

PORTLAND CEMENT CONCRETE PAVEMENT**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Pavement
- B. Curb and Gutter

1.02 DESCRIPTION OF WORK

Includes the requirements for the construction of full depth PCC pavement and curb and gutter.

1.03 SUBMITTALS

Comply with Division 1 - General Provisions and Covenants, as well as the following:

- A. Two weeks prior to commencing any 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 designs approved by the Iowa Department of Transportation or an independent testing laboratory.
- B. Maturity curves for paving mixes and maturity reading results.
- C. Submit all testing and certifications according to Section 7010, 3.07.

1.04 SUBSTITUTIONS

Comply with Division 1 - General Provisions and Covenants.

1.05 DELIVERY, STORAGE, HANDLING, AND SALVAGING

Comply with Division 1 - General Provisions and Covenants, as well as the following:

- A. Aggregate Storage:** Comply with [Iowa DOT Article 2301.02, C.](#)
- B. Cement and Fly Ash:** Comply with [Iowa DOT Article 2301.02, C.](#)
- C. Admixtures:** Store in suitable weather tight enclosures which will preserve quality.
- D. Reinforcing Steel:** Store off ground on timbers or other supports.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 - General Provisions and Covenants, as well as the following:

Complete elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.

1.07 SPECIAL REQUIREMENTS

None

1.08 MEASUREMENT AND PAYMENT**A. PCC Pavement:**

1. **Measurement:** Measurement will be in square yards for each different thickness of PCC pavement. The area of manholes, intakes, or other fixtures in the pavement will not be deducted from the measured pavement area.
2. **Payment:** Payment will be at the unit price per square yard for each thickness of PCC pavement.
3. **Includes:** Unit price includes, but is not limited to, final trimming of subgrade or subbase, integral curb, bars and reinforcement, joints and filler, surface curing and pavement protection (excluding cold weather protection; see Section 7010, 1.08, N), safety fencing, concrete for rigid headers, boxouts for fixtures, pavement smoothness testing, and quality control for stringless paving.

B. Air Content Deficiency:

1. **Measurement:** Measurement will be in square yards for each different thickness of PCC pavement subject to a unit price reduction for air content deficiency according to Section 7010, 3.07.
2. **Payment:** Payment will be at the reduced unit price according to Table 7010.03 for each thickness of PCC pavement. If there is an air content deficiency on a privately contracted roadway project, the Jurisdiction ultimately accepting ownership of the roadway will receive the penalty payment prior to acceptance of the work.

C. Pavement Smoothness Deficiency:

1. **Measurement:** Measurement will be in square yards for each different thickness of PCC pavement subject to a unit price reduction for pavement smoothness according to Section 7010, 3.07.
2. **Payment:** Payment will be at the reduced unit price according to Table 7010.04 for each thickness of PCC pavement. If there is a pavement smoothness deficiency on a privately contracted roadway project, the Jurisdiction ultimately accepting ownership of the roadway will receive the penalty payment prior to acceptance of the work.

D. PCC Pavement Thickness Deficiency:

1. **Measurement:** Measurement will be in square yards for each different thickness of PCC pavement that has deficient pavement thickness as determined in Table 7010.05.
2. **Payment:** Payment will be at the percentage of the unit price indicated in Table 7010.05 for each different thickness of PCC pavement. If there is a pavement thickness deficiency on a privately contracted roadway project, the Jurisdiction ultimately accepting ownership of the roadway will receive the penalty payment prior to acceptance of the work.

E. Curb and Gutter:

1. **Measurement:** Measurement will be in linear feet measured along the face of the curb for each different width and thickness of curb and gutter.
2. **Payment:** Payment will be at the unit price per linear feet of curb and gutter.
3. **Includes:** Unit price includes, but is not limited to, final subgrade/subbase preparation, bars and reinforcement, joints and filler, surface curing and pavement protection (excluding cold weather protection; see Section 7010, 1.08, N), and boxouts for fixtures.

1.08 MEASUREMENT AND PAYMENT (Continued)**F. Beam Curb:**

1. **Measurement:** Measurement will be in linear feet measured along the face of the curb.
2. **Payment:** Payment will be at the unit price per linear feet of beam curb.
3. **Includes:** Unit price includes, but is not limited to, final subgrade/subbase preparation, bars and reinforcement, joints and filler, surface curing and pavement protection (excluding cold weather protection; see Section 7010, 1.08, N), and boxouts for fixtures.

G. Concrete Median:

1. **Measurement:** Measurement will be in square yards of concrete median. When the curb is integral with the pavement, the width will be measured from back of curb to back of curb.
2. **Payment:** Payment will be at the unit price per square yard of concrete median.
3. **Includes:** Unit price includes, but is not limited to, final subgrade/subbase preparation, bars and reinforcement, joints and filler, surface curing and pavement protection (excluding cold weather protection; see Section 7010, 1.08, N), and boxouts for fixtures.

H. PCC Railroad Crossing Approach:

1. **Measurement:** Measurement will be in square yards of railroad crossing approach.
2. **Payment:** Payment will be at the unit price per square yard of railroad crossing approach.
3. **Includes:** Unit price includes, but is not limited to, excavation for modified subbase and subdrain, furnishing and installing subdrain, furnishing and installing subdrain outlet or connection to storm sewer, furnishing and installing porous backfill material, furnishing and placing modified subbase material, furnishing and installing reinforcing steel and tie bars, furnishing and placing concrete, furnishing, placing, and compacting asphalt.

I. PCC Pavement Samples and Testing:

1. **Measurement:** Lump sum item; no measurement will be made.
2. **Payment:** Payment will be at the lump sum price for PCC pavement samples and testing.
3. **Includes:** Lump sum price includes, but is not limited to, certified plant inspection, pavement thickness cores, pavement smoothness measurement (when required by the contract documents), and maturity testing.

J. Granular Surfacing: Comply with [Section 7030](#) for granular surfacing material placed at intersecting roads, driveways, and turnouts.**K. PCC Pavement Widening:**

1. **Measurement:** Measurement will be in square yards for each different thickness of PCC pavement widening. The area of manholes, intakes, or other fixtures in the pavement will not be deducted from the measured pavement widening area.

1.08 MEASUREMENT AND PAYMENT (Continued)

- 2. Payment:** Payment will be at the unit price per square yard for each thickness of PCC pavement widening.
 - 3. Includes:** Unit price includes, but is not limited to, final subgrade/subbase preparation, integral curb, bars and reinforcement, joints and filler, surface curing and pavement protection (excluding cold weather protection; see Section 7010, 1.08, N), safety fencing, concrete for rigid headers, boxouts for fixtures, and pavement smoothness.
- L. Pavement Removal:** Comply with [Section 7040](#).
- M. Fixture Adjustment:** Comply with [Section 6010](#) for adjustment of manholes and intakes and [Section 5020](#) for adjustment of water valves and fire hydrants.
- N. PCC Cold Weather Protection:**
- 1. Measurement:** When cold weather protection is required and authorized by the Engineer, measurement will be in square yards of the area of PCC pavement to be protected. The area of manholes, intakes, or other fixtures in the pavement will not be deducted from the measured pavement area.
 - 2. Payment:** Payment will be at the unit price of \$2.50 per square yard. Payment will be limited to protection necessary only within the contract period and with prior authorization of the work by the Engineer. No price modifications will be made for quantity underruns or overruns for this item. Cold weather protection necessary after the completion date, after all calendar days have passed, or after all working days have been used is incidental to the work regardless if a quantity was included in the contract.
 - 3. Includes:** Unit price includes, but is not limited to, all labor, materials, and equipment to install and remove all required protection.

PART 2 - PRODUCTS**2.01 MATERIALS**

A. Cement: Meet the requirements of [Iowa DOT Section 4101](#) and [Materials I.M. 401](#), including Type I and Type II cements and blended hydraulic cements Type 1P, Type 1S, Type 1T, and Type 1L.

B. Supplementary Cementitious Materials (SCM):

1. **Fly Ash:** Comply with [Iowa DOT Section 4108](#).
2. **Ground Granulated Blast Furnace Slag (GGBFS):** Comply with [Iowa DOT Section 4108](#).
3. **Limestone:** Comply with [Iowa DOT Materials I.M. 401](#).

C. Fine Aggregate for Concrete:

1. Meet the requirements of [Iowa DOT Section 4110](#) and [Materials I.M. 409](#), Source Approvals for Aggregates.
2. Comply with the following gradation:

Sieve Size	Percent Passing
3/8"	100
No. 4	90 to 100
No. 8	70 to 100
No. 30	10 to 60
No. 200	0 to 1.5
Iowa DOT Article 4109.02, Gradation No. 1 in the Aggregate Gradation Table.	

