

**DIVISION 5 SURFACE TREATMENTS AND PAVEMENTS****SECTION 5-01 SUBSEALING****5-01.1 DESCRIPTION**

Section 5-01 describes work consisting of filling voids under existing cement concrete pavement and rigid base asphalt pavements by pumping a mixture of portland cement, pozzolan, or fly ash, and water under the pavement slabs.

**5-01.2 MATERIALS**

Materials shall meet the requirements of the following Sections:

Portland Cement and Blended Hydraulic Cement	9-01
Pozzolans (Fly Ash & Ground Granulated Blast Furnace Slag)	9-23.9 & 9-23.10
Water	9-25

**5-01.3 CONSTRUCTION REQUIREMENTS****5-01.3(1) PROPORTIONING MATERIALS**

The standard mix design for subsealing is as follows:

1 part (by volume)	Portland cement Type I or II
3 parts (by volume)	Pozzolan (natural or artificial)
2.25 parts (by volume)	Water

Any deviation from the above mix design shall be approved by the Engineer. The water content may be varied by the Contractor as required for local conditions.

**5-01.3(2) EQUIPMENT**

All equipment used in performance of subsealing shall be subject to the approval of the Engineer and shall be maintained in satisfactory working condition at all times.

Air compressors to be used for operating air hammers, and for blowing air into the cavities beneath the pavement, shall be of sufficient size and capacity for acceptable performance.

Air hammers shall be equipped with drills that are Capable of cutting 1-1/2 inch diameter holes through the pavement. The equipment shall be in good working condition and operated in such a manner that out-of-round holes shall not be produced.

The grout plant shall consist of a cement injection pump and a high speed colloidal mixing machine. The colloidal mixing machine shall operate at a minimum speed of 1,200 rpm and shall consist of a rotor operating in close proximity to a stator, creating a high shearing action and subsequent pressure release to make a homogeneous mixture.

The dry Material shall be accurately measured, and the water shall be batched through a meter or scale with a totalizer for the day's consumption.

Wooden cylindrical plugs or other devices approved by the Engineer shall be provided to temporarily plug the application holes until the Material has set. The plugs shall be slightly tapered on one end for ease in driving.

**5-01.3(3) CONSTRUCTION**

Subsealing shall not be done when the pavement is wet, or when water is present under the pavement. Application holes shall be drilled through the cement concrete pavement in the approximate pattern as indicated on the Drawings.

Application holes shall be approximately 1-1/2 inches in diameter and shall be perpendicular to the pavement surface. The Contractor shall not drill more holes in a day than can be filled or temporarily plugged during the same day. To prepare the cavity for injection of the subsealing mix Materials, compressed air shall be blown through the application holes for not less than 15 seconds and not more than 60 seconds. After the application holes are blown out and the nozzle is firmly wedged into the hole, the subsealing mix shall be pumped into the application hole until all cavities are filled, or until any one of the following occurs:

1. A pavement slab or portion of a slab starts to rise.
2. Subsealing mix extrudes from adjacent application holes, or along or outside the longitudinal edges of the pavement.
3. The Engineer orders application of subsealing mix stopped. Immediately upon removal of the nozzle, the plug shall be inserted and firmly driven into the application holes.

Following the application and after the mix has set, the wooden plugs shall be removed and the application holes immediately filled with subsealing mix.

Subsealing shall be continued progressively through the pavement requiring subsealing.

Traffic shall not be allowed upon any subsealed area until the subseal has hardened.

In the event the Engineer determines that continued injection at any specific location is no longer economically feasible, the Contractor shall cease operations and move to a new location.

**5-01.4 MEASUREMENT**

Bid items of Work completed pursuant to the Contract will be measured as provided in Section 1-09.1, Measurement of Quantities, unless otherwise provided for by individual measurement paragraphs herein this Section.

Measurement for "Pavement Subseal" will be by the cubic foot of dry Materials used before the addition of water or other additives.

Measurement for "Drill Hole for Subsealing" will be by each hole drilled completely through the pavement.

**5-01.5 PAYMENT**

Compensation for the cost necessary to complete the work described in Section 5-01 will be made at the Bid item prices Bid only for the Bid items listed or referenced as follows:

1. "Drill Hole for Subsealing", per each.  
The Bid item price for "Drill Hole for Subsealing" shall include all costs for the work required to drill the holes.
2. "Pavement Subseal", per cubic foot.  
The Bid item price for "Pavement Subseal" shall include all costs for the work required to complete the subsealing.

**SECTION 5-02 BITUMINOUS SURFACE TREATMENT**

**5-02.1 DESCRIPTION**

**5-02.1(1) GENERAL**

Section 5-02 describes work consisting of constructing a single or multiple course bituminous surface by treating existing crushed rock, screened gravel or bituminous roadway surfaces with liquid asphalt and covering with a Mineral Aggregate thoroughly cemented to the roadway to obtain a wearing surface with good riding and nonskid qualities.

Roadway surfaces shall be classified as treated or untreated roadway surfaces as defined in Section 5-04.3(4)A.

Bituminous surface treatment method shall be Class B unless specified otherwise in the Contract.

Bituminous surface treatment shall not be considered "oil mat surface" (see Section 4-04).

**5-02.1(2) BITUMINOUS SURFACE TREATMENT CLASS A**

This method of treatment requires two applications of asphalt and three applications of aggregate. The second application (tack coat) shall be applied after the first application of prime coat has cured and all loose aggregate has been removed.

**5-02.1(3) BITUMINOUS SURFACE TREATMENT CLASSES B, C, AND D**

These methods require the placing of one application of asphalt and one or more sizes of aggregate as specified to an existing asphalt roadway to seal and rejuvenate the surface and to produce a uniform roadway surface with good nonskid characteristics.

**5-02.2 MATERIALS**

Materials shall meet the requirements of the following Sections:

Asphalt	9-02
Anti-Stripping Additive	9-02.4
Mineral Aggregates	9-03

The grade of asphalt shall be Cationic Emulsified Asphalt (CRS-2) meeting the requirements of Section 9-02.1(6).

Mineral Aggregate for Bituminous Surface Treatment Class A or Class B shall be Mineral Aggregate Type 24, Chip Rock, meeting the requirements set forth in Section 9-03.

When cutback asphalts are specified for Bituminous Surface Treatment Class A, construction shall not begin until the need for anti-stripping additive has been determined. The Contractor shall allow a minimum of seven Working Days after the SPU Materials Laboratory has received samples of the Mineral Aggregate, asphalt, and anti-stripping additive, for testing. Additional time will be required by the Engineer to verify acceptable performance and compatibility, if the Contractor has requested more than one source of asphalt or anti-stripping additive be approved. The Contractor shall take this into consideration in preparing for and meeting Contract Time.

**5-02.3 CONSTRUCTION REQUIREMENTS**

**5-02.3(1) EQUIPMENT**

The equipment used by the Contractor shall include scarifying, mixing, spreading, finishing and compacting equipment, an asphalt distributor, and equipment for heating asphalt Material, and shall be subject to approval by the Engineer before its use on the Work.

The distributor shall have a capacity of not less than 1,000 gallons, and shall be so designed, equipped, maintained, and operated that asphalt Material of an even heat shall be uniformly applied at the required rate. It shall be equipped with a

10-foot spray bar with extensions, pressure pump and gauge, volume gauge so located as to be observed easily by the Engineer from the ground, a tachometer to control accurately the speed and spread of asphalt, and two thermometers, one installed permanently in the tank to indicate temperatures of the asphalt at all times. The power for operating the pressure pump shall be supplied by a power unit which provides a uniform spray from each of the nozzles across the spray bar and extensions.

Rollers shall be self-propelled pneumatic-tired or smooth-wheeled rollers, each weighing not less than 10 tons.

Spreading equipment shall be self-propelled, supported on at least four pneumatic tires, with an approved device for accurately metering and distributing the Mineral Aggregate uniformly over the roadway surface.

Brooms shall be motorized with a positive means of controlling vertical pressure.

Other equipment necessary to acceptably perform the work as specified herein shall be subject to approval by the Engineer before its use on the Work.

Additional units shall be placed on the Work when, in the opinion of the Engineer, it is considered necessary in order to fulfill the requirements of these Specifications, or to complete the Work within the time specified.

Both the asphalt distributor and the self-propelled chip spreader shall be calibrated prior to their use to ensure applications within the specified coverage limits. Adjustment of the asphalt distributor spray bar height shall produce a triple lap of spray fans from bars with a 4-inch nozzle spacing and a double lap from bars having a 6-inch nozzle spacing.

The Contractor shall frequently check and adjust, if necessary, the height of the spray bar during asphalt application to insure the height above the pavement surface does not vary more than 1 inch as the truck load lightens.

### **5-02.3(2) PREPARATION OF ROADWAY SURFACE**

#### **5-02.3(2)A UNTREATED SURFACES**

Refer to Section 5-04.3(4)C.

No traffic will be allowed on the repaired surface until the prime coat of asphalt and Mineral Aggregate is applied.

#### **5-02.3(2)B TREATED SURFACES**

Refer to Section 5-04.3(4)B.

#### **5-02.3(2)C SOIL RESIDUAL HERBICIDE**

The use of soil residual herbicide will not be allowed.

### **5-02.3(3) APPLICATION OF ASPHALT**

Upon the properly prepared roadway surface, Cationic Emulsified Asphalt (CRS-2) shall be applied in non-shaded areas at the rate of 0.35 to 0.40 gallon per square yard, and in shaded areas at 0.38 to 0.45 gallon per square yard. The asphalt spraying application temperature at the distributor shall be between 140°F and 185°F. The Engineer may vary the rate of asphalt application that will give the best results.

To ensure uniform distribution of asphalt prior to beginning the asphalt application, the distributor bar shall be operated over a pit or vat. To avoid gaps and ridges at transverse junctions of separate applications of asphalt, the Contractor shall spread sufficient building paper over the treated surface to make sure that the spray jets function normally when the untreated surface is reached.

The pattern of application of shots, and width and length of application of shots of asphalt Material shall be such as to provide proper coverage of crushed Material within the times specified, provide proper widths to such dimensions as to facilitate an acceptable coverage of crushed cover stone, and provide lapping of subsequent adjacent applications.

Asphalt shall be applied to spandrels of intersections and driveways immediately ahead of, or immediately behind the adjacent longitudinal street application.

Omissions (skips) by the distributor shall immediately be covered by hand application with the same grade of hot asphalt.

Any one spread of asphalt shall cover no more area than can be covered with Mineral Aggregate within 3 minutes from the time of application, upon any part of the spread.

Asphalt shall be spread toward the source of Mineral Aggregate to avoid injury to the freshly treated surface. No asphalt shall be spread until adequate supplies of Mineral Aggregate are on hand at the Project Site.

Where earth curbs or no curbs exist, the application of asphalt shall extend 4 inches beyond the gutter line. Where concrete curb and gutter exist, the application shall lap onto the gutter section, but shall not exceed 2 inches. Where concrete curb exists, the application shall be placed as closely as possible to the vertical surface without excessive splash onto the curb. Where concrete curb or curb and gutter exist, the distributor shall be equipped with a splash board designed to prevent spraying thereon.

All castings shall be protected by securely covering with heavy building paper and weighing down with sand or crushed Material.

Hand sprayers shall be used to apply asphalt around castings, and to areas where coverage is insufficient.

**5-02.3(4) RESERVED****5-02.3(5) APPLICATION METHOD OF AGGREGATES**

Any method of handling the Mineral Aggregate which causes segregation of the various sizes of aggregate particles shall be corrected by the Contractor upon the request of the Engineer so that a uniform product is incorporated in the Work.

After applying the asphalt uniformly over the roadway surface, Mineral Aggregate of the Type specified shall be uniformly applied to the roadway surface at a rate of 25 to 33 pounds per square yard by spreader equipment. The quantity of Mineral Aggregate to be applied shall be such that the asphalt shall be uniformly covered and shall not pick up under traffic. The Mineral Aggregate shall be uniformly applied over the freshly spread asphalt by trailer-type or self-propelled spreader boxes. The Mineral Aggregate shall be applied so that trucks and spreader boxes do not travel on the fresh asphalt and the Mineral Aggregate layer shall be spread in one operation for each application of asphalt. Spandrels of intersections, driveways, and bare spots shall be covered by hand spreading from trucks immediately behind the box application. Mineral Aggregate shall be spread in such a manner as to provide an 8-inch strip of asphalt exposed to provide a lap with the next application of asphalt.

The Mineral Aggregate shall be damp and shall be free of dust and impurities, when applied to the roadway. If the Mineral Aggregate is dry or dusty or both dry and dusty, the Contractor shall spray the aggregate with water to obtain a damp and dust free condition. Dusty or dry Mineral Aggregate which compromises adhesion of the Mineral Aggregate to the substrate will not be allowed.

As soon as the aggregate has been applied to the surface, the aggregate shall be well rolled with a self-propelled pneumatic-tired roller. Places inaccessible to the pneumatic-tired roller, such as spandrels of intersections and private driveways, shall be rolled with a self-propelled smooth-wheel roller.

Where excess Mineral Aggregate has been applied, it shall either be removed or be drifted uniformly over the adjacent roadway by using a motor patrol grader equipped with a wire broom mold board, subject to approval of the Engineer. This type of brooming shall be held to a minimum, and where necessary it shall be very carefully performed so as not to disturb the mat in any way. Thin or bare spots in the spread of Mineral Aggregate shall be corrected by hand spreading or by use of a grader as described above.

Rolling and brooming shall continue until the roadway is uniformly covered and the Mineral Aggregate is well compacted and "set" into the asphalt. This operation shall continue until the asphalt has cured to the extent that it does not "pick up" under traffic. During the maintenance period following the application of the Bituminous Surface Treatment, the Contractor shall perform brooming, spotting, and rolling as necessary to prevent "pick up" or other damage to the surface.

At any time during the progress of the Work, the Engineer may order the use of a different Mineral Aggregate grading in lieu of the Mineral Aggregate specified if in the Engineer's judgment the results contemplated by the Specifications will thereby be better attained.

**5-02.3(6) ADDITIONAL ASPHALT AND MINERAL AGGREGATE**

If the application of asphalt or Mineral Aggregate, or both, is insufficient or excessive for the required results, the Engineer may require the Contractor to make an additional application of one or both Materials in accordance with these Specifications.

**5-02.3(7) PATCHING AND CORRECTION OF DEFECTS**

Omissions by the distributor or damage to the treated surface of any coat shall be immediately covered by hand application with asphalt in adequate quantities. Holes which develop in the surface shall be patched in the same manner as specified in Section 5-04.3(4)C2.

Defects such as raveling, lack of uniformity, or other imperfections caused by faulty workmanship shall be corrected and new work shall not be started until such defects have been remedied.

All improper workmanship and defective Materials resulting from overheating, improper handling or application, shall be removed from the roadway by the Contractor and shall be replaced with approved Materials and workmanship.

If the Engineer determines a fog seal is necessary at any time during the life of the Contract, the Contractor shall apply a fog seal of CSS-1 at the rate of 0.07 to 0.18 (0.02 to 0.05 residual) gallons per square yard. The emulsified asphalt shall be diluted with water at a rate of one part water to one part emulsified asphalt.

**5-02.3(8) PROGRESS OF WORK**

The Contractor shall organize the entire operation ensuring progression in an orderly and expeditious manner.

The sequence of operation for placing Bituminous Surface Treatments shall be as follows:

1. Apply asphalt emulsion on a properly prepared roadway surface resulting in a uniform application.
2. Apply Mineral Aggregate by spreader boxes or other means resulting in a uniform application.
3. Roll with pneumatic-tired and/or self-propelled smooth-wheeled roller.
4. Allow a minimum of 48 hours set time.
5. Sweep with an approved road broom to pick up and remove excess Mineral Aggregate. This work shall be accomplished in the early morning hours before the heat from the sun has warmed the pavement.
6. Maintain roadway surface for 5 calendar Days by sweeping and patching as necessary on a daily basis, maintaining traffic signing, etc.

Ten (10) Calendar Days after the final application, the Contractor shall make a final sweep with a mechanical broom, using the pick up broom only, to clear off any remaining loose aggregates. Gutter brooms shall not be used. The Contractor shall dispose of the excess Mineral Aggregates.

#### **5-02.3(9) PROTECTION OF STRUCTURES**

All handrails, guardrails, curbs, road signs, and other facilities shall be protected from splashing and overspray.

#### **5-02.3(10) UNFAVORABLE WEATHER**

Asphalt shall not be applied to excessively wet Material. Asphalt shall not be applied during rainfall, sand or dust storms, or before any imminent storms that might adversely impact construction. The Engineer will determine whether the surface and Materials are acceptable for construction in inclement weather.

The application of any asphalt to the roadway shall be restricted to the following conditions:

1. The roadway surface temperature shall be at least 60°F and the air temperature at least 60°F and either holding or rising, or
2. The air temperature shall be not less than 70°F when falling and the wind shall be less than 10 miles per hour as estimated by the Engineer.

No asphalt shall be applied which cannot be covered one hour before darkness. The Engineer may require the Contractor to delay application of asphalt until the atmospheric and roadway conditions are within the conditions listed above.

Construction of bituminous surface treatments on any Traveled Way shall not be carried out before May 15 or after September 1 of any year except upon written notice from the Engineer.

#### **5-02.3(11) ANTI-STRIPPING ADDITIVE**

When directed by the Engineer, an anti-stripping additive shall be added to the asphalt Material (see Section 9-02.4).

#### **5-02.3(12) UNTREATED ROADWAY SURFACES**

Existing crushed rock, gravel, and oil mat streets shall be restored with Mineral Aggregate Type 1, to a compacted depth of 4 inches. Final surfacing shall be constructed as specified in Section 5-04.3(4)C2.

#### **5-02.4 MEASUREMENT**

Bid items of Work completed pursuant to the Contract will be measured as provided in Section 1-09.1, Measurement of Quantities, unless otherwise provided for by individual measurement paragraphs herein this Section.

Measurement for "Asphalt (Grade)" will be made by the gallon or ton before dilution.

Measurement for Mineral Aggregate Type will be by the ton.

