) Compliance with the concrete mix design and compliance with the testing requirements and other process control requirements by the Contractor; or

(3) The failure of the Engineer to perform any tests in the process control, nor the performance of any tests in the process control that indicate compliance with the Specifications.