3. The Engineer may authorize a change in gradation, subject to materials available locally at the time of construction.

D. Coarse Aggregate for Concrete:

1. Crushed stone particles with Class 2 durability complying with [Iowa DOT Section 4115](#) and [Materials I.M. 409](#), Source Approvals for Aggregates.
2. Comply with one of the following gradations:

Sieve Size	Gradation No. 3 Percent Passing	Gradation No. 4 Percent Passing	Gradation No. 5 Percent Passing
1 1/2"	100	100	-----
1"	95 to 100	50 to 100	100
3/4"	-----	30 to 100	90 to 100
1/2"	25 to 60	20 to 75	-----
3/8"	-----	5 to 55	20 to 55
No. 4	0 to 10	0 to 10	0 to 10
No. 8	0 to 5	0 to 5	0 to 5
No. 200	0 to 1.5	0 to 1.5	0 to 1.5
Iowa DOT Article 4109.02, Gradation No. 3, 4, and 5 in the Aggregate Gradation Table.			

3. The Engineer may authorize a change in gradation, subject to materials available locally at the time of construction.

2.01 MATERIALS (Continued)

E. Intermediate Aggregate for Concrete: Use if specified in contract documents.

1. Meet the requirements of [Iowa DOT Section 4112](#) and [Materials I.M. 409](#), Source Approvals for Aggregates.
2. For crushed limestone or dolomite, meet the durability class required for the coarse aggregate. When gravel durability is lower than the coarse aggregate durability requirements, pea gravel is not to exceed 15% of the total aggregate mix.
3. Comply with the following aggregate gradation:

Sieve Size	Percent Passing
1/2"	95 to 100
3/8"	-----
No. 4	-----
No. 8	0 to 10
Iowa DOT Article 4109.02, Gradation No. 2 in the Aggregate Gradation Table	

4. The Engineer may authorize a change in gradation subject to materials locally available at the time of construction.
- F. Water Requirements:** Comply with [Iowa DOT Section 4102](#). Potable water obtained from a municipal supply, suitable for drinking, may be accepted without testing.
- G. Admixtures:** Meet [Iowa DOT Materials I.M. 403](#) and the requirements for the liquid admixtures shown below. Other admixtures may be used subject to the approval of the Engineer.
1. **Air Entrainment Admixture:** Comply with [Iowa DOT Section 4103](#).
 2. **Retarding and Water Reducing Admixtures:** Comply with [Iowa DOT Section 4103](#).
 3. **Accelerating admixtures (calcium chloride):** Comply with [Iowa DOT Article 2529.02](#).
- H. Bars:** Comply with [Iowa DOT Section 4151](#) for metallic tie bars and dowel bars or [Iowa DOT Section 4156](#) for glass fiber reinforced polymer dowel bars. Meet the tie bar requirements for bar mats. All metallic bars must be epoxy coated.
- I. Expansion Tubes:** Comply with [Iowa DOT Section 4191](#).
- J. Metal Keyways:** Comply with [Iowa DOT Section 4191](#).
- K. Supports for Bars:** Comply with [Iowa DOT Materials I.M. 451.01](#).
- L. Joint Fillers:**
1. **Joint Fillers:** Comply with [Iowa DOT Article 4136.02](#).
 2. **Preformed Expansion Joint Fillers:** Use the following types of preformed materials for filling expansion joints that comply with [Iowa DOT Article 4136.03](#). When the type is not specified, use a resilient filler.
 - Resilient filler
 - Flexible foam expansion joint filler
 - Tire buffings expansion joint filler
 - Elastomeric joint fillers

2.01 MATERIALS (Continued)

M. Liquid Curing Compound: Comply with [Iowa DOT Section 4105](#) and furnish from an approved supplier listed in [Iowa DOT Materials I.M. 405](#), Appendix A ([MAPLE](#)).

N. Covering:

1. **Burlap:** Comply with [Iowa DOT Section 4104](#).
2. **Plastic Film:** Comply with [Iowa DOT Section 4106](#).
3. **Insulating Cover:** Comply with [Iowa DOT Section 4106](#).

O. Grout Systems: Use polymer grouts that comply with [Iowa DOT Materials I.M. 491.11](#).

2.02 CONCRETE MIXES

A. Mix Design:

1. Comply with Iowa DOT Class C or Class M mix meeting the requirements of [Materials I.M. 529](#). If higher durability mixes are specified, use C-SUD or CV-SUD mixes.
2. Ensure compatibility of all material combinations. If the concrete materials are not producing a workable concrete mixture, a change in the material may be required. Changes will be at no additional cost to the Contracting Authority.

B. Consistency and Workability:

1. Slump:

- a. Use an amount of mixing water that will produce workable concrete of uniform consistency. Unless specifically modified by the Engineer, ensure slump, measured according to [Iowa DOT Materials I.M. 317](#), is no less than 1/2 inch or no more than 2 1/2 inches for machine finish and no less than 1/2 inch and no more than 4 inches for hand finish. When a water reducing admixture is used, the maximum slump may be increased to 5 inches.
- b. If it is not possible to produce concrete having the required consistency without exceeding the maximum allowable water to cement ratio specified, the cement content may be increased or water reducing admixture may be added. Obtain the Engineer's approval. Do not exceed the maximum water to cement ratio. Additional cement or water reducer will be added with no additional cost to the Contracting Authority.
- c. The basic absolute volume of water per unit volume of concrete is based on average conditions. If material characteristics require that the total quantity of water used to secure the required consistency reduces the batch yield (computed on the basis of absolute volumes of the batch quantities used) by more than 2.0%, the Engineer may adjust the proportions to correct the yield. This adjustment will not be a basis for adjustment of the contract unit price.

2. Air Content: Use an approved air entraining agent.

- a. For machine-placed pavement, use a target air content of 8% with a tolerance of plus or minus 2% when measured on the grade just prior to consolidation, as determined by [Iowa DOT Materials I.M. 318](#). The target air content may be adjusted by the Engineer based on random tests of the consolidated concrete behind the paving machine. When random testing is performed, test a minimum of twice per day (the first load and midway through the placement). These additional tests will be used to consider the need for a target value change and will not be used in the acceptance decision.

2.02 CONCRETE MIXES (Continued)

- b. For hand-placed pavement, use a target content for hand finish of 7% with a tolerance of plus or minus 1.5% when measured on the grade and just prior to consolidation, as determined by [Iowa DOT Materials I.M. 318](#).

C. Use of Fly Ash and Ground Granulated Blast Furnace Slag (GGBFS) as Supplementary Cementitious Materials:

1. Mix proportions for the various mixes using fly ash and GGBFS are included in [Iowa DOT Materials I.M. 529](#). The maximum allowable fly ash substitution rate is 20%. Do not use a GGBFS substitution rate of more than 35% by weight (mass). The total supplementary cementitious material substitution rate is not to exceed 50%.
2. If C-SUD or CV-SUD mixes are specified, the maximum allowable Class F fly ash substitution rate is 25% and the maximum Class C fly ash substitution rate is 35%. The maximum combination rate is 20% Class C fly ash and 20% GGBFS.
3. When Type IP, IT, or IS cement is used in the concrete mixture, only fly ash substitution will be allowed. Between October 16 and March 15, use of Type IL cement with fly ash and GGBFS or Type IP, IS, or IT cement with fly ash will be allowed only when maturity method is used to determine time of opening. Transport, store, haul, and batch fly ash and GGBFS in such a manner to keep it dry.

PART 3 - EXECUTION**3.01 EQUIPMENT****A. Batching and Mixing Equipment:****1. General:**

- a. Weighing and Proportioning Equipment:** Comply with [Iowa DOT Article 2001.20](#).
- b. Mixing Equipment:** Comply with [Iowa DOT Article 2001.21](#).
- c. Material Bins:** Involves any structure in which materials are stored. Each part of any bin, including foundations and supports, must be adequate to withstand any stress to which it might be subjected to while in use.

2. Batching:

- a. Ensure the batching plant is Iowa DOT calibrated and approved. Provide copy of current calibrations and approvals.
- b. Coordinate the batch plant operation and batch trucks with the paving operation in order to ensure a steady supply of materials.
- c. Operate the batch plant and trucks to minimize dust, noise, or truck nuisances.