Measurement for roadway preparation will be as specified in Section 5-04.4

#### **5-02.5 PAYMENT**

Compensation for the cost necessary to complete the work described in Section 5-02 will be made at the Bid item prices Bid only for the Bid items listed or referenced as follows:

1. "Asphalt, (Grade)", per gallon or ton.

The Bid item price for "Asphalt, (Grade)" shall include all costs for the work required to construct a single or multiple course bituminous surface treatment.

2. **Other payment information.**

Payment for Mineral Aggregate (Type) will be made in accordance with Section 4-01.5.

Change in Mineral Aggregate Type, or in grade of asphalt, or in Engineer directed application of fog seal will be addressed in accordance with Section 1-04.1(2).

All costs for the work required to coat omissions or to patch defects shall be included in the Bid item price for the applicable Bid item.

All costs for splashing and overspray protection shall be included in the Bid item price for the applicable Bid item.

All costs for roadway preparation will be paid in accordance with Section 5-04.5.

All costs for water will be paid in accordance with Section 2-12.5.

#### **SECTION 5-03 RESERVED**

#### **SECTION 5-04 HOT MIX ASPHALT (HMA) AND WARM MIX ASPHALT (WMA) PAVEMENT**

##### **5-04.1 DESCRIPTION**

This work shall consist of providing and placing one or more layers of plant-mixed hot mix asphalt (HMA), warm mix asphalt (WMA), or both on a prepared foundation or base in accordance with these Specifications and the lines, grades, thicknesses, and typical cross sections shown on the Drawings.

Hot Mix Asphalt (HMA) shall be composed of asphalt binder and Mineral Aggregate as may be required, and then mixed in the proportions specified to provide a homogeneous, stable, workable, and compactable mixture.

Warm Mix Asphalt (WMA) is a technology that allows conventional HMA asphalt concrete mixtures to be produced and placed at reduced temperatures. The reduced temperatures of WMA shall be employed by utilizing water-based foaming processes.

Other WMA technologies including organic or chemical additives may be submitted for approval.

#### 5-04.2 MATERIALS

Materials shall meet the requirements of the following Sections:

Bituminous Materials	9-02
Mineral Aggregates	9-03
Temporary Pavement Marking	9-29.4

The grade of asphalt binder will be specified in the Contract (also see Section 5-04.2(1)).

#### 5-04.2(1) USE OF SUBSTITUTE MATERIALS

The proposed use of substitute or alternate materials by the Contractor in the production of HMA from those specified in the Contract shall be part of the submittal as specified in Section 5-04.3(6) and shall require approval of the Engineer.

**Recycled asphalt pavement (RAP):** Unless the Contract specifies otherwise, the Contractor may propose the use of RAP (see Section 9-03.8(3)B). RAP shall not exceed 20% of the total weight of aggregate in the HMA mix. RAP will not be allowed for asphalt binders with grades of PG-70 or higher.

**Grade of asphalt binder:** Unless the Contract specifies otherwise, the Contractor may propose the use of a substitute grade of asphalt binder. The substitute grade of asphalt binder shall:

1. meet the requirements of Section 9-02.1(4),
2. have a maximum pavement design temperature that is equal to or greater than that of the specified binder, and
3. have a minimum pavement design temperature that is equal to or lower than that of the specified binder.

The Engineer approved substituted grade of asphalt binder shall be used only in HMA of the same class with the Contract-specified grade of asphalt binder. Blending of asphalt binder, whether different manufacturers and/or Suppliers and/or different grades, will not be permitted.

#### 5-04.3 CONSTRUCTION REQUIREMENTS

##### 5-04.3(1) TERMS RELATED TO HMA

In Sections 5-04, 9-02, 9-03.6, and 9-03.8, terms and phrases used (such as "design aggregate structure", "nominal maximum aggregate size", "air voids", "maximum aggregate size", "binder content", etc.) and abbreviations (such as "JMF" for "job mix formula", " $V_a$ ", " $N_{design}$ ", " $G_{sb}$ ", etc.) are consistent with and can be found in WSDOT Standard Operating Procedure (SOP) 732 "Volumetric Design for Hot-Mix Asphalt (HMA)" and such other documents that are incorporated by reference within WSDOT SOP 732. WSDOT SOP 732, and other incorporated by reference documents, are available in the current edition of the Washington State Department of Transportation's Materials Manual M 46-01.

##### 5-04.3(1)A WMA REQUIREMENTS

When provided for in the Contract, the Contractor shall utilize WMA technologies for paving the wearing course. Contractor shall submit a WMA mix design in conformance with the requirements for submitting an HMA mix design, the Contractor shall include a description of the WMA technology to be employed. Description of the technology utilized shall include the following:

1. Manufacturer's recommended mixing and placement temperatures;
2. Description of all variances from the standard hot mix asphalt (HMA) requirements as defined within Section 5-04;
3. Targeted temperature reduction (production and placement);

Contractor shall provide copies of all manufacturers' literature related to the production, mixing, conveying, and placement of the WMA. Contractor shall follow all manufacturers' recommendations for mixing, conveyance and placement of WMA.

WMA will be subject to the Engineer's approval of the mix design.

##### 5-04.3(2) MIXING PLANT

In addition to the requirements of Section 1-06, the Contractor shall allow the Engineer safe access to stockpiles for sampling. An adequate and convenient space for the Engineer to temporarily store and test samples shall be allowed.

Plants used for the preparation of HMA shall conform to the following requirements:

**Equipment for Preparation of Asphalt Binder:** Tanks for the storage of asphalt binder shall be equipped to heat and hold the binder at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the storage tank. The circulating system for the asphalt binder shall be designed to ensure proper and continuous circulation during the operating period. A valve for

the purpose of sampling the binder shall be placed in either the storage tank or in the supply line to the mixer. Also see Section 5-04.3(5) for heating asphalt binder additional requirements.

**Thermometric Equipment:** An armored thermometer, Capable of detecting temperature ranges expected in the HMA mix, shall be fixed in the asphalt feed line at a location near the charging valve at the mixer unit. The thermometer location shall be convenient and safe for observation by the Engineer.

The plant shall also be equipped with an approved dial-scale thermometer, a mercury actuated thermometer, an electric pyrometer, or another approved thermometric instrument placed at the discharge chute of the dryer to automatically register or indicate the temperature of the heated aggregates. This device shall be in full view of the plant operator and shall be convenient to observation by the Engineer.

**Sampling and Testing of Mineral Aggregates:** The HMA plant shall be equipped with a mechanical sampler for the sampling of the Mineral Aggregates by the Engineer (see Sections 1-06.1 and 1-06.2).

### **5-04.3(3) PAVING AND RELATED EQUIPMENT**

#### **5-04.3(3)A HAULING EQUIPMENT**

Trucks used for hauling HMA shall have tight, clean, smooth metal beds. A cover fabricated of canvas or other suitable material and of sufficient size to completely protect the mixture from adverse weather shall be securely attached to the truck. Whenever the weather conditions during the workshift include, or are forecast to include, precipitation or an air temperature less than 45° F, the cover shall be securely attached to protect the HMA.

In order to prevent the HMA mixture from adhering to the hauling equipment, truck beds shall be sprayed with an environmentally benign release agent. Excess release agent shall be drained prior to filling with HMA. For hopper trucks, the conveyer shall be in operation during the process of applying the release agent.

#### **5-04.3(3)B PAVING EQUIPMENT**

##### **5-04.3(3)B1 GENERAL**

As specified in Section 1-05.9, the Contractor shall replace equipment producing defective work.

When requested by the Engineer, the Contractor shall be prepared to timely provide HMA and related equipment manufacturer's written operating instructions and maintenance manual.

##### **5-04.3(3)B2 HMA PAVERS**

HMA pavers shall be self-contained, power-propelled units, provided with an internally-heated vibratory screed or strike-off assembly and shall be Capable of spreading and finishing courses of HMA plant mix material in lane widths specified on the Drawings.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, segregating, or gouging the HMA. Extensions will be allowed provided they produce the same results, including ride, density, and surface texture as obtained by the primary screed or strike off assembly. Extensions without augers, vibration, and heated screeds, shall not be used in the traveled way.

The paver shall be equipped with automatic screed controls with sensors for either or both sides of the paver. The controls shall be Capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing automatic signals that operate the screed to maintain the desired grade and transverse slope. The sensor(s) shall be constructed so it operates from a reference line or a mat referencing device.

The Contractor shall furnish and install all pins, brackets, tensioning devices, wire, and accessories necessary for satisfactory operation of the automatic control equipment. The Contractor shall be prepared to provide samples of the above items prior to installation when requested by the Engineer.

The transverse slope controller shall be Capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. The paver shall be equipped with automatic feeder controls, properly adjusted to maintain a uniform depth of material ahead of the screed.

##### **5-04.3(3)B3 MATERIAL TRANSFER VEHICLES (MTV)**

A material transfer vehicle (MTV) shall not be used on any paving operation without prior written approval of the Engineer.

#### **5-04.3(3)C ROLLERS**

Rollers shall be of the steel wheel, vibratory or pneumatic tire type, in good condition and capable of reversing without backlash. Operation of the roller shall be in accordance with the manufacturer's recommendations. The number and weight of rollers shall be sufficient to compact the mixture in compliance with the requirements of Section 5-04.3(9). The use of equipment that results in crushing of the aggregate will not be permitted. Rollers producing pickup, washboard, uneven compaction of the surface, displacement of the mixture, or other defective work (see Section 1-05.7) will be rejected by the Engineer in accordance with Section 1-05.9.

### **5-04.3(3)D PLANING BITUMINOUS PAVEMENT AND REQUIRED PRE-PANING METAL DETECTION**

#### **5-04.3(3)D1 GENERAL**

Prior to planing, the Contractor shall meet with the Engineer to discuss the planing operations as specified in Section 5-04.3(17).

**5-04.3(3)D2 PLANING BITUMINOUS PAVEMENT**

Planing bituminous pavement shall be by the cold planing method only. Equipment shall be of a type that has operated successfully on work comparable to that in the Contract and shall be subject to the Engineer's approval prior to use. Equipment shall be maintained in good working condition while in use.

Cold planers shall be milling type equipment Capable of cutting at least a 5 foot chord to a depth of up to four (4) inches in one pass. For Contract or Engineer required planing depths in excess of four inches and as the total depth requires, the first pass and all succeeding passes shall each be to a maximum four inch depth, with the final pass depth being four or fewer inches to achieve the total depth. Smaller planers may be used for cutting around castings and other metal objects to remain, and for making taper cuts for butt joints.

Where metal is not visible on the surface but is detected below the surface, the Contractor shall employ methods of pavement removal that do not damage the detected metal if it is to remain, and is beyond the 4 inch maximum depth of planing so as not to damage Contractor equipment. On areas where irregularities or unavoidable obstacles make the use of mechanical planing equipment impractical, the planing shall be done with other equipment or by other means.

For mainline cold planing operations, the equipment shall have automatic controls with sensor for either or both sides of the equipment Capable of sensing the proper grade from an outside reference line. The automatic controls shall also be Capable of maintaining the desired transverse slope. The sensor shall be so constructed that it operates from a reference line or multi-footed ski-like arrangement. The transverse slope controller shall be Capable of maintaining the desired slope within plus or minus 0.1 percent.

**5-04.3(3)D3 REQUIRED PRE-PLANING METAL DETECTION**

The Contractor shall be aware that metal may be buried beneath the existing asphalt surface. Such metal may be rail track associated with Seattle's former street car system, or may be castings buried under asphalt overlay, or other similar metallic items.

Before planing, the Contractor shall adequately sweep the entire area of asphalt to be planed to detect buried metal.

If such metal is detected and is not indicated in the Contract, the Contractor shall surface mark such detected metal and shall notify the Engineer of such condition before planing as required by Section 1-04.7.

Where the Drawings indicate the existence of metal not visible on the existing pavement surface, the Contractor shall remove such surface pavement material and verify the depth to metal before planing. If the depth to metal is beyond the required depth of planing, the Contractor shall note such and shall avoid planing contact with such metal. If the depth to metal is within the depth range of required planing, then one of two outcomes is required, as follows:

1. If a metal casting, then the casting shall be treated as specified in Section 7-20.
2. If a metal object other than a casting, then the Engineer may require removal. If removal is not addressed in the Contract, then this portion of work may be addressed as extra work, see section 1-04.7.

Metal detection equipment shall have adequate sensitivity to detect metal hidden beneath existing pavement surface to a depth of at least 4 inches. Where planing is indicated to a depth greater than 4 inches, the Contractor shall be prepared to make multiple planing passes with each pass not exceeding the four inch depth. Before each planing pass of 4 inches or less, the Contractor shall resweep the same area of asphalt to detect metal.

Where the Engineer directs additional depth planing beyond that required in the Contract, the Contractor shall again sweep for metal before such additional depth planning, as described in this Specification.

Contractor planing equipment damaged by metal buried within asphalt shall be the sole responsibility of the Contractor.

**5-04.3(4) PREPARATION OF STREET SURFACES****5-04.3(4)A PREPARATION CLASSIFICATION DESCRIPTIONS**

In preparing surfaces, the following surface classifications apply:

**Treated surfaces:** cement concrete, asphalt concrete, brick, seal coat or other bituminous surface treatments.

**Untreated surfaces:** crushed rock, gravel, native subgrade, or oil mat surfaces.

Bituminous surface treatments are addressed in Section 5-02, and oil mat surfaces are addressed in Section 4-04.

The work of preparing existing surfaces for asphalt concrete or other bituminous Material overlay shall be classified as follows:

**"Surface preparation"** applies only to treated surfaces, and

**"Roadway preparation"** applies only to untreated surfaces.

**5-04.3(4)B SURFACE PREPARATION – TREATED SURFACES****5-04.3(4)B1 GENERAL**

When an existing treated surface is to be used as a base for one or more courses of new asphalt concrete, or other surfacing (see Sections 4-04 and 5-02), the treated surface shall first be swept, cleaned, and patched as follows:



1. Treated surfaces shall be swept with a power broom until free from dirt and other foreign matter. Hand brooms shall be used to clean omissions of the power broom. Fatty asphalt patches, grease drippings and other objectionable Material shall be removed from the existing pavement.
2. Excess asphalt joint filler shall be completely removed and premolded joint filler shall be removed to at least 1/2-inch below the surface of the existing pavement.
3. In order to obtain a sound base having uniform grade and cross-section, irregularities in the existing treated surface shall be corrected prior to placement of the new asphalt concrete or other bituminous surface treatment. Corrections shall be made by planing, preleveling, grinding, patching or by placing new base pavement.

#### **5-04.3(4)B2 PRELEVELING**

When a surface of the existing pavement or old base is irregular, it shall be brought to a uniform grade and cross section by preleveling. Existing surfaces not requiring planing, but requiring other repair or requiring preleveling, will be addressed in the Contract. If existing asphalt overlay is planed and the surface to remain requires preleveling, then the Engineer will direct preleveling before HMA wearing course placement in accordance with Section 5-04.3(8). As soon as the existing surface has been thoroughly cleaned, holes and discontinuities in the surface and edges and edge breaks shall be repaired as specified in the Contract. Patching shall be accomplished prior to preleveling or installation of the first asphalt course, whichever is applicable.

Preleveling Materials shall be the same HMA class of asphalt concrete as the wearing course or an acceptable alternate approved by the Engineer. If the Contract does not require a finish HMA wearing course, then the preleveling of uneven or broken surfaces shall be accomplished by placing asphalt concrete of the class specified with a motor patrol grader, by hand-raking, by Miller box, or by such other method acceptable to the Engineer.

After placement, the preleveling Material shall be thoroughly compacted with a pneumatic tire roller unless alternate equipment is approved by the Engineer.

When planing is not a Bid item in the Contract, the Contractor shall be prepared to spot grind occasional high areas caused by rutting, etc., to a depth to allow for a uniform application of preleveling.

#### **5-04.3(4)B3 PLANING BITUMINOUS PAVEMENT**

#### **5-04.3(4)B3A PRE-PLANING METAL DETECTION CHECK**

Before beginning planing of pavements, and before any additional depth planning when directed by the Engineer, the Contractor shall conduct a physical survey of existing pavement to be planed with equipment that can identify hidden metal objects.

Should such metal be identified, the Contractor shall promptly bring this to the attention of the Engineer.

See Section 1-07.16(1) regarding the protection of survey monumentation that may be hidden in pavement.

Any damage to equipment resulting from the Contractor's failure to conduct a pre-planing metal detection survey, or from the Contractor's failure to bring to the attention of the Engineer any hidden metal that is detected, shall be the Contractor's sole responsibility.

Also see Section 5-04.3(17) regarding a planing plan and pre-planing briefing prior to beginning planing.

#### **5-04.3(4)B3B PLANING**

See Section 5-04.3(17) regarding a planing plan, and pre-planing briefing prior to beginning planing.

Locations of existing surfacing to be planed will be indicated in the Contract.

Where planing an existing pavement is specified in the Contract, the Contractor shall be prepared to both remove existing surfacing material, and to reshape a surface to remove irregularities. The finished product shall be a prepared surface acceptable for receiving an HMA overlay.

Planing shall be by the cold milling method unless otherwise specified in the Contract. The planer shall not be used on the final wearing course of new HMA.

Planing operations shall be conducted in a manner that does not tear, break, burn, or otherwise damage the surface which is to remain. The finished planed surface shall be slightly grooved or roughened and shall be free from gouges, deep grooves, ridges, or other imperfections. Repair of the surface to remain that is damaged by the Contractor's planing shall be by a method acceptable to the Engineer.

Metal castings and other surface improvements damaged by planing shall be repaired or replaced as determined by the Engineer.

A tapered wedge cut shall be planed longitudinally along curb lines sufficient to provide a minimum of 4 inches of curb reveal after placement and compaction of the final wearing course. The dimensions of the wedge shall be as shown on the Drawings or as specified by the Engineer.

A tapered wedge cut shall also be made at transitions to adjoining pavement surfaces (meet lines) where butt joints are indicated on the Drawings. Butt joints shall be cut in a straight line with vertical faces 2 inches or more in height and shall produce a smooth transition to the existing adjoining pavement.

After planing is complete, the planed surfaces shall be swept, cleaned, and if required by the Contract, patched and preleveled.

The Engineer may direct additional depth planing. Prior to performing this additional depth planing, the Contractor shall first conduct a hidden metal in pavement detection survey as required in Section 5-04.3(4)B3a.

#### **5-04.3(4)B4 TACK COAT AND DISTRIBUTOR EQUIPMENT REQUIREMENTS**

##### **5-04.3(4)B4A TACK COAT REQUIREMENT**

Tack coat shall be CSS-1, CSS-1h, or STE-1 emulsified asphalt. The CSS-1 and CSS-1h emulsified asphalt may be diluted with water at a rate not to exceed one part water to one part emulsified asphalt. The emulsified asphalt shall not exceed the maximum temperature recommended by the emulsified asphalt manufacturer.

A tack coat of asphalt, applied at the rate of 0.02 to 0.08 gallons per square yard of retained asphalt, shall be applied to all paved surfaces on which any course of HMA is to be placed or abutted. The tack coat shall cover the existing pavement uniformly with a residual asphalt film free of streaks and bare spots. Tack coat shall only be applied to surfaces that are dry and free from moisture. Tack coat shall not be applied under the imminent threat of rain as determined by the Engineer.

The Contractor shall make arrangements with the Engineer demonstrating tack coat application at the beginning of such application. Once the Engineer approves the tack coat application method and rate of application, the Contractor shall continue with such application without exception.

Where the new asphalt concrete abuts a curb or gutter, cold pavement joint, trimmed meet line, or any metal surface, tack coat of asphalt shall be applied on the vertical face of the abutting surface. The application on the contact surfaces shall be uniform in order to avoid an accumulation of excess asphalt. Excess tack coat shall be immediately removed. The Contractor shall not apply the tack coat on vertical contact surfaces above the finished height of the asphalt concrete being placed.

Tack coat shall be applied only to surfaces to receive tack coat treatment, and shall not be applied to any other surface. Tack coat applied to surfaces not to be coated shall require immediate removal of the tack coat, including thorough cleaning of the surface area as may be reasonably necessary for leaving no residue.

Equipment shall not operate on tacked surfaces until the tack has broken and cured. If the Contractor's operation damages the tack coat it shall be repaired prior to placement of the HMA. For surfaces open to traffic, the application of tack coat shall be limited to surfaces that will be paved during the same working shift.

##### **5-04.3(4)B4B DISTRIBUTOR EQUIPMENT REQUIREMENT**

The distributor equipment shall be Capable of distributing a uniform tack coat in controlled amounts.

The distributor shall have a capacity of not less than 1,000 gallons, and shall be so designed, equipped, maintained, and operated that asphalt Material of an even heat shall be uniformly applied at the required rate.

The power for operating the pressure pump shall be supplied by a power unit which provides a uniform spray from each of the nozzles across the spray bar and extensions.

In addition, the distributor shall be equipped with the following:

1. a thermometer to indicate the temperature of the tack coat material,
2. a thermometer installed permanently in the tank to indicate temperatures at all times,
3. hand operated spray equipment for use only on inaccessible and irregularly shaped areas,
4. a 10-foot spray bar with extensions,
5. pressure pump and gauge, and volume gauge so located as to be observed easily by the Engineer from the ground, and
6. a tachometer to control accurately the speed and spread of asphalt.

The Engineer may allow hand operated spray equipment separate from the distributor equipment for inaccessible and irregularly shaped areas if the Contractor can demonstrate acceptable tack coat application.

#### **5-04.3(4)C SURFACE PREPARATION OF UNTREATED SURFACES**

##### **5-04.3(4)C1 GENERAL**

Untreated roadway surfaces, including intersections and side roadway approaches which are to receive asphalt concrete pavement, or other surfacing (see Sections 4-04 and 5-02), shall be shaped to a uniform grade and cross-section, conforming as nearly as possible to that which exists except:

Where new lines and grades are indicated in the Contract or established by the Engineer.

The basis for establishing final line and grade in such cases shall be curbs, curbs and gutters, existing pavement, or pavement edges or other existing street improvements. Existing driveways shall be graded as necessary to provide a smooth transition to the final grade of the new pavement surface including such grading as may be necessary to permit driveway adjustment.

Where no curbs or curbs and gutters exist and where none are required by Contract, subgrade preparation shall extend one foot on each side of the roadway beyond the final asphalt paving width indicated on the Drawings. The Contractor shall be prepared to extend this subgrade preparation to such greater width as the Engineer may require to accommodate local conditions such as intersections.

The grade shall be shaped so that all frame castings for maintenance holes, monument boxes, gate valve boxes, catch basins, etc. within the roadway section to be treated, extend above the prepared surface, and such that all castings are flush with the final wearing course. Where existing asphalt or portland cement concrete pavement is being met with new asphalt surfacing, sufficient existing untreated surfacing shall be removed to permit the forming of a butt joint. The completed

finish surface, including castings and transitions with existing treated surfaces, shall be smooth as specified in Section 5-04.3(12).

Those areas and surfaces which are to be prepared for the placement of asphalt concrete pavement or other surfacing shall be considered Subgrade for the new construction. See Section 2-09 for subgrade preparation requirements. Excess native material deemed suitable by the Engineer shall be considered selected Material per Section 2-10 and shall be stockpiled by the Contractor or bladed to the roadway edge and used as needed for fill or shoulder restoration following completion of the paving. The selected Material shall be used to the fullest extent possible as sub-base Material prior to the placement of new crushed rock.

Water shall be available on site and shall be applied as necessary to meet compaction requirements and to alleviate dust.

Excess material shall be disposed of.

#### **5-04.3(4)C2 PRIME COAT TREATMENT**

Where required in the Contract, a prime coat treatment of asphalt complying with the requirements of Section 5-02.3(3) for existing gravel, crushed rock, or oil mat streets shall be applied prior to paving with asphalt concrete. The prime coat shall be applied over the entire area of proposed asphalt pavement construction. Following the application of the prime coat, HMA shall not be placed until the prime coat has cured.

In the event the surface receiving the prime coat is of such gradation and relative density as to resist penetration of the prime coat, the Contractor shall immediately before application of the prime coat, loosen no more than the upper 1/2 inch of surface and regrade it without compaction.

The Contractor shall maintain the completed prime coat by blading or brooming until the asphalt concrete is placed. Should any holes, breaks, or irregularities develop in the roadway surface after the prime coat has been applied, such defects shall be patched or repaired in accordance with Section 5-04.3(4)C1 immediately in advance of placing the asphalt concrete pavement.

Immediately prior to placing the HMA, the surface of the prime coat shall be swept clean of all dirt, dust, and other foreign matter.

#### **5-04.3(4)D CRACK SEALING**

Where the Contract requires "Crack Sealing", all cracks and joints shall be cleaned with a stiff-bristled broom and compressed air. Loose pieces shall be removed and disposed of.

After cleaning, all cracks less than 1/4 inch in width shall be filled with straight CSS-1 emulsified asphalt and topped with sand.

After cleaning, all cracks and joints at least 1/4 inch or greater in width, shall be filled with sand slurry.

Rubberized asphalt shall be used where specified in the Contract.

The Contractor may request substitution of rubberized asphalt for sand slurry; however, such request requires written approval from the Engineer before use. Rubberized asphalt shall not be used to seal cracks greater than 1-1/2 inches in width.

Application of the sand slurry or rubberized asphalt shall be as follows:

**1. Sand Slurry:** The sand slurry shall consist of 20 percent CSS-1 emulsified asphalt, 2 percent portland cement, sufficient water for workability, and the remainder clean U.S. No. 4-0 paving sand. The components shall be thoroughly mixed and poured into the cracks and joints until full. The following day, any cracks or joints that are not completely filled shall be topped off with additional sand slurry. After the sand slurry is placed, the filler shall be struck off flush with the existing pavement surface and allowed to cure. The HMA overlay shall not be placed until the slurry has fully cured.

**2. Rubberized Asphalt:** The sealant Material shall meet the requirements of Section 9-04.10 and shall be applied in accordance with the sealant manufacturer's recommendations. These recommendations shall be submitted to the Engineer by the Contractor prior to the start of this type construction and shall include recommended heating time and temperature, allowable storage time and temperatures after initial heating, allowable reheating criteria, and application temperature range. The cracks shall be completely dry before being filled with the rubberized asphalt. Filling shall be controlled to confine the Material within the crack or joint. Where the sealed cracks are to be overlaid with asphalt, the sealant shall be recessed 3/8 inch below the surface. The Contractor's method of sealant application shall confine the sealant to the crack or joint and shall not result in any spillage on the pavement surface.

Should spillage occur, the Contractor shall have readily available, Supplies and as necessary to timely and effectively remove sealant over-application.

#### **5-04.3(5) HEATING OF ASPHALT BINDER**

The temperature of the asphalt binder shall not exceed the asphalt binder manufacturer's recommended maximum temperature at any time, and shall not fall below the minimum temperature recommended by the asphalt binder manufacturer. The asphalt binder shall be heated in a manner that prevents local variations in heating. The heating method shall provide a continuous supply of asphalt binder to the mixer at a uniform average temperature with no individual variations exceeding 25°F. Also see Section 5-04.3(2) regarding HMA mixing plant requirements.

**5-04.3(6) HMA MIX DESIGN AND SUBMITTAL REQUIREMENTS****5-04.3(6)A PREPARATION OF AGGREGATES**

Sufficient storage space shall be provided for each size of aggregate. The aggregates shall be removed from stockpile(s) in a manner to ensure a minimum of segregation when being moved to the HMA plant for processing into the final mixture. Different aggregate sizes shall be kept separated until they have been delivered to the HMA plant.

**5-04.3(6)B MIX DESIGN****5-04.3(6)B1 GENERAL**

From the stockpiled aggregates to be used in the production of HMA, the Contractor shall determine a design aggregate structure and asphalt binder content in accordance with WSDOT Standard Operating Procedure 732, "Volumetric Design for Hot-Mix Asphalt (HMA)", available in the current edition of the Washington State Department of Transportation's Materials Manual M 46-01. The grade of asphalt binder shall be as specified in the Contract (also see Section 5-04.2(1) where binder substitution is allowed). The nominal maximum aggregate size and design ESALs shall be as required by the Contract. The amount of anti-stripping additive to be added to the mix will be determined by the Engineer based on the Contractor's proposed design and submittal (see the following and Section 9-02.4).

Once the Contractor has determined the aggregate structure and binder content, the Contractor's submittal shall provide data demonstrating that the proposed HMA design meets the requirements of Sections 9-03.8(2) and 9-03.8(6). In no case shall the HMA paving begin before the determination of anti-stripping agent requirement by the Engineer has been made.

**5-04.3(6)B2 APPLICATION DEFINITIONS**

Unless the Contract specifies otherwise, the following definitions shall be used regarding HMA CI mix designs and apply to all HMA submittals:

**Structural application – major quantity:** an HMA CI mix used for vehicular traffic where the project specifies not less than 400 tons of HMA. See Section 5-04.3(6)C for submittal requirements.

**Structural application - minor quantity:** an HMA CI mix used for vehicular traffic where the project specifies less than 400 tons of HMA. See Section 5-04.3(6)D for submittal requirements.

**Non-structural application:** an HMA CI mix used for sidewalks, ditches, slopes, paths, trails, gores and other non-vehicular traffic application. See Section 5-04.3(6)E for submittal requirements.

For any quantity structural application, vehicular traffic shall include roadways of any kind for vehicular traffic, alleys, driveways, and other surfaces as may be specified in the Contract.

**5-04.3(6)C SUBMITTAL – STRUCTURAL APPLICATION – MAJOR QUANTITY****5-04.3(6)C1 GENERAL**

As a convenience to accommodate accelerated submittals for future uses of an Engineer approved HMA CI mix design major quantity structural application, an Engineer approved HMA CI major quantity structural application mix design shall remain "approved" for use on all future projects with a Bid Opening Date within 365 consecutive calendar days from the date of approval of that specific HMA CI mix. The SPU Materials Laboratory will specify the "approval date" on the returned submittal, and will maintain records on such. On future Contracts, the Contractor shall contact the SPU Materials Laboratory (206-386-1236) to find out if and when a specific major quantity structural application mix design has been Engineer approved.

**5-04.3(6)C2 MIX DESIGN AND SAMPLE SUBMITTAL REQUIREMENTS**

For HMA CI mix designs not pre-approved by the Engineer as specified in Section 5-04.3(6)C1, the Contractor's HMA CI submittal shall require 20 Working Days and requires both the Contractor mix design and samples.

The following Contractor mix design information shall be submitted for each HMA class:

1. Project name and Public Works (PW) number.
2. HMA class designation and HMA Supplier.
3. Contractor's mix design number, or other designating identification (designation).
4. Design equivalent single axle loads (design ESALs).
5. Aggregate source (also see Sections 1-06).
6. Aggregate gradations, including blending ratio.
7. Percent (by weight of final mix) of RAP used.
8. Target gradation of final HMA mix.
9. 0.45 power plot of target gradation showing aggregate gradation control points zone.
10. Binder source and performance grade (e.g. – PG xx-yy).
11. Temperature – Viscosity curve of the binder.
12. Recommended binder compaction temperature range.
13. Recommended binder mixing temperature range.
14. Maximum allowable binder temperature.
15. Type and brand of anti-stripping additive.
16. Binder content of RAP (percent by weight of RAP).
17. Percent (by weight of final mix) of binder in final mix ( $P_b$ ).

18. Effective Binder Content ( $P_{be}$ ).
19. HMA compaction temperature for the gyratory compactor.
20. Relative density of the final mix at  $N_{design}$  gyrations.
21. Number of design ( $N_{design}$ ) gyrations used ( $N_{ini}$ ;  $N_{des}$ ;  $N_{max}$ ).
22. Voids in Mineral Aggregate (VMA).
23. Voids filled with asphalt (VFA).
24. Air voids in the compacted mixture ( $V_a$ ).
25. Dust/Asphalt Ratio.
26. Sand Equivalent of the aggregate fraction passing U.S. No. 4 sieve.
27. Percent of flat and elongated particles retained on the U.S. No. 4 sieve.
28. Theoretical maximum density of the mix ( $G_{mm}$ ).
29. Percent of  $G_{mm}$  for extruded specimens at  $N_{ini}$ ,  $N_{des}$  and  $N_{max}$ .
30. Bulk specific gravity of the extruded specimen at  $N_{design}$  gyrations ( $G_{mb}$ ).
31. Bulk specific gravity of the combined aggregates in the mix ( $G_{sb}$ ).
32. Effective specific gravity of the combined aggregates in the mix ( $G_{se}$ ).
34. Bulk specific gravity of the aggregate fraction passing the 3/8" sieve.
35. Bulk specific gravity of the aggregate fraction retained on the 3/8" sieve.
36. Specific gravity of the binder ( $G_b$ ).

**Samples:** The mix design submittal shall be accompanied with the following minimum sized samples:

- |    |   |            |
|----|---|------------|
| 1) | The HMA class mix (if RAP is proposed, the mix shall contain the RAP) | 75 pounds, |
| 2) | Asphalt binder(s)   | 1 quart    |
| 3) | Recycled asphalt pavement component (RAP), if used                    | 25 pounds  |
| 4) | Anti-stripping agent  | 1 quart    |

Any adjustment to an Engineer approved HMA class JMF will require a submittal (Section 1-05.3(5)) and the approval of the Engineer per Section 9-03.8(7).

Submittal of items "2." through "4." (not "2)" through "4)") above may be waived by the Engineer if the Contractor submits a valid and current WSDOT mix design of the same class of HMA utilizing the same constituents from the same sources as the proposed mix design including anti-stripping agent.

The Contractor may propose an asphalt binder from a secondary source in the same submittal as the primary binder source, and shall make this known in the submittal (see items 10, 11, 12, 13, 16, 17, 18, and 36).

Based on the submittal proposed by the Contractor, the Engineer will determine the anti-stripping additive requirement, and will make this information known on the returned submittal.

If the Engineer determines the submitted mix design is defective, the Engineer will provide written notice identifying such defect as may apply.

The Contractor shall not commence production of any HMA class until that HMA JMF mix design has been established and approved by the Engineer.

Any change in source of supply for any of the constituents of an approved HMA class JMF will require a new mix design be submitted and approved prior to use as specified in this Section.

If the results of the verification testing by the Engineer of the submitted sample Materials and proposed mix design meet the requirements of Sections 9-02.1(4) and 9-03.8, then the submittal will be considered approved. The approved mix design will be the "initial" job mix formula (JMF) for the specified HMA class of mix and an Engineer approval date will be assigned.

To aid the Contractor in preparing the HMA mix design submittal, the Contract will contain an HMA Mix Design Submittal form located in the Appendix of the Project Manual.

#### **5-04.3(6)C3 ACCELERATED SUBMITTAL**

When an Engineer approved HMA CI mix design for major quantity structural application is specified in the Contract and this HMA mix is within the 365 calendar Day window before the Bid Opening Date, the Contractor shall submit to the Engineer at least 5 Working Days in advance, a Manufacturer's Certificate of Compliance stating the following:

1. For each HMA class specified in the Contract, the name and location of each Supplier providing the Engineer approved HMA class mix and component parts.
2. Supplier's HMA CI mix design number, or other designating identification (designation) consistent with the Engineer approved HMA class mix.

#### **5-04.3(6)C4 CERTIFICATION TO ACCOMPANY HMA DELIVERY**

For any HMA class major quantity structural application mix, each delivery of HMA CI to the Project Site shall be accompanied with a certification stating the following:

- 1) The HMA mix being delivered is an Engineer approved HMA mix,
- 2) Name and location of HMA CI Supplier,
- 3) Supplier's HMA CI mix identification number,
- 4) Date and time of load out,
- 5) Class of HMA,
- 6) Grade of binder,

- 7) Percent (by weight of binder) of anti-stripping agent, and
- 8) Tonnage of HMA in the hauling vehicle.

#### **5-04.3(6)D STRUCTURAL APPLICATION - MINOR QUANTITY**

For HMA CI minor quantity structural application mixes, the Contractor shall submit at least 5 Working Days in advance of first use, a Manufacturer's Certificate of Compliance showing items (1) through (7) below.