3. Mixing:**a. Construction Mixer:**

- 1) Ensure the concrete is uniform in composition and consistency. If this condition is not produced because of the size of the batch, the size of the batch may be reduced or the mixing time increased, or both, until this result is obtained. If non-uniform, corrective action must be taken.
- 2) Ensure the methods of delivering and handling the concrete are such that objectionable segregation or damage to the concrete will not occur, and they will facilitate placing with a minimum of handling.

b. Central or Stationary On-site Mixed Concrete:

- 1) Ensure central or stationary mixer has all required Iowa DOT certifications and calibration reports. The certified plant inspector will monitor the plant.
- 2) Ensure the concrete is uniform in composition and consistency. If non-uniform, concrete producers must take corrective action.
- 3) Central or stationary on-site mixed concrete is defined as concrete proportioned in a central plant set-up to service a single project and mixed in a stationary mixer for transportation in trucks without agitation, proportioned at a central plant, and only partially mixed in a stationary mixer for transportation and finish mixing in a transit mixer, or proportioned at a central plant, and then mixed in a transit mixer prior to or during transit.
- 4) Ensure each delivery vehicle is capable of discharging concrete having a slump not over 2 inches at an overall rate for its entire load of not less than 1.25 cubic yards per minute. Ensure the concrete is delivered at a rate sufficient to maintain a sustained rate of progress of not less than 100 feet per hour for the width and depth of pavement to be placed.

c. Ready Mixed Concrete:

- 1) Ensure the concrete is uniform in composition and consistency. If non-uniform, concrete producers must take corrective action.
- 2) Ready mixed concrete is defined as concrete proportioned in a plant set up to service multiple projects with different mix requirements, and mixed in a stationary mixer for transportation in trucks without agitation. The concrete can either be proportioned at a wet batch plant, only partially mixed in a stationary mixer for transportation and finishing in a transit mixer, or proportioned at a dry batch plant, and then mixed in a transit mixer prior to or during transit.
- 3) When necessary to add additional mixing water at the site of placement, mix the batch at least an additional 30 revolutions of the drum at mixing speed.

3.01 EQUIPMENT (Continued)

- 4) Ensure each vehicle in which concrete will be delivered is capable of discharging concrete having a slump not over 2 inches at an overall rate for its entire load of not less than 1.25 cubic yards per minute. Ensure the concrete is delivered at a rate sufficient to maintain a sustained rate of progress of not less than 100 feet per hour for the width and depth of pavement to be placed.

- d. **All Methods:** Identify each truck load by a plant charge ticket showing plant name, contractor, project data, quantity, class, time batched, and water added at site.

B. Concrete Delivery Equipment:**1. General:**

- a. In handling concrete from the mixer to the place of deposit, take care to avoid segregation.
- b. When concrete is deposited through a chute, slope the chute to allow concrete to flow slowly without segregation. Place the delivery point of the chute as close as possible to the point of deposit. Keep chutes and spouts clean. Thoroughly flush them with water before and after each run. Discharge the water outside the paving area in an approved concrete washout area.
- c. Provide alternate plan for concrete delivery in event of equipment failure.
- d. Take concrete samples from material placed on the subgrade or subbase.

2. Concrete Transfer Equipment:

- a. Utilize placers, conveyors, buckets, or buggies designed specifically for transporting concrete.
- b. Do not allow concrete to free fall into or out of transfer equipment.
- c. Meet the requirements of Section 7010, 2.02, B, 2 for air entrainment of the concrete mix and testing for compliance.

3. Concrete Pumps:

- a. Do not pump concrete through aluminum conduit or tubing.
- b. Use the concrete pump to deliver the material as close to horizontal as possible, keep restrictions and drops to a minimum, and avoid free fall.
- c. Meet the requirements of Section 7010, 2.02, B, 2 for air entrainment of the concrete mix and testing for compliance.
- d. Sample the first load after pumping a minimum of 3 cubic yards. Sample after each significant change in boom angle.
- e. Sample before and after the pump to determine if any changes in the slump and other significant mixture characteristics occur.
- f. When sampling at the end of the placement line, take care to ensure that the sample is representative of the concrete being placed from the pipeline. Note: Changes to the placement rate or boom configuration can result in changes in the concrete properties. Typically, the vertical position of the boom results in the greatest potential for air loss while the horizontal position of the boom has the least potential. Location of pumping equipment should be determined so that it is possible to maintain a consistent, low boom angle as much as possible during placement.
- g. If air test shows that air entrainment is outside of the allowed range, follow procedure as outlined in Section 7010, 3.07, B.
- h. Leaks in the line or pump hydraulics, which would allow air to be added to the concrete, are prohibited.

C. Concrete Placement Equipment:**1. Consolidating and Finishing Equipment:**

- a. Use a paving machine that meets all of the following:
 - 1) Is designed for the specific purpose of placing, consolidating, and finishing concrete pavement.

3.01 EQUIPMENT (Continued)

- 2) Develops vertical edges on the pavement.
 - 3) Is self propelled and equipped with a means for spreading the concrete to a uniform depth before it enters the throat.
 - 4) Vibrates the concrete to the full width and depth being placed in a single passage. Use vibrating tubes or arms working in the concrete or a vibrating pan operating on the surface of the concrete.
 - 5) Produces a surface reasonably free of voids and tears.
 - 6) When the paver is operated on previously placed concrete, prevent damage to the pavement surface.
 - 7) For slip form pavers, use a paver equipped with automatic horizontal and vertical grade controls.
- b. Hand methods utilizing air screeds and vibrating screeds may be used for short pavement runs, cul-de-sacs, driveways, and some intersections.
 - c. When allowed by the Engineer, use stringless paving equipment capable of providing the same accuracy necessary to comply with the requirements of Section 7010.
 - d. Use a laser guided screed that meets all of the following:
 - 1) Designed for the specific purpose of placing and finishing of concrete pavement using a 3-dimensional surface model.
 - 2) All equipment for laser guided screed, including the guidance system, will meet the project design model tolerances.
 - 3) Will provide consolidation to full width and full depth of concrete placement. Provide intermediate consolidation by using external hand held vibrators.
 - 4) Produces a surface reasonably free of voids and tears.
 - 5) Provide boom-style screed (drive-in screeds are not allowed) with an auger boom, placement head (water spray mechanism not allowed), guidance equipment, and software to produce 3-dimensional surface.
 - 6) Produces pavement smoothness as specified in Section 7010, 3.07, C.

2. Vibrators for Machine Paving:

- a. Consolidate, with a single pass of an approved internal or surface vibrator, the full width and depth of concrete requiring a finishing machine. Operate internal vibrators within a frequency range of 4,000 to 8,000 vibrations per minute. The Engineer may authorize the minimum vibration frequency to be lowered to 3,500 vibrations per minute for particular sections of paving, such as superelevations. Operate surface vibrators within a frequency range of 3,500 to 6,000 vibrations per minute.
- b. Avoid operating vibrators in a manner to cause a separation of the mix ingredients, either a downward displacement of large aggregate particles or an accumulation of laitance on the surface of the concrete. When forward motion of the paver is reduced, vibrator frequency may need to be reduced to avoid separation of the mix.
- c. If a vibrator fails to operate within the specifications, repair or change the vibrator before the paving begins:
 - The following day, or
 - The same day if the continuous paving that day is stopped at a header or at the end of a session.
- d. If two adjacent vibrators fail to operate within the specifications, stop the paving operation and repair or replace the vibrators.
- e. Stop vibrators whenever forward motion of the paver is stopped.
- f. Set the internal vibrator penetration depth into the concrete pavement to mid slab or as deep as possible while passing above reinforcing steel. 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 reinforcing steel or tie bars while paving.
- g. Do not exceed the manufacturer's recommendations for vibrator horizontal spacing. Do not exceed 16 inches from center to center.
- h. Mount the longitudinal axis of the vibrator body approximately parallel to the direction of paving. Tilt the trailing end of each vibrator downward to a slope of 10 to 30 degrees below horizontal.

3.01 EQUIPMENT (Continued)

- i. Use vibrators that meet or exceed the following specifications at the manufacturer's design frequency of 10,000 vpm:
 - 1) Amplitude (peak to peak) 0.070 inches.
 - 2) Centrifugal force 1,200 pounds.
3. **Vibrators for Hand Methods:** Use a vibration rate between 3,500 to 6,000 vibrations per minute, and use an amplitude sufficient to be perceptible on the surface of the concrete more than 12 inches from the vibrating unit.
4. **Hand Finishing Equipment:** Provide all finishing tools necessary for proper finishing of the concrete including straightedges for checking and correcting finished concrete surfaces.
5. **Forms:**
 - a. **Rigid Forms:** Steel, minimum thickness of 5 gage, height at least equal to design thickness of pavement with base width at least 6 inches.
 - 1) Minimum section length of 10 feet, joint connections designed to allow horizontal and vertical adjustment with locking device to hold abutting sections firmly in alignment.
 - 2) Bracing, support, and staking must prevent deflection or movement of forms.
 - b. **Flexible Forms:** Use steel or wood flexible forms for curves with a radius less than 100 feet.
 - 1) Bracing, support, and staking must prevent deflection or movement of forms.
 - 2) Ensure that forms used to shape back of curbs at returns have height at least equal to design thickness of pavement and curb height.
 - 3) Forms must be free from scale and surface irregularities.
6. **Curing Equipment:** Use pressure sprayer capable of applying a continuous uniform film of curing compound. Use equipment with a shield if wind conditions do not allow proper coverage
7. **Concrete Saws:** Use power operated concrete saws capable of cutting hardened concrete neatly.
8. **Joint Filling Equipment:** Use equipment capable of cleaning the joint and heating and installing filler in joints according to manufacturer's recommendations.