At the request of the Engineer, the Contractor shall submit the pre-approved mix design data (previously submitted and approved in Section 5-04.3(6)C2).

The Engineer reserves the right to obtain samples of a previously approved HMA CI mix and/or its individual constituents for verification of the mix design.

In addition, every delivery of the HMA CI mix to the Project Site shall be accompanied with a certificate stating the following:

- (1) Name and location of HMA Supplier,
- (2) Supplier's HMA mix identification designation,
- (3) Date and time of load out,
- (4) Class of HMA,
- (5) Binder grade of PG 64-22,
- (6) Percent (by weight of binder) of anti-stripping agent including brand name and type,
- (7) Minimum design ESALs of 10,000,000, and
- (8) Tonnage in vehicle.

#### **5-04.3(6)E NON-STRUCTURAL APPLICATIONS**

For HMA CI non-structural application mixes, the Contractor shall submit at least 5 Working Days in advance of first use, a Manufacturer's Certificate of Compliance showing items (1) through (3) below.

At the request of the Engineer, the Contractor shall submit the pre-approved mix design data specified in Section 5-04.3(6)C3.

The Engineer reserves the right to obtain samples of a previously approved HMA CI mix and/or its individual constituents for verification of the mix design.

In addition, every delivery of the HMA CI mix to the Project Site shall be accompanied with a certificate stating the following:

- (1) HMA Class ½ Inch,
- (2) Binder grade of PG 64-22 (binder grade may be substituted as described in Section 5-04.2(1)),
- (3) Supplier designed at any ESAL level, and
- (4) Tonnage in hauling vehicle.

#### **5-04.3(7) HMA MIXING PROCESS**

##### **5-04.3(7)A GENERAL**

After the required amounts of Mineral Aggregate and asphalt binder have been introduced into the mixer, the HMA shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the asphalt binder throughout the Mineral Aggregates is ensured.

When discharged, the temperature of the HMA shall not exceed the maximum temperature recommended by the asphalt binder manufacturer.

A maximum water content of 1 percent in the HMA, at discharge, will be allowed providing the water causes no problems with compaction, handling, stripping, or flushing. If the water content in the HMA causes any of these problems, the HMA will be considered defective Material. The Contractor shall stop production of the HMA and discontinue the placing of HMA. As specified in Section 1-05.7, the Contractor shall provide a remedy acceptable to the Engineer addressing the water content of the HMA. Defective Material in place shall be removed and replaced with Material that meets the specified requirements.

Storing or holding of the HMA in approved storage facilities will be permitted during the daily operation but in no event shall the HMA be held for more than 24 hours. HMA held for more than 24 hours after mixing will be rejected. Rejected HMA shall be disposed of by the Contractor at no expense to the Owner. The storage facility shall have an accessible device located at the top of the cone or about the third point from the top. The device shall indicate the amount of material in storage. No HMA shall be accepted from the storage facility when the HMA in storage is below the top of the cone of the storage facility, except as the storage facility is being emptied at the end of the working shift.

Where HMA has been held in approved storage and no load out has occurred for 4 continuous hours, then the first 4 tons to be loaded out of the storage facility shall be wasted and disposed of at the Contractor's expense.

##### **5-04.3(7)B ACCEPTANCE SAMPLING AND TESTING – HMA MIXTURE**

Acceptance of HMA will be based on the following:

1. **Aggregates.** The acceptance criteria for aggregate properties of sand equivalent, flat and elongated, fine aggregate angularity and fracture will be their conformance to the requirements of Section 9-03.8(2).
2. **Hot Mix Asphalt Mixture.** The acceptance criteria for the HMA mixture shall be as specified in Section 9-03.8(7), HMA Tolerances and Adjustments.

**A. Sampling**

1. No samples will be obtained from either the first or last 25 tons of HMA produced in each production shift.
2. Samples for acceptance testing will be obtained on a random basis at the point of delivery in accordance with AASHTO T168.

**B. Definition of Sampling Lot and Sublot**

A lot is defined as a discrete quantity of as-constructed pavement to which an acceptance procedure is applied. For the purpose of acceptance sampling and testing, a lot is defined as the total quantity of Material or work produced for each job mix formula (JMF) placed. A lot is represented by randomly selected samples that will be tested for acceptance. Only one lot per JMF is expected. The initial JMF is defined in Section 5-04.3(7)A, Mix Design. The Contractor may request a change in the JMF in accordance with Section 9-03.8(7). If the request is approved, all of the Material produced up to the time of the change will be evaluated on the basis of tests on samples taken from that JMF and a new lot will begin.

Sampling evaluation will be performed on a random basis at the frequency of one sample per subplot. Sublot size will be determined to the nearest 100 tons to provide not less than two uniform sized sublots, based on proposal quantities, with a maximum subplot size of 400 tons. Sampling and testing will be performed on a random basis as determined by the Engineer. The quantity of material represented by the final subplot may be increased to a maximum of 2 times the subplot quantity calculated.

**C. Test Results**

The Engineer will furnish the Contractor with a copy of the results of the acceptance testing performed in the Laboratory.

Sublot sample test results may be challenged by the Contractor.

To challenge the Laboratory's test results, the Contractor shall comply with the requirements of Section 1-04.5.

Resolution of this challenge shall be by a split of the original acceptance sample that will be retested by the Owner's Laboratory. The split of the sample with challenged results will not be tested by the same tester that conducted the original acceptance test. The challenge sample will be tested for a complete gradation analysis, for asphalt binder content, and for percent air voids ( $V_a$ ). The results of the challenge sample will be compared to the original results of the acceptance sample test and evaluated according to the following criteria:

<b>Property</b>	<b>Deviation from JMF</b>	
	<b>Allowable deviation (%)</b>	<b>Standard Specification Reference</b>
U.S. No. 4 and larger sieves	± 4.0 % for each sieve	9-03.8(6)
U.S. No. 8 sieve	± 2.0 %	9-03.8(6)
U.S. No. 200 sieve	± 0.4 %	9-03.8(6)
Asphalt binder content	± 0.3 %	5-04.3(6)C2, item 18
Air Voids in the Compacted Mixture ( $V_a$ )	± 0.7 %	5-04.3(6)C2, item 24

If the results of the challenge sample testing are outside the allowable deviation established above for any of the above parameters, the Contractor agrees the subplot is defective and that the subplot shall be removed and replaced and the cost of retesting be deducted at the rates published in Section 1-05.7 from any monies due or that may come due the Contractor under the Contract. If the results of the challenge sample testing are within all parameters established above, the subplot will be accepted and the cost of retesting will be the Owner's responsibility.

**D. Test Methods**

Testing of HMA for compliance of volumetric properties (VMA, VFA  $V_a$  and Dust/Asphalt Ratio) will be by WSDOT SOP 731, "Method for Determining Volumetric Properties of Asphalt Concrete Pavement Class Superpave". WSDOT FOP for AASHTO T 166, "Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens." WSDOT FOP for AASHTO T 209 "FOP for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures "Rice Density." Testing for compliance of asphalt binder content will be by WSDOT FOP for AASHTO T 308, "Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method." WAQTC FOP TM 6, "Moisture Content of Bituminous Mixtures by Oven." Testing for compliance of gradation will be by WAQTC FOP for AASHTO T 27/T 11.

**E. Reject Mixture**

1. **Rejection by Contractor:** The Contractor may, prior to sampling, elect to remove any defective Material and replace it with new Material. Any such new Material may be sampled, tested, and evaluated for acceptance.
2. **Rejection by Engineer:** Sublots found to be defective during acceptance sampling and testing shall be removed and replaced. In addition, the Engineer may also isolate and reject within a subplot any Material that is determined to be defective.

If, during paving, the Engineer determines Material being placed does not meet Specification, the Contractor shall shut down operations and shall not resume HMA placement until such time as the Engineer is satisfied that specified Material is being supplied.

The Engineer may, without sampling, reject any batch, load, or section of HMA that appears defective in gradation, temperature or asphalt binder content. Material rejected before placement shall not be incorporated into the pavement. Any rejected HMA section of roadway shall be removed. The Contractor may request that the rejected Material be tested. If the Contractor elects to have the rejected Material tested, a minimum of three representative samples will be obtained and tested. Acceptance of rejected Material will be based on conformance with the Specifications. No payment will be made for Material that fails to meet Specification. In addition, the cost of sampling and testing shall be borne by the Contractor. If the Material meets Specification, the cost of sampling and testing will be borne by the Owner and payment for the HMA will be made at the Bid item price.

#### 5-04.3(8) SPREADING AND FINISHING

The mixture shall be laid upon an approved surface, spread, and struck off to the grade and elevation established.

Unless otherwise directed by the Engineer, the nominal compacted depth of any layer of any course shall conform to the following limits:

Material	Maximum
HMA Class 1"	0.35 feet
HMA Class 3/4"	0.30 feet
HMA Class 1/2"	0.25 feet
HMA Class 3/8"	0.10 feet

When more than one course is necessary to meet the final paving grade, the first course shall include any widening of the existing roadway and preleveling of the existing pavement surface. The preleveling course or courses shall be constructed so that the final wearing course has a uniform compacted depth and conforms to the finished grade and cross section elevations specified. Construction of one course upon another shall not proceed until the underlying course has cooled and set.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the paving may be done with other approved equipment or by hand.

When more than one JMF is being utilized to produce HMA, the Material produced for each JMF shall be placed by separate spreading and compacting equipment. The intermingling of HMA produced from more than one JMF is prohibited. Each strip of HMA placed during a working shift shall conform to a single JMF established for the class of HMA specified unless there is a need to make an adjustment in the JMF. No adjustment to the JMF will be allowed without approval of the Engineer.

When laying HMA, the paver shall be operated at a uniform forward speed consistent with the trucking delivery rate and roller train capacity to result in a continuous operation. The auger speed and flight gate opening shall be adjusted to coordinate with the operation.

During mainline paving, the wings on the receiving hopper shall not be folded, and the mix level in the hopper shall be maintained so that the conveyors are not exposed, unless the Engineer approves otherwise.

Manual operation of the screed will be permitted in the construction of irregularly shaped and minor areas. These areas include, but are not limited to, gore areas, road approaches, tapers and left-turn channelizations.

When specified in the Contract, reference lines for vertical control will be required. Lines shall be placed on both outer edges of the traveled way of each roadway. Horizontal control utilizing the reference lines will be permitted. The grade and slope for intermediate lanes shall be controlled automatically from reference lines, or by means of a mat referencing device and a slope control device. When the finish of the grade prepared for paving is superior to the established tolerances and when, in the opinion of the Engineer, further improvement to the line, grade, cross-section, and smoothness can best be achieved without the use of the reference line, a mat referencing device may be substituted for the reference line. Substitution of the mat referencing device will be subject to the continued approval of the Engineer. The reference line may be removed after the completion of placing the first course of HMA when approved by the Engineer. Whenever the Engineer determines that any of these methods are failing to provide the necessary vertical control, the reference lines shall be promptly reinstalled by the Contractor before further placement of HMA.

#### 5-04.3(8)A UTILITY ADJUSTMENTS

Utility castings shall be adjusted to finished grade prior to the construction of the final wearing course as described Section 7-20.



**5-04.3(9) COMPACTION****5-04.3(9)A GENERAL**

Immediately after the HMA has been spread and struck off, and after surface irregularities have been adjusted, the mix shall be thoroughly and uniformly compacted. The completed course shall be free from ridges, ruts, humps, depressions, objectionable marks, and irregularities and shall conform to the line, grade, and cross-section shown in the Drawings. If necessary, the JMF may be altered in accordance with Section 9-03.8(7) to achieve desired results.

Compaction shall take place when the mixture is in the proper condition so that no undue displacement, cracking, or shoving occurs. All compaction equipment shall be Capable of producing the required compaction. Areas inaccessible to large compaction equipment shall be compacted by mechanical or hand tampers. Any HMA that becomes loose, broken, contaminated, shows an excess or deficiency of asphalt, or is in any way defective, shall be removed and replaced at no additional cost with fresh material which shall be immediately compacted to conform with the surrounding area.

The type of rollers to be used and their relative position in the compaction sequence shall generally be the Contractor's option, provided Specification densities are attained. An exception shall be that pneumatic tired rollers shall be used between October 1st of any year and April 1st of the following year unless the Engineer directs otherwise. Coverages with a vibratory or steel wheel roller may precede pneumatic tired rolling.

Vibratory rollers shall not be operated in the vibratory mode when the internal temperature of the mix is less than 175°F. Regardless of mix temperature, a vibratory roller shall not be operated in a vibratory mode when checking or cracking of the mat occurs. Vibratory rollers in the vibratory mode are prohibited on bridge decks, brick bases, and cobblestone bases.

HMA for preleveling shall be thoroughly compacted to the satisfaction of the Engineer.

**5-04.3(9)B CONTROL****5-04.3(9)B1 COMPACTION REQUIREMENT**

For an HMA CI having a specified compacted course thickness greater than 0.10 foot, the acceptable level of relative density shall be a minimum 92.0 percent of the reference maximum density. The reference maximum density will be determined by the Engineer as the moving average of the most recent three determinations for the JMF being placed to accommodate start-up for a large placement. Where less than three determinations have been made, the reference maximum density will be the average of all determinations made to that time to accommodate start-up for a large placement. The actual density attained for a subplot of an HMA CI will be determined as the average of five nuclear density gauge tests (after completion of the finish rolling) at randomly selected locations within each density subplot. In addition to the randomly selected locations, the Engineer may select any additional location(s) for testing that appears to be deficient or in any way defective. Such additional tests shall be included in the calculation of the average density for that subplot. The quantity represented by each subplot for density testing will be no greater than a single day's production or 400 tons, whichever is less. For density testing of very large daily placements of HMA, the Engineer may increase the size of the final subplot to a maximum of 600 tons. A lot shall be as defined 5-04.3(7)B.

**5-04.3(9)B2 TEST RESULTS**

Density sublots not meeting the prescribed minimum relative density shall be considered defective work, and shall be removed and replaced. No payment will be made for defective Material that fails to meet the minimum relative density.

For compaction lots subject to rejection, cores may be used as an alternate to the nuclear density gauge tests. When cores are taken by the Engineer at the request of the Contractor, they shall be requested by no later than 12:00 AM of the next Working Day after receiving the test results. The cores will be taken at locations selected by the Engineer. Cores shall not be located in wheel paths. On sublots which fail to attain the minimum relative density, the cost for the coring will be deducted from any monies due or that may become due the Contractor under the Contract at the rates published in Section 1-05.7.

In addition to the randomly selected locations for relative density tests for a subplot, the Engineer may also isolate any area that is suspected of being defective in relative density. The isolated area will be evaluated as a separate representative area. Such isolated area determinations shall be at the sole discretion of the Engineer.

**5-04.3(10) JOINTS****5-04.3(10)A LONGITUDINAL AND TRANSVERSE JOINTS**

The placing of the top or wearing course shall be as nearly continuous as possible, and the roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is discontinued for such length of time as to permit the mixture to become chilled. When this work is resumed, the previously compacted mixture shall be sawcut back to produce a slightly beveled edge for the full thickness of the course.

Where a transverse joint is being made and pavement will be open to traffic, a temporary wedge of HMA shall be constructed of a 5:1 H:V slope. The HMA in the temporary wedge shall be separated from the permanent HMA by strips of heavy wrapping paper. When paving operations are renewed, the wrapping paper shall be removed and the joint trimmed to a slightly beveled edge for the full thickness of the new HMA course. The Material which is cut away shall be disposed of and new mix shall be laid against the fresh cut. Rollers or tamping irons shall be used to seal the joint.

All joints shall be flush and provide a smooth transition across the meet line.

The longitudinal joint in any one layer shall be offset from the layer immediately below by not more than 6 inches nor less than 2 inches. All longitudinal joints constructed in the top layer shall be at a lane line or edge line of the traveled way. Where traffic conditions, project geometry or other condition exist that make the construction of longitudinal joints at the lane

line or edge of the traveled way impractical or impossible, a longitudinal joint may be constructed at the center of the traffic lane with the Engineer's written approval.

Hot lap joints may be allowed by the Engineer provided planned grades are maintained, no surface irregularities exist and compaction requirements are met. Two paving machines shall be used to construct longitudinal hot lap joints; a minimum average compacted density in accordance with 5-04.3(10) shall be achieved throughout the traffic lane; and construction equipment other than rollers shall not operate on any uncompacted mix.

Immediately following the compaction of the top wearing course, meet line joints where the new asphalt concrete abuts existing asphalt concrete pavements, portland cement concrete pavements, oil mats, concrete curbs and gutter, etc., shall be sealed per Section 5-04.3(10)B.

#### **5-04.3(10)B NEW PAVEMENT CONNECTIONS WITH EXISTING PAVEMENTS**

Where construction of new asphalt concrete pavement connects with an existing roadway surface, driveway, bridge, railway crossing, gutter, or other similar facility, the Contractor shall provide a smooth riding transition between the new surface and existing surface. Such work may require the modification of the existing roadway profile by burning, planing or milling in order to achieve the desired smooth riding transition or may require other adjustment of the new connecting surface.

Butt joints are required at the meet lines of new construction and existing surfaces, the existing abutting pavement shall be trimmed by chipping, planing, milling or such other acceptable method in order to insure a minimum depth of 2 inches of compacted asphalt concrete at the point of connection. Meet lines shall be trimmed straight and the edges vertical. Waste Material resulting from such trimming or chipping shall be disposed of by the Contractor.

Where the transition is to be made by shimming or feathering, it shall be accomplished at the time the final course is being constructed by raking out the oversize aggregate from the HMA class being used. The Contractor shall not leave the asphalt open graded when feathering and shimming down to an existing surface. If approved by the Engineer, shimming and feathering may be accomplished at a later date. In such case, structural HMA Class 3/8 Inch shall be used.

Surfaces to be in contact with the new asphalt shall be tacked in accordance with Section 5-04.3(4)C2.

Meet lines between new and existing surfaces shall be sealed while the new asphalt concrete is still warm by painting with tack coat and then immediately covering the asphalt paint strip with clean, dry paving sand (mineral Aggregate Type 6) complying with Section 9-03.16.