3.02 PAVEMENT CONSTRUCTION

- A. **Removal of Pavement:** Comply with [Section 7040, 3.02](#).
- B. **Final Subgrade/Subbase Preparation:**
 1. **General:**
 - a. Meet the requirements of [Section 2010](#) for subgrade construction, subgrade treatment, and subbase construction.
 - b. Trim the subgrade or subbase to the final grade for placement of concrete.
 - c. Unless otherwise ordered by the Engineer, the subgrade or subbase, at time of placing concrete for concrete pavement, must be in a uniformly moist but not muddy condition to a depth of not less than 1 inch.
 2. **Subgrade and Subbase Loading:**
 - a. Travel of concrete delivery trucks on a subgrade or subbase must be approved by the Engineer. In such cases, watering of the subgrade or subbase must be limited to just ahead of the paving machine.

3.02 PAVEMENT CONSTRUCTION (Continued)

- b. Enter and exit from side streets to minimize repetitive loading on the subgrade or subbase by concrete trucks.
- c. Do not allow loads in excess of the legal axle load on the completed subgrade or subbase.
- d. Partially loaded trucks may be required.
- e. If subgrade or subbase failure occurs, coordinate the repair with the Engineer.

3. Paving Suspended:

- a. Suspend the paving operation where subgrade or subbase stability has been lost.
- b. Do not place concrete on a subgrade or subbase that has become unstable, bears ruts or tire marks of equipment, or that is excessively softened by rain until such subgrade or subbase has been reconsolidated and reshaped to correct the objectionable condition.
- c. If necessary, scarify to a minimum depth of 6 inches, aerating, and recompact at no additional cost to the Contracting Authority. Meet the compaction requirements of [Section 2010, 3.06](#).

4. Maintenance of Subgrade or Subbase: Maintain the completed subgrade or subbase during subsequent construction activities.**C. Surface Fixture Adjustment:**

1. Adjust manhole frames and other fixtures within area to be paved to conform to finished surface. Comply with [Section 6010, 3.04](#) for manhole adjustments and [Section 5020, 3.04](#) for water fixture adjustments.
2. Clean outside of fixture to depth of pavement before concrete placement.
3. Construct boxouts where allowed for later adjustment of fixtures. See [Figure 7010.103](#) for the size and shape of the boxout.

D. Setting of Forms: When forms are used, meet the following requirements.

1. Ensure forms have sufficient strength to support paving operations being used.
2. Set base of forms at or below subgrade elevation with top of forms at pavement surface elevation. With Engineer approval, extra height forms may be used to shape the back of integral curb and edge of pavement; set base at or below subgrade elevation with top of form at top of curb elevation.
3. Place and secure forms to required grade and alignment. Do not vary the top face of the form from a true plane by more than 1/8 inch in 10 feet, and do not vary the vertical face from a true plane by more than 1/4 inch in 10 feet.
4. If the soil supporting the forms is softened by rain or standing water so that the forms are inadequately supported, or if voids occur under the forms, remove forms. Rework subgrade to proper elevation and density, and reinstall forms.
5. Ensure forms are free of latent concrete and coated with release agent before concrete is placed.

E. Bar and Reinforcement Placement: Ensure bars are clean, straight, free from distortion and rust, and are firmly secured in position as specified in the contract documents. Place all bars in approved storage to prevent damage; do not distribute along the work site except as needed to avoid delay in paving.

3.02 PAVEMENT CONSTRUCTION (Continued)**1. Tie Bars:**

- a. Place bars prior to vibration. For slip form paving, tie bars may be installed after vibration, provided the concrete is consolidated around the bars. Bars may be supported by approved chairs or may be placed in position by a machine or method approved by the Engineer.
- b. Use approved continuous bolsters with runners to support reinforcement for bridge approach sections. Place the supports transversely across the approach and space them longitudinally no greater than 4 feet. For double reinforced approach sections the top layer of reinforcing may be chaired off the bottom layer of reinforcing using approved continuous high chairs with runners, provided they are positioned directly above the continuous bolsters with runners supporting the bottom layer of reinforcing. Hold epoxy coated reinforcing steel in place with epoxy or plastic coated bar supports and epoxy or plastic coated tie wires.

2. Dowel Bar Assemblies:

- a. When dowel bar assemblies are required in the contract documents, accurately place these assemblies as shown. To prevent their movement during subsequent concrete paving operations, securely stake or fasten to the base to line and grade.
- b. Do not use assemblies that are damaged prior to placement. If assemblies are damaged after placement, replace prior to paving. Ensure horizontal and vertical alignment of the load transfer bars does not exceed 1/4 inch from parallel to line and grade. Place each assembly so the bars are in a horizontal plane at $T/2 \pm 1/2$ inch.
- c. Check the placement of each assembly and the position of the bars within the assembly using a suitable template or other device approved by the Engineer. If the assembly is found to be placed outside of the above tolerances, correct the placement.
- d. Cutting the tie wires of the load transfer assemblies is optional.

3. Bar Mats for Reinforced Pavement:

- a. When reinforced pavement is specified, assemble bar mats accordingly and firmly fastened together at all bar intersections.
- b. Place, secure, latch, and tie bar mats for a continuous mat as specified in the contract documents. Displacement during concrete placement operations is not allowed.
- c. Use chairs to ensure proper placement of bar mats.

4. Tie Bars and Dowel Bars in Existing Pavement:

- a. When anchoring in existing concrete, use a grout system according to the manufacturer's instructions. Obtain the Engineer's approval for the grout system.
- b. For horizontal installations, use either a pressure injection system with mechanical proportioning and mixing, or use encapsulated chemical anchors. Install as follows:
 - 1) Ensure drilled holes to receive the grout match the dimensions and spacing specified in the contract documents. When not specified in the contract documents, the maximum nominal diameter of the hole must be 1/8 inch larger than the outside diameter of the dowel or bar, or as recommended by the manufacturer. Drill holes for tie bars and dowel bars into the face of the existing pavement at midpoint. To ensure proper horizontal alignment, do not allow any hole misalignments to exceed 1/4 inch in the vertical or horizontal plane. Clean the hole with compressed air immediately prior to placing the grout.
 - 2) Use a polymer grout to secure the dowels in the existing pavement. Inject the grout into the rear of the hole with pressure. Use sufficient grout so that when the bar to be grouted is placed in position, excess grout will be forced out the front of the hole. Rotate the bar during the insertion process to ensure complete coating with the grouting material. Hand proportioning and mixing is not allowed.
 - 3) If using grout with approved encapsulated anchors, install according to the manufacturer's recommendations.

3.02 PAVEMENT CONSTRUCTION (Continued)

- 4) Use horizontal installation procedures for vertical or angled installations; however, pourable grouts may be used. Pourable grouts must be mechanically mixed.

F. Concrete Pavement Placement:

1. Use paving machine for all uniform width pavements 8 1/2 feet or more in width and 250 feet or more in length, unless alternate methods are approved by the Engineer. Screeds and laser guided screeds may be used on short pavement runs up to 250 feet.
2. Place, consolidate, and finish the concrete to the full depth and width conforming to the specified crown and cross-section in a single operation.
3. Keep a uniform pile of concrete in front of the paving machine, up to a maximum of 6 to 8 inches above the design surface elevation. Distribute and spread the concrete as soon as placed. A mechanical concrete spreader may be used.
4. Deposit the concrete upon the in-place bars keeping segregation to a minimum.
5. Use shovels, not rakes, to do necessary hand spreading and spading.
6. Do not allow the edges of pavement, including all longitudinal construction joints, to deviate from the line shown on the plans by more than 1/2 inch at any point.
7. If the paving machine operates on adjacent pavement, protect pavement from damage.
8. When placing by hand methods, consolidate the concrete by using vibrating units. Use a definite system or pattern in the operation of the vibrator so the full width of concrete in each linear foot of lane will receive adequate and uniform consolidation. The system and methods of vibrating is subject to approval of the Engineer. Do not use vibrating equipment as a tool for moving concrete laterally.
9. Stringless Paving:
 - a. Provide an electronic file identifying x, y, and z coordinates for curbs and pavement edges, as well as pavement centerline based on project alignments and elevations.
 - b. Location and elevation of the finished slab should be verified against grade check hubs at 25 foot intervals for the first 100 feet of each days run and at critical locations, such as intakes and through intersections where grades may be flat. The Engineer may waive these requirements if experience has shown compliance with the design elevations.
 - c. Record each verification check and submit to the Engineer.
 - d. At the beginning of paving operations on the project or after each modification to the paving machine, verify the paving equipment is calibrated per the manufacturer's recommendations.

G. Integral Curbs: Integral curbs are placed with the pavement in a single paving machine operation; however, hand methods may be allowed for radius, returns, and sections of curb and gutter 100 feet or less in length or in other special sections where mechanical equipment cannot be used.