#### **5-04.3(11) RESERVED**

#### **5-04.3(12) SURFACE SMOOTHNESS**

##### **5-04.3(12)A GENERAL**

The completed surface of all courses shall be of uniform texture, be smooth, have a continuous "plane" grade except across the crown. All surfaces shall be free from defects of all kinds. The completed surface of the wearing course shall not vary more than 1/8-inch from the lower edge of a 10-foot straightedge placed on the surface parallel to the centerline. The transverse slope of the completed surface of the wearing course shall vary not more than 1/4-inch in 10 feet from the rate of transverse slope shown on the Drawings.

When deviations in excess of, but not more than twice, the above tolerances are found, the pavement surface shall be corrected to low places, or the removal of Material from high places by grinding with an acceptable grinding machine. The corrected deviation shall be sealed in accordance with Section 5-04.3(18). Where the Engineer determines grinding or filling does not allow for an acceptable repair, removal and replacement of the wearing course of asphalt concrete will be required. Correction of defects shall be carried out until there are no deviations greater than the allowable tolerances.

All areas in which the surface of the completed pavement deviates more than twice the allowable tolerances described above, these areas shall be removed and replaced to the extents determined by the Engineer.

However, if deviations are found which exceed the allowable tolerances but are not in excess of twice the allowable tolerances described above, and, in the opinion of the Engineer, correction by means of any of the methods specified above do not produce acceptable results as to smoothness and serviceability, the Engineer may accept the completed pavement. Under these described circumstances, the decision whether to accept the completed pavement or to require corrections as described above shall be vested entirely in the Engineer.

##### **5-04.3(12)B CONCRETE OVERLAYING ASPHALT**

When portland cement concrete pavement is placed on asphalt concrete pavement, the surface tolerance of the asphalt concrete pavement shall be such that no elevation lies above the proposed finished grade minus the specified depth of portland cement concrete pavement. Prior to placing the portland cement concrete pavement, any such irregularities shall be brought to the required tolerance by grinding or other means acceptable to the Engineer.

#### **5-04.3(13) RESERVED**

#### **5-04.3(14) RESERVED**

##### **5-04.3(15) WEATHER LIMITATIONS**

Asphalt for prime coat shall not be applied when the ground temperature is lower than 50°F without written approval of the Engineer.

HMA shall not be placed on any wet surface, or when the average surface temperatures are less than those specified in the following table, or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures:

Surface Temperature Limitation		
Compacted Thickness (Feet)	Wearing Course	Other Courses
Less than 0.10	55°F	45°F
0.10 to 0.20	45°F	35°F
0.21 to 0.35	35°F	35°F

**5-04.3(16) RESERVED**

**5-04.3(17) PAVING AND PLANING UNDER TRAFFIC**

**5-04.3(17)A GENERAL**

In addition to the requirements of Section 1-07.23 and the traffic controls required in Section 1-10, unless the Contract specifies otherwise or the Engineer agrees to otherwise, the Contractor shall comply with the following:

1. **Intersections:** The Contractor shall keep intersections open to traffic at all times, except when paving or planing operations through an intersection requires closure. Such closure shall be kept to the minimum time required to place and compact the HMA mixture, or plane as appropriate. For paving, such closure shall be scheduled to individual lanes or portions thereof that allow the traffic volumes and schedule of traffic volumes as required in the approved Traffic Control Plan. Work shall be scheduled so that adjacent intersections shall not be impacted at the same time and shall comply with the traffic control restrictions required by the Traffic Engineer. Each individual intersection closure or partial closure, shall be addressed in the Traffic Control Plan to be submitted to and approved by the Engineer (see Section 1-10.2(5)).

When planing or paving and related construction must occur in an intersection, the Contractor shall consider scheduling and sequencing such work into quarters of the intersection, or half or more of an intersection with side street detours. The Contractor shall also be prepared to sequence the work to individual lanes or portions thereof.

Should closure of the intersection in its entirety be necessary, and no trolley service is impacted, such closure shall be kept to the minimum time required to place and compact the HMA mixture, plane, remove asphalt, tack coat, and as needed.

Any work in an intersection shall include advance warning in both signage and in Working Days advance notice as determined by the Engineer, to alert traffic and emergency services of the intersection closure or partial closure.

Work shall be scheduled so that consecutive intersections shall not have construction in-progress at the same time. New compacted HMA asphalt shall cool to ambient temperature before any traffic is allowed on it. Traffic shall not be allowed on newly placed asphalt until approval has been obtained from the Engineer.

2. **Centerline marking, post-paving temporary marking, temporary stop bars, and maintaining temporary pavement marking:** The Contractor shall comply with the requirements of Section 1-10.3(3)L.
3. **Permanent pavement marking:** The Contractor shall comply with the requirements of Section 8-22.3(1).

**5-04.3(17)B SUBMITTALS - PLANING PLAN AND HMA PAVING PLAN**

The Contractor shall submit a separate planing plan and a separate paving plan to the Engineer at least 5 Working Days in advance of each operation's activity begin date. These plans shall show, as to be discussed at the pre-planing briefing and pre-paving briefing, how the moving operation and traffic control are coordinated. When requested by the Engineer, the Contractor shall provide each operation's Traffic Control Plan on 24" x 36" or larger size Shop Drawings with a scale showing both the area of operation and sufficient detail of traffic beyond the area of operation where detour traffic may be required. The scale on the Shop Drawing shall be 1 inch = 20 feet, or may be changed if the Engineer agrees sufficient detail is shown.

The planing operation and the paving operation includes, but is not limited to, metal detection, removal of asphalt and temporary asphalt of any kind, tack coat and drying, staging of supply trucks, paving train(s), rolling, scheduling, and as may be discussed at the briefing.

When intersections are to be partially or totally blocked, the Contractor shall provide a minimum 2 Working Days in advance, adequately sized and noticeable signage alerting traffic of closures to come. The Traffic Control Plan shall show where Peace Officers are to be stationed when signalization is to be, or may be, countermanded, and show areas where flaggers are proposed.

At a minimum, the planing and the paving plan shall include the following elements:

1. A copy of the approved Traffic Control Plan (per Section 1-10.2(5)) detailing each day's traffic control as it relates to the specific requirements of that day's planing, and paving. Briefly describe the sequencing of traffic control consistent with the proposed planing and paving sequence, and scheduling of placement of temporary pavement markings and channelizing devices after each day's planing, and paving.
2. A copy of each intersection's Traffic Control Plan (see item 2 in Section 5-04.3(17)A).

3. Haul routes from Supplier facilities, and locations of temporary parking and staging areas, including return routes. The complete round trip shall be described as it relates to the sequencing of paving operations.
4. Names of, and locations of HMA Supplier facility(ies) to be used.
5. Listing of all equipment to be used for paving.
6. Listing of personnel and associated job classification assigned to each piece of paving equipment.
7. Description (geometric or narrative) of the scheduled sequence of planing and of paving, and intended area of planing and of paving for each day's work. Such description shall include the directions of proposed planing and of proposed paving, sequence of adjacent lane paving, sequence of skipped lane paving, intersection planing and paving scheduling and sequencing, and proposed notifications and coordinations to be timely made. The plan shall show HMA joints relative to the final pavement marking lane lines.
8. Names, job titles, and contact information for field, office, and plant supervisory personnel.
9. A copy of the approved Mix Design(s).
10. Tonnage of HMA to be placed each Day.
11. Approximate times and Days for beginning and ending daily operations.

#### **5-04.3(17)C PRE-PAVING AND PRE-PLANING BRIEFING**

At least two (2) Working Days **before** the first paving operation and the first planing operation, and as may be scheduled by the Engineer for future paving and planing operations, to ensure the Contractor has adequately prepared for notifying and coordinating as required in the Contract, the Contractor shall be prepared to discuss that day's operations as they relate to other entities and the public's safety and convenience, including driveway and business access, garbage truck operations, Metro transit operations and working around energized overhead wires, school and nursing home and hospital and other accesses, other contractors who may be operating in the area, pedestrian and bicycle traffic, emergency services, and as may be applicable. The Contractor, and Subcontractors as may be part of that day's operations, shall meet with the Engineer and discuss the proposed operation as it relates to the submitted planing plan and paving plan, approved Traffic Control Plan, public convenience and safety, and as may be necessary. Such discussion shall include, but not be limited to:

1. **General for both Paving Plan and for Planing Plan:**
  - A. The actual times of beginning and ending daily operations;
  - B. In intersections, how break up the intersection, and address traffic control and signalization for that operation including use of peace officers;
  - C. The sequencing and scheduling of paving operations and of planing operations, as applicable, as it relates to traffic control, to public convenience and safety, and to other contractors who may operate in the Project Site;
  - D. Notifications required of Contractor activities, and coordinating with other entities and the public as may be necessary;
  - E. Describe the sequencing of installation and types of temporary pavement markings as it relates to planing and to paving;
  - F. Describe the sequencing of installation of, and the removal of, temporary pavement patch material around exposed castings and as may be needed;
  - G. Describe the procedures and equipment to identify hidden metal in the pavement (such as survey monumentation, monitoring wells, street car rail, and castings) prior to planing (see Section 5-04.3(4)B3a);
  - H. Describe how flaggers will be coordinated with the planing, paving, and related operations;
  - I. Describe the sequencing of traffic controls for the process of rigid pavement base repairs; and
  - J. Other items the Engineer may deem necessary to address.
2. **Paving - additional topics:**
  - a) When begin applying tack and coordinating with paving;
  - b) The types of equipment and numbers of each type equipment to be used. If more pieces of equipment than personnel are proposed, describe the sequencing of the personnel operating the types equipment. Discuss the continuance of operator personnel for each type equipment as it relates to obtaining Specification requirements;
  - c) The number of JMFs to be placed and if more than one JMF, how the Contractor ensures that the different JMFs are distinguished, how pavers and MTVs are distinguished if more than one JMF is being placed at the time, and how pavers and MTVs are cleaned so that one JMF does not adversely influence the other JMF;
  - d) Describe contingency plans for that day's operations such as equipment breakdown, rain out, and Supplier shutdown of operations;
  - e) Number of sublots to be placed, sequencing of density testing, and other sampling and testing.

#### **5-04.3(18) SEALING OF PAVEMENT SURFACES**

Any wearing course or other pavement course to be used for the driving surface will be evaluated by the Engineer to determine whether a fog seal is required. Determination will be made when the results of nuclear or core density testing show that a seal is needed. The fog seal shall be CSS-1 or CSS-1h emulsified asphalt uniformly applied to the pavement. The finished application shall be free of streaks and bare spots. The emulsified asphalt shall be diluted at a rate of one part water to one part emulsified asphalt. The diluted emulsified asphalt shall be applied at the rate of 0.10 to 0.18 (0.03 to 0.05 residual) gallons per square yard. The emulsified asphalt shall be applied within the temperature range specified for these asphalt

emulsions in Section 5-02.3(3). Unless otherwise approved by the Engineer, the fog seal shall be applied prior to opening to traffic.

#### **5-04.3(19) ANTI-STRIPPING ADDITIVE**

Anti-stripping additive shall be added to the HMA in accordance with the Engineer determined anti-stripping additive requirement as made known on the returned submittal (see Section 5-04.3(6)C2).

#### **5-04.3(20) SHOULDER PAVING**

Shoulders, if required, shall be constructed to the lines, grades, and cross-sections specified. Material for building up shoulders shall be Mineral Aggregate Type 1.

#### **5-04.3(21) NON-STRUCTURAL HMA APPLICATIONS**

##### **5-04.3(21)A HMA SIDEWALKS**

Asphalt walkways shall be constructed at the locations and to the width specified on the Drawings. Unless the Contract specifies otherwise, asphalt walkways shall be constructed with a 4 inch section of compacted crushed rock Mineral Aggregate Type 2 and covered with 3 inches of compacted HMA Class ½ Inch.

##### **5-04.3(21)B HMA DRIVEWAYS**

Asphalt driveways shall be constructed as shown on the Drawings. Unless the Contract specifies otherwise, the Contractor shall provide 3 inches of compacted HMA of the class specified in the Contract over 4 inches of compacted Mineral Aggregate Type 2.

#### **5-04.3(22) RESERVED**

#### **5-04.3(23) TEMPORARY PAVEMENT PATCHING**

Unless the Contract designates an HMA CL asphalt concrete as a temporary patch Material, the temporary asphalt patch Material shall be in accordance with Section 9-02.5.

The Contractor shall furnish, place and maintain a 4 inch minimum compacted thickness of temporary pavement patch Material over open cuts. Such temporary asphalt patching will be required where vehicular or pedestrian traffic must be accommodated and permanent pavement patching cannot be placed immediately. Trench backfill shall be compacted as specified in Section 2-10. Temporary pavement patch Material shall be compacted and leveled to coincide with adjacent surfaces.

In the event that the temporary surface subsides after the initial placement, additional temporary pavement patch Material shall be placed over the subsided Material as necessary to maintain a surface level with existing pavement. The Contractor shall timely maintain such temporary patching.

Prior to final restoration of the pavement, the Contractor shall remove the temporary pavement patch Material and such underlying material as may exist, clean the exposed face of the existing pavement to remain, and restore the pavement.

#### **5-04.4 MEASUREMENT**

Bid items of Work completed pursuant to the Contract will be measured as provided in Section 1-09.1, Measurement of Quantities, unless otherwise provided for by individual measurement paragraphs herein this Section.

Measurement for HMA of the class specified will be by the ton whether the HMA is used for structural or non-structural applications, and whether a major quantity or a minor quantity. The net weight of HMA being delivered to the Project Site shall be weighed in the transporting equipment on a certified platform scale, and with accuracy, as specified in Section 1-09.2.

Measurement of HMA of the class specified will be based upon the actual quantity incorporated into the Work as determined by the Material load tickets received and accepted by the Engineer on the day the Material was delivered and incorporated into the Work. Deductions will be made for any asphaltic Material included in the measurement that is not incorporated into the Work on the day delivered.

Measurement for "Roadway Preparation" will be made by a single linear foot measurement along the centerline of the main roadway being prepared. All related intersections, side street approaches, and irregular shaped areas thereto will be incidental to this one measurement. Measurement will be to the nearest whole linear foot.

Measurement for "Surface Preparation, Plane Bituminous Pavement" will be by the square yard and will be based on the average depth shown on the Drawings plus any additional depth up to 4 inch maximum to cover removal of high spots, to cover extra thickness in existing pavement, and to cover the extra depth required to provide a 4 inch reveal along the curb line as specified in Section 5-04.3(4)B3B. Should the Drawings indicate or the Engineer order an area be planed in excess of 4 inches, that area planed in excess of 4 inch total depth will be measured in additional square yards of surface planed for up to an additional 4 inch depth. In general, any area planed in excess of 4 inches will be measured by the square yard for each incremental depth of 4 inches. The final planed depth beyond the first 4 inch thickness will include multiples of 4 inches with the last planing pass up to 4 inch maximum. (Example – an area of pavement planed to 9.5 inch total depth will be measured as 3 times the square yardage for that area, or 4 inch + 4 inch + 1.5 inch or up to 4 inch.). Measurement shall also include sweeping to detect metal hidden below the surface for each 4 inch or less depth increment of pavement to be planed.

Measurement for "Surface Preparation, Prelevel" will be by the ton of HMA class placed for preleveling surfaces based on the actual quantity incorporated into the Work as determined by the Material load tickets received and accepted by the Engineer on the day the Material was delivered and placed.

Measurement of permanent pavement patching will be by the ton for the HMA class specified.

Measurement of temporary pavement patch will be made by the ton for the initial placement only. Additional temporary pavement patch required to maintain the surface of the temporary patch level with adjacent roadway surfaces will not be measured. An exception for measuring pavement patch for electrical conduit construction as specified in Section 8-33 will be based on actual measured dimensions with the width of restoration no greater than 24 inches.

Measurement of "Material Transfer Vehicle (MTV)" will be made by the ton of HMA transferred through the MTV and placed. Measurement will not be made for "Material Transfer Vehicle (MTV)" for placed HMA not transferred through the MTV.

Measurement for "Pavement, WMA (Class)" will be by the ton in the same manner as measurement for HMA.

#### 5-04.5 PAYMENT

Compensation for the cost necessary to complete the work described in Section 5-04 will be made at the Bid item prices Bid only for the Bid items listed or referenced as follows:

1. **"Pavement, HMA (Class)", per ton.**

The Bid item price for "Pavement, HMA (Class)" shall include all costs for the work required to furnish, haul, place and compact the HMA mix, including tack coat, fog seal and sealing joints and meet lines, sand for joints and meet lines, cleaning, and such other work as may be necessary and not otherwise set forth as a separate Bid item in the Bid Form.

2. **"Roadway Preparation", per linear foot.**

The Bid item price for "Roadway Preparation" shall include all costs for the work required to prepare the untreated roadway, including scarifying, blading, shaping, and compacting to remove irregularities and secure a uniform surface except prime coat treatment which will be paid in accordance with Section 5-02.

3. **"Surface Preparation, Prelevel", per ton.**

The Bid item price for "Surface Preparation, Prelevel" shall include all costs for the work required to prelevel uneven or broken treated surfaces by placing and compacting asphalt as specified in Section 5-04.3(4)B2.

4. **"Surface Preparation, Plane Bituminous Pavement", per square yard.**

The Bid item price for "Surface Preparation, Plane Bituminous Pavement" shall include all costs for the work required to prepare the treated surface including sweeping for hidden metal, exposing metal below the pavement surface where indicated on the Drawings before planing, milling and planing and other type pavement removal as may be necessary, removing and disposing of cuttings, extra planing for butt joints, and feathering meet areas in preparation for an asphalt overlay.

5. **"Crack Sealing", per linear foot.**

The Bid item price for "Crack Sealing" shall include all costs for the work required to clean and fill the cracks and joints.

6. **"Pavement Patch, Temporary", per ton.**

The Bid item price for "Pavement Patch, Temporary" shall include all costs for the work required to install and remove the temporary patch. The costs for additional Material required to maintain temporary pavement patches after the initial installation shall be at the sole expense of the Contractor.

7. **"Material Transfer Vehicle (MTV)", per ton.**

The Bid item price for "Material Transfer Vehicle (MTV)" shall include all costs for the work required to place HMA through the MTV. All cost for the MTV not included in "Material Transfer Vehicle (MTV)" shall be included in other Bid items and no separate or additional payment will be made therefore.

8. **"Pavement, WMA (Class)", per ton.**

The Bid item price for "Pavement, WMA (Class)" shall include all costs for the work required to furnish, haul, place and compact the WMA mix, including tack coat, fog seal and sealing joints and meet lines, sand for joints and meet lines, cleaning, and such other work as may be necessary and not otherwise set forth as a separate Bid item in the Bid Form.

9. **Other payment information.**

Payment for Mineral Aggregate (Type) will be made in accordance with Section 4-01.5.

Payment for removal will be made in accordance with Section 2-02.5.

All costs for the rejection and disposal of Materials held for more than 24 hours after mixing, as specified in Section 5-04.3(8), shall be at the Contractor's sole expense and at no additional or separate cost to the Owner.

When cores are taken by the Engineer at the request of the Contractor, the Owner shall be reimbursed for the coring expenses as specified in Section 1-05.7.

Where samples have been taken by the Engineer from the uncompressed asphalt concrete, new Material shall be placed and compacted at no additional expense to the Owner.

Where the Engineer accepts area of pavement that does not meet the smoothness requirement as specified in Section 5-04.3(12)A, the total payment for yardage of that pavement will be reduced by \$500.00 for each and every increment of section of a single traffic lane of 100 feet in length. Where more than 100 feet of such pavement exists, whether in one or more lanes, payment will be reduced as described. Payment for the last incremental section of said pavement will be reduced by \$500.00 if such last incremental section is less than 100 feet.

Where the placement of asphalt for portland cement concrete overlay requires grinding to provide for the full thickness of concrete pavement overlay, all expense for grinding shall be at the Contractor's sole expense and no separate or additional payment will be made therefore.

Payment for backfill and compaction of the subgrade shall be included in the Bid item price for the particular Bid item(s) of Work necessitating such work.

Payment for subgrade preparation as required by Section 5-04.3(4)C1 will be in accordance with Section 2-09.5.

Payment for Material used for fog seal as specified in Section 5-04.3(18) will be paid as asphalt for tack coat, except no payment will be made for sealing pavement that has been repaired as specified in Section 5-04.3(12).

All costs for anti-stripping additive as specified in Sections 5-04.3(6) and 5-04.3(19) shall be incidental to and included in the applicable Bid item prices and no separate or additional payment will be made.

All costs for temporary pavement marking and removal shall be incidental to and included in the applicable Bid item prices and no separate or additional payment will be made therefore.

All costs to repair pavement damaged by the removal of temporary marking tape specified in Section 5-04.3(17) shall be at the Contractor's sole expense and no additional or separate payment will be made therefore.

All cost to repair existing pavement to remain, that is damaged by the Contractor's planing as specified in Sections 5-04.3(4)B2 and 5-04.3(4)B3, shall be at the sole expense of the Contractor and no separate or additional payment will be made therefore.

If the Contractor requests and the Engineer approves a change in grade of asphalt binder as specified in Section 5-04.2(1), the Contractor accepts no change in the Bid item price, and no separate or additional payment will be made therefore.

All cost associated with Contractor proposed and Engineer approved use of RAP, and use of substitute asphalt binder grade as specified in Section 5-04.2(1), shall be at no cost to the Owner and no separate or additional payment will be made therefore.

All cost to remove and replace newly placed pavement that is defective shall be at the Contractor's sole expense and no separate or additional payment will be made therefore.

All cost related to planing equipment that is damaged by contacting metal hidden in pavement shall be at the Contractor's sole expense and no separate or additional payment will be made therefore. See Sections 5-04.3(3)D and 5-04.3(4)B3.

All cost for adjusting metal castings below the existing pavement surface shown on the Drawings, and not visible on the surface, shall be in accordance with Section 7-20.5.

All cost related to addressing hidden metal found in pavement as required before beginning planing that are not shown on the Drawings, shall be in accordance with Section 1-04.7.

## SECTION 5-05 CEMENT CONCRETE FOR ROADWAY AND RELATED WORK

### 5-05.1 DESCRIPTION

This Work shall consist of constructing a pavement composed of portland cement concrete or blended hydraulic cement concrete on a prepared Subgrade or base in accordance with this Section and in conformity with the lines, grades, thicknesses, and typical cross-sections shown in the Drawings, Standard Plans, or established by the Engineer. Cement concrete pavement construction consists of the following:

1. **Roadway Paving:** may be full reconstruction, but typically selective reconstruction of cement concrete roadway or cement concrete roadway base with asphalt overlay.
2. **Non-Roadway:** (requirements for cement concrete): alleys, driveways, sidewalks, curb ramps, curbs, curb and gutters, and other cement concrete construction on prepared subgrade or base.

Extra Work for using colored and/or imprinted concrete, including color matching joint material, when specified is also addressed.

### 5-05.2 MATERIALS

Materials shall meet the requirements of the following Sections:

Portland Cement and Blended Hydraulic Cement	9-01
Fine Aggregate	9-03
Coarse Aggregate	9-03
Combined Aggregate	9-03

Premolded Joint Filler	9-04.1
Joint Sealants	9-04.2
Deformed Steel Bars (Rebar)	9-07.2
Dowel Bars	9-07.5
Tie Bars	9-07.6
Wire Mesh	9-07.7
Concrete Patching Material	9-20
Curing Materials and Admixtures	9-23
Water	9-25
Epoxy Resins	9-26

### 5-05.3 CONSTRUCTION REQUIREMENTS

#### 5-05.3(1) CONCRETE MIX DESIGN

The Contractor shall provide a concrete mix design for each cement concrete class specified in the Bid Form.

The Contractor shall use ACI 211.1 as a guide to determine proportions. Concrete strength, placement, and workability shall be the responsibility of the Contractor. The maximum slumps determined in accordance to AASHTO T 119 (ASTM C 143) shall be 4-inches unless otherwise accepted by the Engineer.

The specified cement concrete mix designs shall be meet the requirements of this Section and the parameters specified by the following cement concrete classes and Table 1:

1. **Roadway Cement Concrete, Variable Mixes;** "Variable Mixes" indicates that design parameters are broad and more than one mix design for this class is allowed to provide the Contractor with more control of work. Mix designs meeting the requirements of any of the following three roadway cement concrete class may be provided for this class. Only one pay item exist, thus the means and method of mix usage and associated costs of mixes within Contract requirements are determined by the Contractor.
2. **Roadway Cement Concrete, HES;** "HES" indicates a high-early-strength cement concrete. "HES" &"Roadway" are included in the Bid item description, as well as a time from batching to opening to traffic (3000 psi).
3. **Roadway Cement Concrete;** traditional 28-Day cement concrete without pozzolans. "Roadway" is included in the Bid item description.
4. **Roadway Cement Concrete, W/25% pozzolans;** "W/25% pozzolans" indicates that this is minimal cement content is desired and the use of pozzolans is required. "W/25% pozzolans"& "Roadway" are included in the Bid item description.
5. **Non-Roadway Cement Concrete, HES, High Strength;** "HES" indicates a high-early-strength cement concrete. "HES", "High Strength" &"Non-Roadway" are included in the reference, as well as a time from batching to opening to traffic; 3000 psi for commercial driveways and 2500 psi for non-commercial driveways, and 2500 psi for other applications.
6. **Non-Roadway Cement Concrete, High Strength;** "High Strength" indicates a high- strength non-roadway cement concrete. "High Strength" &"Non-Roadway" are included in the reference.
7. **Non-Roadway Cement Concrete, High Strength W/25% pozzolans;** "High Strength" indicates a high-strength non-roadway cement concrete. "W/25% pozzolans" indicates that this is minimal cement content is desired and the use of pozzolans is required. "High Strength", "Non-Roadway" & "W/25% pozzolans" are included in the reference.
8. **"Non-Roadway Cement Concrete;** traditional non-roadway cement concrete. Only "Non-Roadway" is included in the reference.
9. **Non-Roadway Cement Concrete, W/25% pozzolans;** "W/25% pozzolans" indicates that this is minimal cement content is desired and the use of pozzolans is required. "Non-Roadway" & "W/25% pozzolans" are included in the reference.



Mix designs for the preceding classes of cement concrete shall meet the design strengths (by arithmetic mean) and be proportioned within the limits as specified in Table 1 which follows:

TABLE 1

Cement concrete mix class	Design Strength Parameters		Cementitious Material		Pozzolans	
	Minimum flexural strength (psi)	Minimum compressive strength (psi)	Minimum (lbs/CY)	Maximum (lbs/CY)	Minimum % of Cementitious Material	Maximum % of Cementitious Material
Roadway Cement Concrete, <b>Variable Mixes</b>	570 at 28-Days <sup>1</sup> and 650 at 42-Days	3600 at 28 Days <sup>5</sup>	505	675 <sup>4</sup>	None	10-Microsilica 25-Fly Ash 25-GGBFS 25-Combined <sup>3</sup>
Roadway Cement Concrete, <b>HES</b>	650 at 14-Days	3600 at 28 Days <sup>5</sup>	564	675 <sup>4</sup>	None	10-Microsilica 25-Fly Ash 25-GGBFS 25-Combined <sup>3</sup>
Roadway Cement Concrete	570 at 28-Days <sup>1</sup> and 650 at 42-Days	3600 at 28 Days	505	587	None	10-Microsilica 25-Fly Ash 25-GGBFS 25-Combined <sup>3</sup>
Roadway Cement Concrete, <b>W/25% pozzolans</b>	570 at 28-Days <sup>1</sup> and 650 at 42-Days	3600 at 28 Days	505	587	25-Combined <sup>3</sup>	10-Microsilica 25-Fly Ash 25-GGBFS 25-Combined <sup>3</sup>
Non-Roadway features are alleys, driveways, sidewalks, curb ramps, curbs, curb and gutters. Mix requirements below are referenced from Specification Sections addressing those features.						
Non-Roadway Cement Concrete, <b>HES, High Strength</b>	N/A	3000 at 28 Days <sup>5</sup>	564	675 <sup>4</sup>	None	10-Microsilica 25-Fly Ash 25-GGBFS 25-Combined <sup>3</sup>
Non-Roadway Cement Concrete, <b>High Strength</b>	N/A	3000 at 28 Days	463 <sup>2</sup>	564	None	10-Microsilica 25-Fly Ash 25-GGBFS 25-Combined <sup>3</sup>
Non-Roadway Cement Concrete, <b>W/25% pozzolans, High Strength</b>	N/A	3000 at 28 Days	463 <sup>2</sup>	564	25-Combined <sup>3</sup>	10-Microsilica 25-Fly Ash 25-GGBFS 25-Combined <sup>3</sup>
Non-Roadway Cement Concrete	N/A	2500 at 28 Days	463 <sup>2</sup>	505	None	10-Microsilica 25-Fly Ash 25-GGBFS 25-Combined <sup>3</sup>
Non-Roadway Cement Concrete, <b>W/25% pozzolans</b>	N/A	2500 at 28 Days	463 <sup>2</sup>	505	25-Combined <sup>3</sup>	10-Microsilica 25-Fly Ash 25-GGBFS 25-Combined <sup>3</sup>

<sup>1</sup> Mix design can be accepted based on 28 day requirement provided no single beam test is under 550 psi and quality level is not less than 80-percent per the Quality Level Calculation in this Section.

<sup>2</sup> 548 if 3/8" or 1/2" course aggregate used.

<sup>3</sup> Combined use of Fly Ash and GGBFS; Microsilica not included.

<sup>4</sup> Maximum for HES 24 hour or less mix is 752 pounds; a higher limit requires approval of the Engineer.

<sup>5</sup> Mix design for high-early-strength will require 5 sets of cylinders tests at the specified time from batching for a lower compressive strength for opening to traffic as specified herein (3000 psi roadway, commercial driveways, and alleys, 2500 psi for residential driveways). The quality level shall not less than 80-percent per the Quality Level Calculation in this Section.

**Materials:**

Materials shall conform to Section 5-05.2 and shall meet the requirements of Section 5-05.

**Roadway Cement Concrete:**

Fine aggregate shall conform to Section 9-03.1(2), Class 1. Coarse aggregate shall conform to Section 9-03.1(3), AASHTO grading No. 467. An alternate combined gradation conforming to Section 9-03.1(4) may be proposed, that has a nominal maximum aggregate size equal to or greater than a 1½-inch sieve.

**Non-Roadway Cement Concrete:**

Fine aggregate shall conform to Section 9-03.1(2), Class 2. Coarse aggregate shall conform to Section 9-03.1(3). The Coarse aggregate used shall be ¾ inch to 1-1/2 inch, at the option of the Contractor, except as provided for below.

1. An alternate combined gradation conforming to Section 9-03.1(4) may be proposed, that has a nominal maximum aggregate size equal to or greater than a 1½-inch sieve.
2. The maximum size of aggregate used for extruded or slip-formed curb construction or pattered cement concrete shall be at the option of the Contractor, but in no case shall the maximum size be larger than one inch nor smaller than 3/8-inch.

**Pozzolans:**

Fly ash, if used, shall conform to Section 9-23.9 and shall be limited to Class F with a maximum CaO content of 15-percent by weight.

Ground granulated blast furnace slag, if used shall conform to Section 9-23.10.

Blended Hydraulic Cement if used shall meet the requirements of Section 9-01.2(4).

The water/cement ratio shall be calculated on the total weight of cementitious material. The following are considered cementitious materials: portland cement, fly ash, ground granulated blast furnace slag (GGBFS) and microsilica.

**Submittals:**

The Contractor's submittal shall include the mix proportions per cubic yard, test results from flexural strength (beams; roadway concrete only) and compressive strength (cylinders; all cement concrete), the proposed material sources and applicable certifications for all ingredients. For roadway concrete, the mix shall be capable of providing a minimum flexural strength of 650-psi. For non-roadway concrete, the mix shall be capable of providing the minimum time based compressive strength.

- a. Roadway Concrete: Evaluation of roadway concrete strength shall be based on statistically analyzed results of 5 beam specimens made according to AASHTO T 126 and tested according to AASHTO T 177 that demonstrate a quality level of not less than 80-percent analyzed in accordance with the Quality Level Calculation in this Section.  
  
In addition the Contractor shall fabricate, cure, and test 5 sets of cylinders, for evaluation of 28-day strengths, according to AASHTO T 22 and AASHTO T 23 using the same mix design as used in fabrication of the beams.
- b. Non-Roadway Concrete: Evaluation of non-roadway concrete strength shall be based on statistically analyzed results of 5 sets (10) cylinders specimens made according to AASHTO T 22 and tested according to AASHTO T 23 that demonstrate a quality level of not less than 80-percent analyzed in accordance with the Quality Level Calculation in this Section.
- c. High-Early-Strength (HES) Concrete: In addition to the above, evaluation of high-early-strength concrete at specified (HES) time, for road opening strengths shall be based on statistically analyzed results of 5 sets (10) cylinders specimens made according to AASHTO T 22 and tested according to AASHTO T 23 that demonstrate a quality level of not less than 80-percent analyzed in accordance with the Quality Level Calculation in this Section.

Mix designs submitted by the Contractor shall provide a unique identification for each proposal and shall include test data confirming that concrete made in accordance with the proposed design will meet the requirements of this Section. Test data shall be from an independent testing lab or from a commercial concrete producer's lab. If the test data is developed at a producer's lab, the Engineer or a representative may witness all testing.

Following acceptance of the Contractor's mix design in accordance with Section 1-05.3, the following Conformance requirements shall apply.

**Conformance to Mix Design:**

Cement and coarse and fine aggregate weights shall be within the following tolerances of the mix design:

Portland Cement Concrete Batch Weights, per cubic yard of Concrete		
Cement	+5%	-1%
Coarse Aggregate	+ 200-Pounds	- 200-Pounds
Fine Aggregate	+ 200-Pounds	- 200-Pounds

If the total cementitious material weight is made up of different components, these component weights shall be within the following tolerances:

- Portland cement weight plus 5-percent or minus 1-percent of that specified in the mix design.
- Fly ash and ground granulated blast furnace slag weight plus or minus 5-percent of that specified in the mix design.
- Microsilica weight plus or minus 10-percent of that specified in the mix design.

Water shall not exceed the maximum water specified in the mix design.

The Contractor may initiate minor adjustments to the approved mix proportions within the tolerances noted above without resubmitting the mix design.

Utilizing admixtures to accelerate the set or to increase workability will be permitted only when approved by the Engineer. Only nonchloride accelerating admixtures that meet the requirements of Section 9-23.6, Admixture for Concrete, shall be used.

The Contractor shall notify the Engineer in writing of any proposed modification. A new mix design will designate a new lot.

#### Quality Level Calculation:

The procedures for determining the quality level are as follows:

- Determine the arithmetic mean,  $\bar{X}$
- Compute the sample standard deviation,  $S_n$
- Compute the lower quality index, (QI), where L is mix design requirement.

For  $n=5$  sets, a  $QI \geq 0.88$  is required for a quality level not less than 80-percent

$$QI = (\bar{X}-L)/S_n$$

#### 5-05.3(2) CONSISTENCY

The materials shall be mixed with sufficient water to produce a stiff concrete which will hold its shape when deposited upon the Subgrade. Concrete placed during wet weather shall be mixed with sufficient water to produce a very stiff mixture. The consistency shall be such that separation of the mortar from the coarse aggregate will not occur in handling.

##### For Roadway Concrete:

The water/cementitious material ratio, by weight, shall not exceed 0.44. When slip form paving equipment is used, the Contractor shall further control concrete consistency to ensure that edge slump conforms to the requirements of Section 5-05.3(11).

##### For Non-Roadway Concrete:

Cement		Max. W/C
Sacks	Pounds	
4.5	423	0.65
5	470	0.58
5.5	517	0.53
6	564	0.49
6.5	611	0.45
7+	658+	0.44

Interpolate between values for cement contents not listed.