1. Pave, edge, protect, saw, and cure curb in same manner as pavement.
2. Finish curb as rapidly as finishing operations on pavement permit. Maximum distance behind paving machine is 100 feet.
3. Complete final finish on curbs by hand methods, including the use of a 6 foot straightedge.

3.02 PAVEMENT CONSTRUCTION (Continued)

4. Check surfaces of curb and gutter with 10 foot straightedge; correct variations greater than 1/8 inch. Ensure top of curb slopes to street when Class A sidewalk will be constructed adjacent to the curb.
 5. For drop curb at driveways and where sidewalks intersect streets, use forms to shape the backs of such curbs.
 6. When using hand methods for building curb, the following additional requirements will apply:
 - a. Remove free water, latency, dust, leaves, or other foreign matter from the slab prior to placing concrete for curb.
 - b. Use freshly mixed concrete; do not store concrete in receptacles at side of pavement for use in curb at a later time; do not use concrete requiring retempering.
 - c. Consolidate curb concrete to obtain adequate bond with the pavement slab and to eliminate honeycomb in the curb. Avoid disturbing the alignment of forms or the gutter flow line.
- H. PCC Railroad Crossing Approach:** Construct according to Section 7010 and [Figure 7010.903](#). Construct asphalt section according to the full depth patch requirements of [Section 7040](#).
- I. Finishing:**
1. **Grade and Crown:** Promptly after concrete has been placed and vibrated, strike off the surface to the true section by the screed. Finish the surface true to crown and grade.
 2. **Watering the Surface:** The practice of lubricating the pavement surface by sprinkling water by spray, brush, or other methods to afford greater ease in finishing operation is not allowed.
 3. **Floats:** Finish surface with wood or magnesium floats; finish from both sides simultaneously if pavement is placed to full width with one pass of paving machine.
 4. **Straightedging:**
 - a. After the longitudinal floating has been completed and the excess water has been removed, and while the concrete is still plastic, test the pavement surface for trueness.
 - b. Immediately fill any depressions found with freshly mixed concrete, struck off, consolidated, and refinished.
 - c. Check surface longitudinally while concrete is still plastic; correct any surface deviations greater than 1/8 inch in 10 feet.
 5. **Surface Treatment:**
 - a. **Drag Surface Treatment:** Unless otherwise specified, texture the finished surface with an artificial turf or burlap drag treatment.
 - 1) Pull the artificial turf or burlap drag longitudinally over the finished surface to produce a tight, uniform, textured surface, and round the edges in a workmanlike manner.
 - 2) Remove the artificial turf or burlap drag from the pavement surface at regular intervals and clean with water to remove accumulated concrete from the fabric in order to maintain a consistent finished texture.
 - 3) When the desired texture is not attained, the Engineer may require the final finish be a broom finish.

3.02 PAVEMENT CONSTRUCTION (Continued)**b. Longitudinal Surface Tining:**

- 1) Complete longitudinal surface tining using a machine with a wire broom or comb. For small or irregular areas, or during equipment breakdown, hand methods may be used. Use a broom or comb with a single row of tines 1/8 inch (+/- 1/64 inch) in width and uniformly spaced at 3/4 inch intervals. The depth of the grooves must be a minimum of 1/8 inch to a maximum of 3/16 inch in the plastic concrete.
 - 2) Use equipment with horizontal and vertical string line controls to ensure straight grooves.
 - 3) Conduct this operation at such time and in such manner that the desired surface texture will be achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets.
 - 4) At longitudinal joints, leave a 2 to 3 inch wide strip of pavement surface (centered along the joint) that is not grooved for the length of the joint.
- 6. Edge Finish:** Before the concrete has taken its initial set, finish all edges of the pavement with an 1/8 inch radius edging tool.
- 7. Honeycomb Repair:** When paving without forms, fill any honeycombed area immediately with freshly mixed concrete and work into the slab prior to initial set and the application of curing. Failure to do so may prompt the Engineer to declare the work defective and cause it to be removed and replaced at no additional cost to the Contracting Authority.

J. 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 finishing. 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.
 - a. Use a white pigment liquid curing compound for concrete not receiving an asphalt overlay. When specified in the contract documents, use a linseed oil solution.
 - b. Use a dark-colored curing compound for concrete receiving an asphalt overlay.
2. Apply compound with power sprayer; rate of application not less than 15 square yards per gallon (0.067 gallon per square yard); do not dilute compound. For concrete receiving an asphalt overlay, use a minimum rate for dark-colored cure of 12.5 square yards per gallon (0.08 gallon per square yards).
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 within 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. Coating of the sawed surface with curing compound will not be allowed on joints that are to be filled. When pavement is opened to traffic prior to 72 hours after application of the curing coating, a re-coating will not be required.

3.02 PAVEMENT CONSTRUCTION (Continued)**K. Construction of Joints:****1. General:**

- a. Construct joints of the type, dimensions, and at the locations specified in the contract documents. See the [7010 figures](#).
- b. Place longitudinal joints coincident with or parallel to the pavement centerline.
- c. Place all transverse joints at right angles to the centerline and extend the full width of the pavement.
- d. Place all joints perpendicular to the finished grade of the pavement and do not allow the alignment across the joint to vary from a straight line by more than 1 inch.
- e. Exercise care in placing, consolidating, and finishing the concrete at all joints.

2. Saw Joints:

- a. Mark joint locations with a string line before sawing.
- b. Begin transverse joint sawing as soon as the concrete has hardened sufficiently to allow sawing without raveling or moving of aggregate. Saw joints before uncontrolled cracking takes place.
- c. Saw all joints in a single cutting operation for a specific joint. Make saw cuts true to line and to the dimensions specified in the contract documents.
- d. Discontinue sawing a joint if a crack develops ahead of the saw.
- e. Saw longitudinal joints within 24 hours of the concrete being placed.
- f. If necessary, continue the sawing operations both day and night.
- g. The concrete must be capable of supporting the sawing operations to allow the use of an early green concrete saw.
- h. Repair or replace pavement with uncontrolled or random cracking at no additional cost to the Contracting Authority. Use repair methods approved by the Engineer. Repair or replace at the direction of the Engineer.
- i. Use wet sawing for dust control when specified in the contract documents.
- j. Where boxouts occur in pavement, construct joints as shown on [Figures 7010.103](#) and [7010.904](#).

3. Construction Joints:

- a. Place longitudinal and transverse construction joints where specified in the contract documents, at boxouts, and at headers.
- b. Locate and place forms for boxouts on grade prior to paving as shown on [Figures 7010.103](#) and [7010.904](#).
- c. Construct a Days Work (DW) or a Rigid Tie (RT) transverse construction joint no closer than 5 feet of an existing or planned transverse contraction joint. Construct the DW or RT transverse construction joint if concrete placement is delayed for more than 30 minutes, at planned pavement gaps, or at the end of each day.
- d. Finish the edges of the pavement at construction joints with a 1/8 inch radius edging tool.

4. Expansion Joints:

- a. Install expansion joints as specified in the contract documents.
- b. Prevent movement of or damage to joint assembly when placing concrete; set joint material low enough to clear the finish machine.
- c. Construct double width expansion joint in curb over expansion joint in pavement. The backside of the joint must be clear of concrete.
- d. Align the expansion joint straight and true. After the mechanical finishing equipment has passed over the joint, check the joint for movement. If movement in excess of 1/2 inch has occurred, immediately correct the installation to its intended position.
- e. If joint fillers are assembled in sections, or if joints as a whole are constructed in sections, do not allow offsets between adjacent fillers.
- f. Where more than one section is used in a joint, securely lace or clip the sections together.

3.02 PAVEMENT CONSTRUCTION (Continued)

- g. Supplemental vibration equipment is required for proper consolidation of the concrete.
- h. After the surface finishing has been completed, finish the edge of the joint with a 1/8 inch edging tool.

L. Joint Filling:**1. Timing:**

- a. Unless otherwise allowed or approved by the Engineer, before any portion of the pavement is opened to the Contractor's equipment or to general traffic, clean joints that require filling.
- b. The Engineer may limit the wheel loads and axle loads of equipment operating on the pavement during this operation, if prior to the age and strength specified in Section 7010, 3.05. Additional tests to determine the pavement strength may be required.

2. Cleaning:

- a. For those joints that are not to be filled, cleaning is not required.
- b. Within 3 hours after a joint has been wet sawed to the finished dimension, flush the wet sawing residue away from the sawed faces using a high pressure water blast operating with a minimum pressure of 1,000 pounds per square inch. Within 3 hours after a joint has been dry sawed to the finished dimension, blow the dry sawing residue from the joint using air compressors that provide moisture and oil free compressed air.
- c. Immediately prior to installation of filler, clean joints with an air blast. Do not perform filling until visual examination verifies the joint surfaces appear dry, in addition to being clear of dust and contamination.

3. Filling:

- a. Prepare and install joint filler in the joint and to the proper level specified in the contract documents and as recommended by the manufacturer.
- b. Heat hot-poured filler in a thermostatically controlled heating kettle; heat the material to the temperature required for use, but not above that recommended by the manufacturer. After filling, remove excess filler from the pavement surface.
- c. Fill joints the same day they are cleaned. Apply filler only when the joint surfaces appear dry by visual examination.
- d. Place joint filler only when the pavement and ambient air temperatures are 40°F or above. When near this minimum, additional air blasting or drying time, or both, may be necessary to ensure a satisfactory bond to the joint faces. When this filler cannot be properly placed due to late fall work, submit a joint construction plan and filling details to the Engineer for approval before commencing paving. Delay the cleaning, filling, and, if required, resawing of joints until the following spring. This delay requires the Engineer's approval.
- e. When surface correction is required, repair filler damaged from the corrective work. Joint preparation, cleaning, and filling may be delayed until after corrective work, provided the pavement is not opened to traffic before corrective work is performed.

M. Pavement Backfill: Following slipform paving operations, place backfill material along the pavement within 48 hours of pavement attaining opening strength or as directed by the Engineer to prevent flow of water and any subsequent damage caused by undermining of the pavement. Prior to placement of full backfill material, construct check dams or other protection as appropriate to ensure no damage to the subgrade and/or subbase occurs.

N. Form Removal:**1. Timing:**

- a. Remove forms after the initial set of the concrete has taken place.
- b. Remove stakes and forms with care to prevent cracking, spalling, or over stressing concrete. If damage does occur, repairs will be made as required by the Engineer.

3.02 PAVEMENT CONSTRUCTION (Continued)**2. Honeycomb Repair:**

- a. When the forms are removed, fill honeycombs with mortar composed of 1 part cement and 2 parts fine aggregate by weight.
- b. If the honeycombing is to the degree and nature that it is considered by the Engineer as defective work, remove and replace at no additional cost to the Contracting Authority.

3. **Paving Protection:** In the area adjacent to the curbs and pavement edge, immediately place backfill after the forms are removed. Construct dams or other protection to ensure that no saturation or erosion of the subgrade under or near the pavement occurs. This may include check dams, pumping, etc.

3.03 CURB AND GUTTER CONSTRUCTION (See [Figure 7010.102](#))

- A. Complete the construction of curb and gutter separate from pavement in the same manner as for pavement in Section 7010, 3.02.
- B. Use a paving machine for curb and gutter. For curb and gutter sections less than 250 feet, hand finish methods may be used.

3.04 PAVEMENT PROTECTION

- A. **Weather Conditions:** Do not place concrete when stormy or inclement weather or temperature prevents good workmanship. Temperature restrictions and protection requirements may be modified by the Engineer under unusual conditions.

1. Cold Weather:

- a. **Paving:** Do not place aggregates containing frozen lumps, and do not place concrete on a frozen subgrade or subbase. Take all necessary actions to prevent the pavement from freezing.
 - 1) Concrete mixing and placement may be started, if weather conditions are favorable, when the air temperature is at least 34°F and rising. At the time of placement, concrete must have a temperature of at least 40°F.
 - 2) Stop mixing and placing when the air temperature is 38°F or less and falling or if the temperature stops rising and does not reach 38°F.
- b. **Protection:** Prior to applying protection, cure all concrete pavement and curb/gutters, including exposed edges of the pavement and curb. In addition, protect concrete less than 36 hours old as follows:

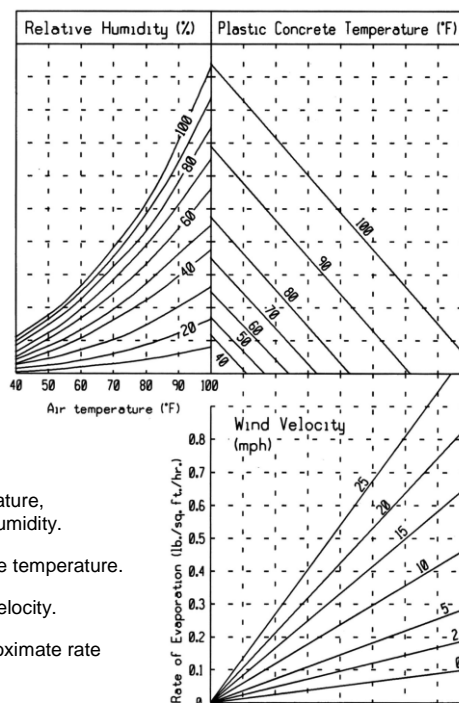
Night Temperature Forecast	Type of Protection ¹
35°F to 32°F	One layer of burlap for concrete.
31°F to 25°F	Two layers of burlap or one layer of plastic on one layer of burlap.
Below 25°F	Four layers of burlap between layers of 4 mil plastic or equivalent commercial insulating material approved by the Engineer.

¹ Keep protection in place until one of the following conditions is met:

- a. The pavement is 5 calendar days old.
- b. Opening strength is attained.
- c. Forecasted low temperatures exceed 35°F for the next 48 hours.
- d. Forecasted high temperatures exceed 55°F for the next 24 hours and subgrade temperatures are above 40°F.

3.04 PAVEMENT PROTECTION (Continued)

- 1) Shut down paving operations in time to comply with protection requirements outlined above. During cold weather, allow more time for finishing and protection. Perform all finishing and covering operations prior to darkness. Temperature restrictions and protection requirements may be modified by the Engineer.
 - 2) Equivalent commercial insulating material approved by the Engineer may be used. This material must be waterproof and have a minimum R value of 1.0. If initial set has not yet occurred, place a layer of burlap on top of concrete prior to placing insulating blankets.
 - 3) Use a method of protection and materials that will maintain the concrete temperature above 40°F.
- 2. Hot Weather:** Hot weather condition is defined as any combination of the following conditions that tend to impair the quality of plastic concrete by accelerating the rate of moisture loss and rate of cement hydration causing thermal shrinkage and resulting in plastic shrinkage cracking:
- High Ambient Temperature
 - High Concrete Temperature
 - Low Relative Humidity
 - High Wind Velocity
 - Solar Radiation
- a. General:
 - 1) During hot weather conditions, the Engineer may restrict concrete placement to early morning or evening hours.
 - 2) During hot weather conditions, advise the Engineer of the results of the theoretical evaporation rate throughout paving operations.
 - b. Determine the Theoretical Rate of Evaporation: Use the following chart and the National Weather Service's predicted maximum air temperature, relative humidity, and maximum steady wind velocity without gusts, for the date and the location of the paving pour.

Theoretical Rate of Evaporation Chart

To Use this Chart:

1. Enter with air temperature, move up to relative humidity.
2. Move right to concrete temperature.
3. Move down to wind velocity.
4. Move left, read approximate rate of evaporation

3.04 PAVEMENT PROTECTION (Continued)

- c. If the evaporation rate exceeds 0.1 pounds per square foot per hour but is less than 0.3 pounds per square foot per hour, provide the following concrete evaporation protection.
 - 1) Increase the surface cure application to 1.5 times the standard specified rate. After initial floating, immediately apply an approved evaporation retarder to the concrete pavement and curb.
 - 2) Take special precautions to ensure that the forms and subgrade are sufficiently moist or protected to avoid lowering the water content at the pavement/subgrade interface. In hot weather conditions, moisten the subgrade the evening before operations.
 - 3) Ensure that the time between placing and curing is minimized and eliminate delays.
 - 4) Moisten concrete aggregates that are dry and absorptive.
 - 5) Use a fog spray to raise the relative humidity of the ambient air if there is a delay in immediately applying the curing compound.
 - 6) Minimize solar heat by shading, wetting, or covering concrete chutes or other equipment that comes in contact with plastic concrete.
- d. If the evaporation rate is 0.3 pounds per square foot per hour or greater, discontinue placement of concrete.

3. Rain Protection:

- a. Have materials available, near the work site, for proper protection of the edges and surface of concrete. Protective material may consist of sheets of burlap or plastic film. Also have planks or other material with suitable stakes that can be used as temporary forms available.
- b. If initial set has not occurred, take every precaution necessary to protect the surface texture of the concrete.
- c. If so determined by the Engineer, failure to properly protect concrete will constitute cause for removal and replacement of defective pavement.

B. Night Conditions: Perform all finishing and covering operations prior to darkness (half an hour after sunset). Do not commence construction until half an hour before sunrise. Do not place or finish concrete under artificial light, unless approved by the Engineer.

C. Protection from Traffic:**1. General:**

- a. Protect the new pavement and its appurtenances from traffic, both public and that caused by the Contractor's own employees and agents, at no additional cost to the Contracting Authority. This includes the erection and maintenance of warning signs, lights, barricades, watchmen to direct traffic, and pavement bridges or crossovers.
- b. Do not operate equipment with metal tracks, metal bucket blades, or metal motor patrol blades directly on new paving. Do not unload soil or granular materials, including base rock for storage and future reloading directly onto new paving.