#### 5-05.3(3) EQUIPMENT

Equipment necessary for handling materials and performing all parts of the Work shall conform to the following requirements:

**5-05.3(3)A BATCH PLANT AND EQUIPMENT**

All concrete shall be batched in a prequalified manual, semi-automatic, or automatic plant as described in Section 6-02.3(4)A. The Engineer is not responsible for any delays to the Contractor due to problems in getting the plant certified.

**5-05.3(3)B MIXING EQUIPMENT**

1. **General.** Concrete may be mixed at a batching plant or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.
2. **Truck Mixers and Truck Agitators.** Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling plant-mixed concrete, shall conform to the requirements of Section 6-02.3(4)A.
3. **Nonagitator Trucks.** Bodies of nonagitator hauling equipment for concrete shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. Covers shall be provided when needed for protection. Plant-mixed concrete may be transported in nonagitator vehicles provided that the concrete is delivered to the site of the Work and discharge is completed within 45-minutes after the introduction of mixing water to the cement and aggregates, and provided the concrete is in a workable condition when placed.

**5-05.3(3)C FINISHING EQUIPMENT – ROADWAY**

When and where indicated in the Contract, or as desired by the Contractor and approved by the Engineer, the method of constructing concrete pavement for continuous roadway paving shall be with approved slip-form paving equipment designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so a dense and homogeneous pavement is achieved with a minimum of hand finishing. When and where indicated this method shall be used for both cement concrete and cement concrete base paving when practicable.

Cement concrete pavement shall be placed with approved placement and finishing equipment utilizing stationary side forms except where slip-forms are used.

Hand screeding and float finishing of cement concrete pavement may only be utilized on small irregular areas as allowed by the Engineer.

**5-05.3(3)D JOINT SAWING EQUIPMENT - ROADWAY**

The Contractor shall provide approved power driven concrete saws for sawing joints, adequate in number of units and power to complete the sawing at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the Work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement. Sawing equipment shall be available immediately and continuously upon call by the Engineer on a 24-hour basis, including Saturdays, Sundays and holidays.

**5-05.3(3)E SMOOTHNESS TESTING EQUIPMENT – ROADWAY**

A long-handle, 10-foot straight edge for checking the surface smoothness as described in Section 5-05.3(12) shall be furnished by the Contractor and shall be at the site of pavement construction prior to the commencing of placing concrete. The straight edge shall be lightweight, straight and true, equipped with a long handle to allow for checking the smoothness of the surface in the direction of traffic and across traffic lanes.

**5-05.3(4) CEMENT CONCRETE BATCHING AND ACCEPTANCE****5-05.3(4)A MEASURING, AND BATCHING MATERIALS**

The batch plant site, layout, equipment, and transport of material shall ensure a continuous supply of material to the Work.

1. **Measuring Materials:**
  - a. **Aggregates.** The fine aggregate and each size of coarse aggregate shall be measured by weighing, the weight for the particular aggregates used being proportional to their respective bulk specific gravities. The weighing of each size of material shall be a separate and distinct operation.  
Corrections shall be made for variations in weight of materials due to the moisture content.  
The equipment for weighing aggregates shall conform to the requirements of Section 1-09.2.
  - b. **Cement.** Cement shall be weighed on scales meeting the requirements of Section 1-09.2. Adequate provision shall be made to prevent loss of cement between the batch box and the mixer.
  - c. **Water.** Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over 1-percent.
2. **Batching Materials:**

On all projects requiring more than 2500-cubic yards of portland cement or blended hydraulic cement concrete for paving, the batching plant shall be equipped to proportion aggregates and cement by weight by means of automatic and interlocked proportioning devices of approved type.

#### **5-05.3(4)B ACCEPTANCE OF PORTLAND CEMENT OR BLENDED HYDRAULIC CEMENT CONCRETE**

Acceptance of cement concrete pavement per class shall be as provided under a **representative area method** Section 5-05.3(4)B2.

The point of acceptance will be per WAQTC FOP for TM 2 or at the point of discharge when a pump is used. The concrete producer shall provide a certificate of compliance for each truckload of concrete in accordance with Section 6-02.3(5)B.

Acceptance testing for compliance of air content and 28-day compressive strength shall be conducted from samples prepared according to WAQTC FOP TM 2. Air content shall be determined by conducting WAQTC FOP for AASHTO T 152. Compressive Strength shall be determined by AASHTO T 23 and AASHTO T 22.

The Contractor shall provide cure boxes in accordance with Section 6-02.3(5)H, and protect concrete cylinders in cure boxes from excessive vibration and shock waves during the curing period in accordance with Section 6-02.3(6)D.

##### **Acceptance Parameters - Roadway Cement Concrete**

Representative area method Section 5-05.3(4)B2, for acceptance will apply to all other projects and cement concrete work described in Section 5-05.

The lower limit for Air Content (LLAC) shall be 4.0-percent, and the upper limit for Air Content (ULAC) shall be 7.0-percent. The lower limit for Compressive Strength (LLCS) shall be 1200-psi less than that established in the mix design as the arithmetic mean of the 5 sets of 28-day compressive strength cylinders, or 3600-psi, whichever is higher. These compressive strength cylinders are to be cast at the same time as the flexural beams that were used to prequalify the mix design under Section 5-05.3(1). There is no upper limit for 28-day compressive strength.

Parameters for pavement thickness are as shown in the Contract Documents. See Section 5-05.5(1) Pavement Thickness Deficiency Adjustments.

##### **Acceptance Parameters - Non-Roadway Cement Concrete**

For "Non-Roadway" cement concrete, the lower limit for compressive strength shall be 2500-psi for standard non-roadway mix and 3000-psi for "High Strength" non-roadway mix. The lower limit for Air Content (LLAC) shall be 4.0-percent, and the upper limit for Air Content (ULAC) shall be 7.0-percent.

#### **5-05.3(4)B1 RESERVED**

#### **5-05.3(4)B2 REPRESENTATIVE AREA METHOD**

For "Non-Roadway" Cement Concrete, and "Roadway" Cement Concrete areas as determined by the Engineer, will be sampled at the discretion of the Engineer and acceptance shall be based on the representative area method.

Each representative area (including individual subplot when not included in a lot) will be deemed to have met the specified acceptance requirements for compressive strength and air content when the compressive strength is equal to or greater than the LLCS, and the air content is equal to or fall between the LLAC and ULAC.

Each representative area as determined by the Engineer will be **rejected** if any of the following conditions are occur:

1. Individual strength tests representing at representative area falls below the lower limit for Compressive Strength (LLCS) for strength by more than 12-percent, or (500-psi for Roadway, 300-psi for Non-Roadway), whichever is least.
2. Individual strength tests representing at representative area falls below the lower limit for Air Content (LLAC = 4%) by more than 1-percent.
3. Individual strength tests representing at representative area falls above the upper limit for Air Content (ULAC = 7%) by more than 1-percent.

Sublots not meeting the full requirements and not rejected may remain in place but are subject to a lot based Pay Adjustment disincentive as indicated in the following table:

The price adjustment factor shall be 60% for compressive strength and 40% for air content. Thus, the Composite Pay Factor for strength and air is the Pay Factor for Strength by 60-percent plus the lower Pay Factor for air content by 40-percent.

However, if either Pay Factor is zero (0), than the Composite Pay Factor is 0 and the complete lot is **rejected** and no payment

will be made.

	Pay Factor =1.00	0.90	0.75	0.50
<b>Cement concrete mix</b>	<b>LLCS (28-day Compressive Strength, psi)</b>			
		<b>96% of LLCS</b>	<b>92% of LLCS</b>	<b>88% of LLCS</b>
Non-Roadway Cement Concrete	>= 2500	>= 2400	>= 2300	>= 2200
Non-Roadway Cement Concrete, High Strength	>= 3000	>= 2820	>= 2760	>= 2640
Roadway Cement Concrete	1200-psi less than mix design arithmetic mean, or 3600-psi,	<i>Calc</i>	<i>Calc</i>	<i>Calc</i>
<b>LLAC &amp; ULAC (% Air Content)</b>				
Non-Roadway Cement Concrete	>=4 and <= 7	<4.0 and >= 3.6, or >7.0 and <= 7.4	<3.6 and >= 3.3, or >7.4 and <= 7.7	<3.3 and >= 3.0, or >7.7 and <= 8.0
Non-Roadway Cement Concrete, High Strength				
Roadway Cement Concrete				

**5-05.3(4)B3 RE-TESTING BY CORING**

When compressive strengths fail to satisfy the acceptance requirements above requirements, the Contractor may request acceptance of in-place concrete strength based on core results. This method will not be used if the Engineer determines coring would be harmful to the integrity of the Structure. Cores, if allowed, shall be obtained by the Contractor in accordance with AASHTO T 24 and delivered to the Owner for testing in accordance with AASHTO T 22. Cores will not be taken within 18 inches of joints

If the concrete in the Structure will be dry under service conditions, the core will be air-dried at a temperature of between 60°F and 80°F and at a relative humidity of less than 60-percent for 7-Days before testing, and will be tested air dry.

Acceptance for each subplot or failed area by the core method requires that 3 cores be at least 85-percent of the specified strength (LLCS) with no one core less than 75 percent. The failing area may be subdivided to form smaller areas with each requiring 3-cores. When the Contractor requests strength analysis by coring, the results obtained will be accepted by both parties as conclusive and supersede all other strength data for the area represented. Failing subplot compressive strengths within a lot will be replaced by the new data and if applicable sub-sublots and sub-sublot sizes.

If the Contractor elects to core, cores shall be obtained no later than 50-Days after initial concrete placement. The Engineer will concur in the locations to be cored. Repair of cored areas shall be the responsibility of the Contractor. The cost incurred in coring and testing these cores, including repair of core locations, shall be borne by the Contractor.

**5-05.3(4)C REJECTION OF CONCRETE**

- 1. Rejection by the Contractor.** The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the Owner. Any such new material will be sampled, tested, and evaluated for acceptance.
- 2. Rejection by the Engineer without testing prior to placement.** The Engineer may reject any load that appears defective prior to placement. Material rejected before placement shall not be incorporated into the pavement. No payment will be made for the rejected materials unless the Contractor requests that the rejected material be tested. If the Contractor elects to have the rejected materials tested, a sample will be taken and both the air content and strength shall be tested by the Engineer. Payment for rejected material will be based on the results of one sample, which was taken and tested. If the rejected material fails either test, no payment will be made for the rejected material; in addition, the cost of sampling and testing at the rate of \$300.00 per sample shall be borne by the Contractor. If the rejected material passes both tests, the mix will be compensated for at a Composite Pay Factor (CPF) of lot or representative area and the cost of the sampling and testing will borne by the Owner.

The Engineer may reject any load that exceeds a maximum slump of 4-inches or as otherwise shown in the accepted mix design. Slump will be determined in accordance to AASHTO T 119 (ASTM C 143).

- 3. Rejection by the Engineer for visual defects after placement.** The Engineer may reject any concrete visually showing segregation or lack of consolidation. Acceptance based on visual bases where aesthetics are a critical feature, such as sidewalks, patterned, colored, or exposed aggregate concrete, will be at the sole discretion of the Engineer. No payment will be made for the rejected materials and the Contractor shall remove and replace the material at no cost to the Owner.
- 4. Rejection under representative area method;** The Engineer will reject any lot, sub-lot, or representative area that fails to meet the requirements Section 5-05.3(4)B2. No payment will be made for the rejected materials and the Contractor shall remove and replace the material at no cost to the Owner.

5. **Rejection due to thickness deficiency;** The Engineer will reject any primary unit or secondary unit that fails to meet the requirements Sections 5-05.5(1). No payment will be made for the rejected materials and the Contractor shall remove and replace the material at no cost to the Owner.

**5-05.3(5) MIXING CONCRETE**

The concrete may be mixed in a batching plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials are in the drum. Ready-mixed concrete shall be mixed and delivered in accordance with the requirements of Section 6-02.3(4)A and 6-02.3(4)B and other requirements of Section 6-02.3(4) not address within this Section 5-05.3(5).

When mixed in a batching plant, the mixing time shall not be less than 50-seconds nor more than 90-seconds.

The mixer shall be operated at a drum speed as shown on the manufacturer's nameplate on the mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at no expense to the Owner. The volume of concrete mixed per batch shall not exceed the mixer's rated capacity, as shown on the manufacturer's standard rating plate on the mixer.

Each concrete mixing machine shall be equipped with a device for counting automatically the number of batches mixed during the day's operation.

Retempering concrete by adding water or by other means will not be permitted.

**5-05.3(5)A LIMITATIONS OF MIXING**

Concrete shall not be mixed, placed, or finished when the natural light is inadequate, as determined by the Engineer, unless an adequate and approved artificial lighting system is operated.

Mixing and placing concrete shall be discontinued when a descending air temperature in the shade away from artificial heat reaches 40°F and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F unless authorized in writing by the Engineer.

When mixing and placing is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might injure the materials. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50°F and not more than 90°F at the time of discharge into or from the hauling conveyance. No concrete shall be mixed with aggregates less than 32 °F.

**5-05.3(6) SUBGRADE**

The Subgrade shall be constructed in accordance with Section 2-06.

Concrete shall not be placed on a frozen Subgrade nor during heavy rainfall.

The Subgrade shall be moist before the concrete is placed.

When the Subgrade is an asphalt treated base the surface shall be clean and free of any deleterious materials. When placing concrete on a treated base, the surface temperature shall not exceed 90°F. If water is used for cooling any excess water standing in pools or flowing on the surface shall be removed prior to placing concrete.

When applicable, the Subgrade shall be prepared and compacted to a minimum of 3-feet beyond each edge of the area which is to receive concrete pavement in order to accommodate the slip-form equipment.

Where thickened edges for pavements are required or desired by the Contractor, such as shown on the Standard Plans, the subgrade shall be excavated and shaped to provide for the section shown.

**5-05.3(7) PLACING, SPREADING, AND COMPACTING CONCRETE**

All the requirements apply regardless of the methods used to place concrete pavement.

The Specifications relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete.

**5-05.3(7)A SLIP-FORM CONSTRUCTION – CONTINUOUS PAVING**

When and where indicated in the Contract, or as desired by the Contractor and approved by the Engineer, the method of constructing concrete pavement may be constructed by the use of slip-form paving equipment.

The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well-defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of pavement and/or a series of equally spaced longitudinal vibrating units. The space from the outer edge of the pavement to the outer longitudinal unit shall not exceed 9-inches. The spacing of internal units shall be uniform and not exceed 18-inches.

The term internal vibration means vibration by vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be not less than 7,500-cycles per minute, and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least 1-foot. The frequency of vibration or amplitude shall be varied proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

#### **5-05.3(7)B STATIONARY SIDE FORM CONSTRUCTION**

Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the Work. Metal side forms shall be used unless other forms are approved by the Engineer.

Side forms may be built up by rigidly attaching a section to either top or bottom of forms. If such buildup is attached to the top of metal forms, the buildup shall be of metal.

Side forms shall be of sufficient rigidity, both in the form and in the interlocking connection with adjoining forms, that springing will not occur under the weight of grading and paving equipment or from the pressure of concrete. The Contractor shall provide sufficient forms so that there will be no delay in placing the concrete due to lack of forms.

Before placing side forms, the underlying material shall be at the proper grade. Side forms shall be placed to the required grade and alignment of the edge of the finished pavement. Wood wedges may be used to adjust the form elevation provided they do not extend into the concrete. The forms shall be firmly supported during the entire operation of placing, compacting, and finishing the pavement.

Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars where specified.

Immediately in advance of placing concrete and after all Subgrade operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing concrete. No concrete shall be placed until the forms are approved by the Engineer.

Side forms shall remain in place at least 12-hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms are removed.

Side forms shall be thoroughly cleaned and oiled each time they are used and before concrete is placed against them.

Unless otherwise approved by the Engineer, concrete shall be spread, screeded, shaped, and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that completed pavement will conform to required cross-section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the Work required at a rate equal to that of concrete delivery.

Concrete for the full paving width shall be effectively consolidated by means of surface vibrators, in combination with internal vibrators, or by some other method of consolidation that produces equivalent results without segregation.

When vibrators are used to consolidate concrete, the rate of vibration shall be not less than 3,500-cycles per minute for surface vibrators and shall be not less than 7,000-cycles per minute for internal vibrators. Amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than 1-foot from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating frequency of vibration.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

#### **5-05.3(8) JOINTS - ROADWAY**

Joints in cement concrete pavement will be designated as longitudinal and transverse contraction joints, longitudinal and transverse construction joints, through joints, or isolation joints, and shall be constructed as shown in the Drawings or Standard Plans in accordance with the following Specifications:

The faces of all joints shall be constructed perpendicular to the surface of the cement concrete pavement.



All joints in intersections where traffic lanes cross shall be considered transverse joints and dowel bars shall be used on all joints in accordance with the following or as shown on the Drawings.

If bar details are not shown in joint details on Drawings, then Standard Plans reinforcement steel details shall apply for steel placement.

When cement concrete pavement is placed adjacent to existing cement concrete pavement, the vertical face of all existing working joints shall be covered with a bond-breaking material such as polyethylene film, roofing paper, or other material as approved by the Engineer.

#### **5-05.3(8)A CONTRACTION JOINTS**

All contraction joints shall be constructed at the locations, intervals, and depths shown in the Contract. Sawed joints are typically used with continuous or full reconstruction paving. Unless otherwise specified, the use of sawed or formed contraction joints is at the option of the Contractor, however, sawing into adjacent cement concrete paving or curbs will not be allowed.

#### **5-05.3(8)A1 SAWED CONTRACTION JOINTS**

The depth of sawcuts shall be as shown in the Drawings or Standard Plans and shall not cut underlying pavement tie bars or dowels.

Transverse and longitudinal contraction joints shall be sawed with suitable power-driven concrete saws. The Contractor shall provide sufficient sawing equipment capable of completing the sawing to the required dimensions and at the required rate to control cracking. To ensure continuity of sawing, standby equipment shall be on the job and all sawing equipment shall be available immediately and continuously on a 24 hour basis.

The Contractor shall provide adequate artificial lighting facilities for night sawing. Joints shall not vary from the specified or indicated line by more than  $\frac{3}{4}$ -inch.

Commencement of sawing transverse contraction joints will be dependent upon the setting time of the concrete and shall be done at the earliest possible time following placement of the concrete without tearing or raveling the adjacent concrete excessively.