2. End of Day's Run:

- a. At the end of each day's run and at all side streets, erect and maintain safety barriers and fencing as necessary to protect the pavement from damage.
- b. Install safety fences within 1 hour of the completion of finishing and curing operations. Leave fences in place and maintained until the concrete has attained the minimum strength or age.
- c. Intermediate safety fences may be required for the purpose of opening the pavement for access to a side road, side street, or entrance.

3. Repair of Damages: At the discretion of the Engineer, and at no additional cost to the Contracting Authority, repair or replace any part of the pavement damaged by traffic or other causes occurring prior to final acceptance of the pavement.

3.05 USE OF PAVEMENT

Time for opening pavement for use is determined by maturity method complying with [Iowa DOT Materials I.M. 383](#) or age and test results. The minimum age and test results needed for opening are shown in Table 7010.01.

Table 7010.01: Minimum Age and Tested Strength of Pavement Before Opening

Class of Mix	Minimum Age For Opening ¹	Minimum Compressive Strength (psi)	Minimum Flexural Strength Center Point (psi)
C	7 Days ²	3,000	500
M	48 Hours	3,000	500

¹ Opening without testing only allowed upon approval of Engineer

² Five calendar days for concrete 9 inches thick or more. If maturity testing is used to determine opening, minimum flexural strength may be lowered to 350 psi if approved by the Engineer.

3.06 TRANSPORTATION RESTRICTIONS

- A. Do not use concrete transported with continuous agitation when the cement has been in contact with the aggregate more than 90 minutes before it is placed. With the approval of the Engineer, an approved retarding admixture may be used at the rates required in [Iowa DOT Materials I.M. 403](#).
- B. Do not use concrete transported without continuous agitation if the period elapsed between the time the concrete is mixed and the time it is placed is greater than 30 minutes. With the approval of the Engineer, an approved retarding admixture may be used at the rates required in [Iowa DOT Materials I.M. 403](#) and the mixed-to-placed time may be extended.
- C. Ensure the methods of delivering and handling the concrete are such that objectionable segregation or damage to the concrete will not occur, and concrete placing will occur with a minimum of rehandling.
- D. Thoroughly clean the truck compartment in which concrete is transported and flush with water to ensure that hardened concrete will not accumulate. Discharge the flushing water from the truck compartment to the designated discharge point before it is charged with the next batch.

3.07 QUALITY CONTROL

- A. Testing:** Provide the following material certifications and testing required to be performed by Supplier or Contractor.

Table 7010.02: Material Certifications and Testing

Material or Construction Item	Tests	Applicable Standard ¹	Methods of Acceptance of Sampling and Testing	Field Sampling and Testing	
				Frequency (minimum)	Responsible Party
Fine Aggregates	Gradation	I.M. 302, 306, 336	Cert. Plant Insp. ²	1/250 CY or min 1/day	Supplier/ Contractor
	Moisture	I.M. 308, 527	Cert. Plant Insp. ²	1 per 1/2 day	
	Specific Gravity	I.M. 307	Cert. Plant Insp. ²	1/250 CY or min 1/day	
	Quality	I.M. 209	Approved Source	Prior to use	
Coarse Aggregates	Gradation	I.M. 302, 306, 336	Cert. Plant Insp. ²	1/250 CY or min 1/day	
	Moisture	I.M. 308, 527	Cert. Plant Insp. ²	1 per 1/2 day	
	Specific Gravity	I.M. 307	Cert. Plant Insp. ²	1/250 CY or min 1/day	
	Quality	I.M. 209	Approved Source	Prior to use	
Portland Cement	Quality	I.M. 401	Approved Source	Prior to use	
Fly Ash	Quality	I.M. 491.17	Approved Source	Prior to use	
GGBFS	Quality	I.M. 491.14	Approved Source	Prior to use	
Curing Compound	Quality	Iowa DOT Section 4105	Approved Source	Prior to use	
Joint Filler	Quality	I.M. 436.01	Approved Source	Prior to use	
Epoxy Dowel Bars and Assemblies	Quality	I.M. 451.03B	Approved Source	Prior to use	
Tie Bars	Quality	I.M. 451	Approved Source	Prior to use	
Plastic Concrete	Air Content ⁴	I.M. 318, 327	Field Test	1/200 CY or min. 1/day	Engineer
	Slump ⁵	I.M. 317	Field Test	1/200 CY or min. 1/day	
	Cylinders	I.M. 315	Field Test	Set of 3/500 CY or two sets/day	
	Beams	I.M. 316, 327, 328	Field Test	Set of 3/500 CY or two sets/day	
	Thickness	-----	Field Test	1/200 CY	
Hardened Concrete	Smoothness	SUDAS 7010, 3.07	Field Test - Straightedge	Project length	Contractor
	Smoothness	SUDAS 7010, 3.07	Field Test - Inertial Profiler	Project length	
	Thickness	SUDAS 7010, 3.07	Field Test	1 core/1000 SY or 3 cores/project	
	Strength	I.M. 383	Maturity Tests ³	Prior to placement	

¹ Refers to the Iowa DOT Materials I.M.s, Iowa DOT Standard Specifications, or SUDAS Standard Specifications.

² Certified plant inspection per [Iowa DOT Materials I.M. 527](#).

³ The Contractor is responsible for developing the maturity curve for the specified mix, taking maturity readings, and delivering a copy of the results to the Engineer.

⁴ If central or stationary on-site mixed concrete is being used and air content and consistency are being monitored as required at the mixing site, field testing can be reduced to 1/500 CY or minimum 1 per day.

⁵ Slump testing is not required for slipform paving operations. Edge slump of the pavement behind the paver will be monitored by the Contractor and the Inspector.

B. Air Content:

- Air content of the concrete will be evaluated according to [Iowa DOT Materials I.M. 318](#) and [327](#).

3.07 QUALITY CONTROL (Continued)

2. When a test result is outside the tolerance for the target air content, the contractor will be notified immediately. An air test will then be immediately run behind the paver to aid in identifying the limits of the non-complying air. A test result between 5% and 8% behind the paver will be considered complying. This test will represent all concrete from the back of the paver back to the last documented complying test. Make immediate adjustments to the mix production and placement process to bring the air content back within tolerance. Do not use succeeding loads below the lower target air content tolerance by more than 0.5%. Each subsequent load will be tested until air content is within tolerance for two consecutive loads. For all incorporated, non-complying concrete that is out of tolerance, the Engineer will determine if removal and replacement is required or if a price adjustment, according to Table 7010.03, will be applied.

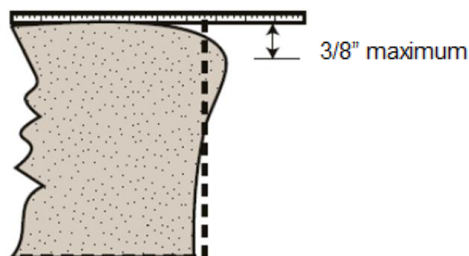
Table 7010.03: Concrete Air Content Price Adjustments

Air Content Range			% Payment of Unit Price
Minimum		Maximum	
1.1*	and	below	0%
0.6	to	1.0*	50%
0.1	to	0.5*	75%
	Low air tolerance limit		100%
	Target		100%
	High air tolerance limit		100%
0.1	to	0.5**	95%
0.6	to	1.0**	85%
1.1	to	1.5**	75%
1.6	to	2.0**	60%
2.1**	and	above	0%

*Air content deviation below the acceptable limits

** Air content deviation above the acceptable limits

- C. Edge Slump:** Edge slump behind the paver will be observed to ensure proper stiffness of the concrete mix. If the Engineer notes the pavement is slumping, it will be measured to verify. For pavement without a curb, edge slump must be less than 3/8 inch as measured below. For curbed profiles, ensure the horizontal deviation measured from a point equal to the proposed curb height plus 4 inches does not exceed 1/2 inch from a vertical level placed at the top edge of the back of curb. In cases of the edge slump exceeding the maximum allowable, immediately adjust the concrete stiffness.



3.07 QUALITY CONTROL (Continued)

D. Pavement Smoothness: Evaluate pavement smoothness for all PCC pavement and overlay surfaces.

1. **Straightedge:** The Engineer will check PCC pavement surfaces with a 10 foot straightedge placed parallel to the centerline. Areas showing high spots of more than 1/4 of an inch in 10 feet will be marked. Complete surface corrections according to the following procedures to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straightedge.
 - a. Complete surface corrections by diamond grinding, placing a PCC overlay, or replacement.
 - b. Use grinding and texturing equipment complying with [Iowa DOT Section 2532](#). Use a minimum 36 inch wide cutting head, unless a 24 inch cutting head is necessary due space limitations.
 - c. Perform surface correction parallel to lane lines or edge lines as directed by the Engineer. Make each pass parallel to the previous pass. Ensure the ground surface is of a uniform texture.
 - d. Do not allow adjacent passes to overlap more than 1 inch or have a vertical difference of 1/8 inch as measured from bottom of groove to bottom of groove.
 - e. Begin and end smoothness corrections at lines normal to the pavement lanes lines or edge lines within any one corrected area. Proceed from the centerline or lane line toward the pavement edge to maintain pavement cross slope.

Surface corrections will be completed at the direction of the Engineer with no additional cost to the Contracting Authority.

2. **Inertial Profilers:**
 - a. If specified in the contract documents, comply with [Iowa DOT Section 2317](#) and [Materials I.M. 341, Appendix A](#) to measure pavement smoothness with an inertial profiler and start appropriate corrective measures, if necessary; the engineer will determine the corrective measures to be taken. No incentive for pavement smoothness will be made.
 - b. Evaluate according to the smoothness requirements of Table 7010.04 and make surface corrections and/or price reductions. Surface corrections will be completed with no additional cost to the Contracting Authority. No incentive for pavement smoothness will be made.
 - c. Smoothness measurements will be suspended for structures and through intersections.

Table 7010.04: Smoothness Adjustment/Correction

Segment Speed	Mean Roughness Index (inches per mile)	Pay Factor
Greater than 45 mph	< 200	100%
	200 to 250	-\$15.00/foot/lane or grind ¹
	≥ 250	Grind ¹
Less than or equal to 45 mph	< 250	100%
	250 to 300	-\$15.00/foot/lane or grind ²
	≥ 300	Grind ²

¹ Correct to below 200 inches per mile

² Correct to below 250 inches per mile

3.07 QUALITY CONTROL (Continued)**D. Pavement Thickness:**

1. At locations determined by the Engineer, cut samples from the pavement by drilling with a core bit that will provide samples with a 4 inch outside diameter. Restore the surface by tamping low slump concrete into the hole, finishing, and texturing. The Engineer will witness the core drilling, identify, and take possession of the cores. The Engineer will determine the core locations, measure the cores, and determine the thickness index according to [Iowa DOT Materials I.M. 346](#) and [347](#), except as modified as follows:
 - a. For regular or irregular shaped areas, use a lot size of 1,000 square yards. Include remnants less than 500 square yards in the last lot and remnants greater than 500 square yards in a separate lot. Take a minimum of three cores per project.
 - b. For any core with a deficiency greater than 0.15 inch, take two additional cores in that pavement lot and use the average of the three cores.
2. If approved by the Engineer, take non-destructive measurements to determine the pavement thickness and the thickness index for each section.
 - a. Use Magnetic Imaging Tomography (MIT) Scan T2 or T3 gauge to perform thickness measurements.
 - b. Use 24 gauge commercial steel as targets that are 11.81 inches in diameter with G90 coating meeting ASTM A 653.
 - c. The Engineer will determine the location of each lot, the random location of each metal target, and the random thickness measuring scheme for each section using an Iowa DOT developed spreadsheet. Immediately prior to paving, the Engineer will place the target or observe the contractor place the target. The program will randomly determine which targets to measure.
 - 1) For regular or irregular areas, the section will be divided longitudinally into 1,000 square yard lots. One target will be located in each lot based on the spreadsheet selection. Beginning with the first station at +00, place a target from the edge of the pavement halfway between dowel baskets, if applicable. If the +00 station falls on a basket, move the target location ahead halfway between the dowel baskets. A minimum of 10 targets will be tested. If a target location falls on a bridge or in an approach section, it will be eliminated.
 - 2) The transverse location of the targets will be randomly determined by the spreadsheet. The random locations will be 4 feet from edge of pavement, left or right. Place targets in the center of the pavement panel to prevent interference by the steel in the joints. For ease of measuring, plates may be placed 18 inches from the edge if there is no tie steel or a work bridge is not available.
 - d. Follow the manufacturer's instructions for operating the thickness gauge. It is important to avoid testing close to any steel including vehicles, equipment, steel toed shoes as well as tie bars, dowel bars and baskets, and manhole covers. When wearing steel toed shoes, always keep both toes at least 2 feet from the gauge during the test. Three repeat readings will be taken. The readings should all be within 0.15 inch of each other.
 - e. Evaluate each section according to [Iowa DOT Materials I.M. 346](#).
 - f. The Engineer will perform quality assurance testing at a minimum of one random test per seven plate locations, using one of the following methods.
 - 1) Probe during paving operations according to [Iowa DOT Materials I.M. 396](#). Plates may be moved to 18 inches from the edge of the pavement to allow easier testing.
 - 2) Survey, to a minimum of 0.005 foot, on the plate prior to paving and on top of the pavement directly over the plate after placement to determine an accurate thickness verification.
 - 3) MIT gauge according to [Iowa DOT Materials I.M. 346](#). Use a different gauge than the one used by the contractor on the project.

3.07 QUALITY CONTROL (Continued)

- g. Include all MIT Scan measurements and quality assurance measurements for calculation of pavement thickness. The final pavement thickness will be determined by one of the following:
 - 1) If all the quality assurance measurements are within ± 0.25 inch of the MIT Scan measurements, the MIT Scan measurements will be considered validated. The Engineer will determine final thickness based on the average MIT Scan measurements.
 - 2) If at any one location, the quality assurance measurements are greater than ± 0.25 inch difference from the MIT Scan measurements, core at the plate location and 2 feet away from the plate location. If the core at the plate location indicates that it has moved during placement, use the core thickness from the core taken 2 feet away as the pavement thickness. The Engineer will replace the MIT Scan thickness at the location with the core thickness taken 2 feet away along with the average MIT Scan measurements as final pavement thickness.
 - 3) If all of the quality assurance measurements are greater than ± 0.25 inch difference from the MIT Scan measurements, the Engineer will randomly select a minimum of 10 random locations, at 2 feet from the plate location, for coring by the Contractor. The Engineer will use the average core thickness, tested according to [Iowa DOT Materials I.M. 346](#), to determine final pavement thickness.
 - h. If any measurement is deficient from T by 0.5 inch or more, the measurement should be rechecked to confirm the reading and the equipment. If the repeat measurement is also 0.5 inch or more below T, mark the location directly over the target. Drill a 4.0 inch diameter core at that location. If the core length confirms the pavement is deficient by 0.5 inch or more, drill a core 60 feet in each direction longitudinally at the same transverse location from the deficient core. Drilling will be continued at 60 feet intervals until a core is obtained that is not deficient. Interpolate between this core and the adjacent core to determine the limits of the deficient area. These additional cores are to be used to define the deficient area and will not be used in the thickness index calculation. When an obstruction, such as a bridge, intersection, previous work, etc., prevents drilling a core at the required 60 feet interval in either direction longitudinally, continue the balance of the distance on the other side of the obstruction.
3. Coring of pavement or other work for thickness determination may be waived by mutual agreement for sections of the same design thickness less than 2,500 square yards.
 4. Based on the thickness index determined by the Engineer, the pavement payment will be as shown in Tables 7010.05 and 7010.06.
 5. If the thickness index deficiency is greater than 0.51 for pavements thinner than 9 inches or 0.91 for pavements 9 inches or thicker, the Engineer will study the extent and severity of the deficiency of the pavement areas. The Engineer will require one of the following based on a review on the level of deficiency, the amount of the payment penalty, and the estimated reduction in the design life of the deficient pavement:
 - a. Removal and replacement of the deficient areas with pavement complying with the contract documents at no additional cost to the Contracting Authority.
 - b. Completion of an agreement that provides a combination of an extended guarantee period and payment penalty and allows the deficient pavement to be left in place.

3.07 QUALITY CONTROL (Continued)**Table 7010.05: Pay Factor for PCC Pavement for Design Thickness less than 9"**

Thickness Index Range	Percent Payment
More than 0 to -0.15	100
-0.16 to -0.25	95
-0.26 to -0.50	85
-0.51 or less	As determined by the Engineer

Table 7010.06: Pay Factor for PCC Pavement for Design Thickness 9" or Greater

Thickness Index Range	Percent Payment
More than 0.00 to -0.15	100
-0.16 to -0.20	99
-0.21 to -0.25	98
-0.26 to -0.30	97
-0.31 to -0.35	96
-0.36 to -0.40	95
-0.41 to -0.45	94
-0.46 to -0.50	93
-0.51 to -0.55	92
-0.56 to -0.60	91
-0.61 to -0.65	90
-0.66 to -0.70	89
-0.71 to -0.75	88
-0.76 to -0.80	87
-0.81 to -0.85	86
-0.86 to -0.90	85
-0.91 or less	As determined by the Engineer

- E. Defects or Deficiencies:** Remove and replace or repair pavement containing excessive cracks, fractures, spalls, or other defects at no additional cost to the Contracting Authority. The method of replacement or repair will be determined by the Engineer.

END OF SECTION