Longitudinal contraction joints shall be sawed as required to control cracking and as soon as practical after the initial control transverse contraction joints are completed. For "HES" (high-early strength) concrete this should be within six hours of placement. Any sawing of joints that result in premature or uncontrolled cracking shall be revised immediately by adjusting the time interval between placing of concrete and the sawing of joints.

Any damage to the curing material during the sawing operations shall be repaired immediately after the sawing is completed. If Curing Compound is used, the area disturbed by sawing of joints shall be reapplied immediately upon completion of the sawing operation and care shall be exercised to prevent the curing compound from getting into the groove.

Formed transverse contraction joints shall be installed where designated by the Engineer, if necessary to prevent uncontrolled transverse cracks from occurring before the pavement can be sawed.

#### **5-05.3(8)A2 SEALING SAWED CONTRACTION JOINTS (NON-BASE ONLY)**

Sawed contraction joints shall be filled with joint sealant filler conforming to the requirements of Section 9-04.2. Joints shall be thoroughly clean at the time of sealing and if the hot-poured type is used the joints shall be dry. Care shall be taken to avoid air pockets. The hot-poured compound shall be applied in two or more layers, if necessary. The hot-poured compound and the cold-poured compound shall be applied under sufficient pressure to fill the groove from bottom to top and the cured joint sealant shall be between  $\frac{1}{4}$ -inch and  $\frac{5}{8}$ -inch below the top surface of the concrete.

#### **5-05.3(8)A3 FORMED CONTRACTION JOINTS (NON-BASE ONLY)**

Formed contraction joints shall be constructed by embedding a  $\frac{3}{8}$ -inch thick premolded joint filler in accordance with Section 9-04.1 and as shown in the as shown in the Drawings or Standard Plans. The depth of the formed joints shall be as shown in the Drawings or Standard Plans. The premolded joint filler shall be cut to the exact section of the joint. The length of the premolded joint filler shall extend to within  $\frac{1}{4}$ -inch of any panel edge.

Formed contraction joints shall be placed after compaction and finishing of concrete have been completed and before initial set. A vertical groove shall be cut into the surface at the location of the joint, using a tool provided with stops (tee iron) to prevent cutting the groove deeper than the planned depth. The preformed joint filler shall then be embedded into the groove until the top is flush with the pavement surface, with a deviation of not more than  $\frac{1}{8}$ -inch below the surface. The premolded joint filler shall be perpendicular to the surface and always in a straight line.

The surface of the pavement shall be finished against the filler strip with hand floats to restore the surface finish. The premolded joint filler shall be maintained in a perpendicular position, true to alignment without irregularities.

#### **5-05.3(8)A4 WEAKENED PLANE CONTRACTION JOINTS (BASE ONLY)**

A weakened plane shall be made in the plastic concrete to match existing cracks as designated by the Engineer, or as shown in the Drawings. Typically, maximum joints spacing shall not exceed 15 feet for a base slab thickness greater than 7-inches; and, shall not exceed  $12\frac{1}{2}$  feet for a base slab thickness less than 7-inches.

The plane shall be weakened with a joint cutter to a minimum depth of 2 inches. Bulging caused by the joint cutter shall be corrected by floating lightly; and

If new curb is also being placed, unless otherwise specified, preformed joint filler shall be placed completely through the curb at the point where the weakened plane intersects the curb.

#### **5-05.3(8)B CONSTRUCTION JOINTS**

When placing of standard or slow curing (non-high-early-strength) concrete is discontinued for more than 45-minutes, a transverse construction joint shall be installed. Construction joints shall be as shown in the Standard Plans. When placing traffic cement concrete construction joints will be at the direction of the Engineer.

Transverse construction joints shall be constructed between cement concrete pavement and reinforced concrete bridge approach slabs.

All transverse and longitudinal construction joints, including the joint between new and existing pavement when widened, shall either be:

1. Sawed and sealed with joint filler conforming to the requirements of Sections 5-05.3(8)A1 and 9-04.2, or;
2. Formed and sealed with a 3/8-inch thick premolded joint filler in accordance with Section 9-04.1(1) as shown in the as shown in the Drawings or Standard Plans.

Unless otherwise specified, all longitudinal construction joints shall be shall be constructed with tie bars and all transverse construction joints shall be shall be constructed with dowel bars as shown in the Drawings or Standard Plans. See Section 5-05.3(10)A for exceptions to tie-bars and dowels placement requirements for "new to existing" joints.

Unless otherwise specified, optional keyways shall be allowed only as detailed in the Standard Plans.

#### **5-05.3(8)C THROUGH JOINTS**

Through joints are placed only where shown on the Drawings. Unless otherwise shown, joint alignment shall be at right angles to the pavement structure centerline.

Through joints shall be constructed with ¾-inch premolded joint filler conforming to Section 9-04.1(2). The premolded joint filler shall extend from 1 inch below the subgrade to 1 inch below the top of the pavement. Through joints shall extend the full width of the pavement structure. Dowels shall be used unless otherwise directed by the Engineer or indicated on the Drawing.

The premolded joint filler shall be held accurately in place during the placing and finishing of the concrete by a bulkhead, a holder, a metal cap or any other approved method. The joint shall be perpendicular to the paved surface and the holder shall be in place long enough to prevent sagging of the Material, especially on streets having steep grades.

A wood filler strip or metal cap shall be placed on the top of the premolded joint filler to form the groove 1 inch deep.

After concrete is significantly set and prior to opening to traffic, remove the wood filler strip or the metal cap above the top of the premolded joint filler and thoroughly cleaned of all loose material. It shall then be filled level with the pavement surface with joint sealant meeting the requirements of Sections 9-04.2(2).

The joint sealant Material shall be heated and placed in accordance with the manufacturer's instructions. Burned Material will be rejected. The through joint groove shall be dry at the time of pouring the sealing compound.

#### **5-05.3(8)D ISOLATION JOINTS**

When drainage features are placed within the concrete pavement premolded joint filler in accordance with Section 9-04.1(2) shall be placed as detailed in the Drawings through the full depth of concrete pavement.

#### **5-05.3(8)E JOINT LOCATION**

Unless otherwise shown on the Drawings or directed by the Engineer, the following shall apply:

##### **5-05.3(8)E1 TRANSVERSE JOINTS**

Standard spacing of transverse contraction joints along straight sections of pavement structures (between through joints or between intersections or other irregular areas), shall be at intervals as shown in the Standard Plans. Where the spacing between intersections, transverse through joints, or other irregular areas are not in even multiples, the last several spaces approaching the through joint or header shall be varied by shortening the spaces. The Contractor shall give advance notice to the Engineer and coordinate the spacing. On horizontal curves, the joint spacing shall be measured along the outer edge of the outside lane and at right angles to the center line.

When paving adjacent to existing pavement or a previously paved lane, the new transverse joints shall be placed to match joint locations in the adjacent pavement. Where the existing joint spacing is greater than intervals as shown in the Standard Plans, intermediate transverse joints shall be constructed. The Contractor shall give advance notice to the Engineer and coordinate the spacing.

For intersections and other irregular areas, the arrangement of contraction joints shall be in accordance with standard intersection pattern(s), see Drawings and Standard Plans. The area of any one irregular panel formed by doweled contraction joints in intersections shall:

1. not exceed 225 square feet and dimensions shall not exceed 15 feet for a slab thickness greater than 7-inches; and,
2. not exceed 156¼ square feet and dimensions shall not exceed 12½ feet for a slab thickness less than 7-inches.

The Contractor shall give advance notice to the Engineer and coordinate the spacing.

Unless otherwise directed by the Engineer, where uncontrolled cracks have appeared or exist in the adjacent lane not to be replaced, they shall be matched as nearly as possible by uniform transverse joints in the second lane. In the event uncontrolled cracks in the existing paved lane are too frequent or in random locations and impossible to match with a uniform spacing, the two lanes shall be completely separated by a Longitudinal Through Joint when directed by the Engineer.

Where integral curb or doweled curb is placed along the concrete pavement, premolded joint filler shall be placed transversely across the full section of the curb in true alignment with the pavement joint, perpendicular to the pavement grade.

All joints in an intersection shall be considered transverse joints except those joints that terminate normal to the curb radius.

#### **5-05.3(8)E2 LONGITUDINAL JOINTS**

Standard locations for longitudinal joints for the following pavement widths, whether contraction or construction, shall be in accordance with the Standard plans unless specified otherwise shown in the Drawings. Typically, longitudinal joints shall be placed at lane lines; bike lane shall be combined with parking and treated as a single lane. Longitudinal or skewed joints shall not be placed within bike lanes.

Typically, maximum longitudinal joints spacing

1. shall not exceed 15 feet for a slab thickness greater than 7-inches; and,
2. shall not exceed 12½ feet for a slab thickness less than 7-inches.

A 3/8-inch by 2 inches (minimum) preformed joint filler shall be placed between the two lanes when the second lane is constructed. See Standard Plans.

#### **5-05.3(9) CASTINGS AND STEEL REINFORCING IN CONCRETE PAVEMENT**

Unless otherwise specified in the Drawings or directed by the Engineer, reinforcing steel shall be used to reinforce cement concrete in rigid pavement around all maintenance hole castings and monument casings in the roadway, except when the casting crosses or is less than 18 inches from any pavement joint. One of the following methods of reinforcement shall be used:

1. **Steel Reinforcement (Wire Mesh):** Castings shall have a (6-1/2 ft to 7 ft) x (6-1/2 ft to 7 ft) (square or rectangle) of steel reinforcement placed around the casting at mid-depth of the concrete pavement slab as shown on Standard Plan no. 406. The centered hole cut for the casting shall be cut a minimum of 3 inches to a maximum of 4 inches from the casting at mid-depth of the concrete pavement. The dimensions of the mesh shall be reduced where pavement joints are encountered such that no reinforcing steel shall be within 2½ - inches of any cement concrete pavement joints or surfaces.

Wire mesh shall be W2.9 with spacing of 4 inches on-center in both the lateral and transverse directions. Wire mesh for concrete reinforcement shall conform to the requirements of Section 9-07.7.

2. **Steel Reinforcement (Rebar):** Castings shall have 2 squares of steel reinforcing bars (rebar) placed around the casting at mid-depth of the concrete pavement slab as shown on Standard Plan no. 406. Rebar shall be size #5 and shall be tied at rebar intersection points as shown. No reinforcing steel shall be within 2½ - inches of any cement concrete pavement joints or surfaces. Rebars shall conform to the requirements of Section 9-07.2.

When any portion of castings is within 18 inches of a pavement joint see Standard Plans, Drawings, or contact the Engineer for addition installation details.

See Section 7-20.3(1)D for temporary transition tapers around exposed castings.

If reinforcement details are shown in the Drawings, those details shall be followed as described. Unless otherwise indicated, any wire mesh and rebar shown in these details shall meet the applicable requirements in methods 1 and 2, respectively.

#### **5-05.3(10) TIE BARS AND DOWEL BARS**

Unless otherwise indicated or directed by the Engineer, tie bars shall be placed at all longitudinal contraction and construction joints, in accordance with the requirements shown in the Standard Plan. In addition, tie bars shall be installed when concrete Shoulders are placed as a separate operation or when widening existing pavement. See 5-05.3(10)A for "New to Existing" joints tie bars and dowel use requirements.

Tie bars shall be placed at longitudinal construction joints between lanes in a manner that the individual bars are located at the required elevation and spaced as shown in the Standard Plan and in a manner that the vertical edge of the concrete is not deformed or otherwise damaged during placement of the bars.

Placement tolerances for tie bars shall be within 1-inch of the middle of the concrete slab, within 1-inch of being centered over the joint and placed parallel or perpendicular to centerline within 1-inch of the vertical and horizontal plane.

Unless otherwise indicated or directed by the Engineer, dowel bars will be required for the construction joint at the end of paving operations each day and they shall be placed in accordance with the Standard Plan. Unless otherwise indicated or directed by the Engineer, dowel bars shall be placed at all transverse contraction joints as shown in the Contract or in accordance with the Standard Plans. See 5-05.3(10)A for "New to Existing" joints tie bars and dowel use requirements. All dowel bars shall have a parting compound, such as curing compound, grease or other Engineer approved equal applied to them prior to placement. Wire baskets that remain in the pavement to hold the dowels shall be approved by the Engineer. Any dowel bar delivered to the project that displays rust/oxidation, pinholes, questionable blemishes, or deviates from the round shall be rejected.

The Contractor shall furnish a Manufacturer's Certificate of Compliance in accordance with Section 1-06.3, including mill test report verifying conformance to the requirements of Section 9-07.5 as well as written certification identifying the patching material, when applicable, used at cut dowel bar ends.

Only one type of dowel bars will be allowed per contract; intermixing of different dowel bar types will not be allowed.

Placement tolerances for dowel bars shall be within 1-inch of the middle of the concrete slab, within 1-inch of being centered over the transverse joint and parallel to centerline within 1/2-inch of the vertical and the horizontal plane.

Cutting of stiffeners within the dowel bar cage is not allowed.

**5-05.3(10)A "NEW TO EXISTING" JOINTS – TIE-BARS AND DOWELS**

Unless otherwise directed by the Engineer, when new concrete pavement is to be placed against existing cement concrete pavement, tie bars and dowel bars shall be drilled and grouted into the existing pavement with either Type I or IV epoxy resin as specified in Section 9-26.

Tie bars and dowels are not required:

1. when indicated on the drawing by "No Tie-Bars" or "No Dowel Bars"
2. when existing pavement is less than a thickness of 8 inches, or
3. when the Engineer determines the existing concrete to be incompetent.

The epoxy-bonding agent shall be either Type I or IV epoxy resin as specified in Section 9-26. The Contractor may use any method for drilling the holes, provided the method selected does not damage the existing concrete. Any damage caused by the Contractor's operations shall be repaired by the Contractor at no cost to the Owner in accordance with Section 1-07.13.

The tie bar holes shall be blown clean with compressed air before grouting. The bar shall be centered in the hole for the full length of embedment before grouting. The grout shall then be pumped into the hole around the bar in a manner that the back of the hole will be filled first. Blocking or shimming shall not impede the flow of the grout into the hole. Dams, if needed, shall be placed at the front of the holes to confine the grout. The dams shall permit the escape of air without leaking grout and shall not be removed until grout has cured in the hole.

**5-05.3(11) ROADWAY FINISHING**

After the concrete has been given a preliminary finish by means of finishing devices the surface of the fresh concrete shall be checked by the Contractor with a straightedge device not less than 10-feet in length. High areas indicated by the straightedge device shall be removed by the hand-float method. Each successive check with the straightedge device shall lap the previous check path by at least 1/2 of the length of the straightedge.

Any edge slump of the pavement, exclusive of specified edging, in excess of 1/4-inch shall be corrected before the concrete has hardened. If edge slump on any 1-foot or greater length of hardened concrete exceeds 1-inch, the concrete shall be repaired as provided in Section 5-05.3(22).

**5-05.3(11)A EDGING (NON-BASE ONLY)**

Before the final finishing is completed and before the concrete has taken the final set, the pavement shall be edged as indicated in the following table:

Location	Radius
Edge of Pavement	1/2-inch
Contraction Joints (non-sawed)	1/4-inch
Through or Construction Joints	1/2-inch

Particular attention shall be given to edge at the appropriate time. The concrete shall have attained a partial set and all free water shall have disappeared so that the edged joints are clearly defined with no tearing or slump of the edges.

**5-05.3(11)B ROADWAY SURFACE FINISHING (NON-BASE ONLY)**

**Rough Finish:** The pavement shall be given a final finish surface by texturing with a comb perpendicular to the centerline of the pavement. The comb shall produce striations approximately 1/8-inch to 3/16-inch in depth. Randomly space the striations from 1/2-inch to 1 1/4-inch. The comb shall be operated mechanically either singly or in gangs with several placed end to end. Finishing shall take place with the elements of the comb as nearly perpendicular to the concrete surface as is practical, to eliminate dragging the mortar. If the striation equipment has not been previously approved, a test section shall be constructed prior to approval of the equipment. If the pavement has a raised curb without a formed concrete gutter, the texturing shall end 2-feet from the curb line. This 2-foot untextured strip shall be hand finished.

**5-05.3(11)C ROADWAY BASE FINISHING (BASE ONLY)**

Roadway Cement Concrete Base is pavement that is intended as a base for an asphalt wearing course, the concrete shall be placed and screed to the finished grade and floated to a uniform surface. It shall be brushed transversely with a fiber or wire brush of a type approved by the Engineer. The brush finish should provide a texture finish throughout the pavement base surface. The surface tolerance shall be 3/8 inch in 10 feet.

**5-05.3(11)D UTILITY ADJUSTMENTS**

Utility castings shall be adjusted to roadway finished grade prior to the construction of the final wearing course. See Section 7-20.3(1) for adjustment tolerances of maintenance holes, catch basins, and similar structures; and, corrective action for non-compliance.

**5-05.3(12) ROADWAY SURFACE SMOOTHNESS**

Surface smoothness will be measured with a 10-foot straightedge no later than 5:00 p.m. of the Day following the placing of the concrete. A 10-foot straightedge will be placed as to bridge any depressions and touch all high spots. Surface variances (SV) are as follows:

- Roadway: 1/4-inch
- Alleys: 3/8-inch
- Cement Concrete Base: 3/8-inch

Should the surface vary more than the specified surface variance (SV) from the lower edge of the straightedge, the high portion shall be reduced by the Contractor to the specified surface variance (SV) tolerance by abrasive means at no expense to the Owner. It is further provided that if reduction of high portions of the surface involves breaking, dislodging, or other disturbance of the aggregates, such cutting will not be permitted until the pavement has achieved its design strength. If in the opinion of the Engineer irregularities cannot be satisfactorily removed by such methods, the Contractor shall remove and replace the pavement at no expense to the Owner.

Smoothness perpendicular to the centerline will be measured with a 10-foot straight edge across all lanes with the same cross slope, including shoulders when composed of cement concrete pavement. The overlapping 10-foot straight edge measurement shall be discontinued at the point 6-inches from the most extreme outside edge of the finished cement concrete pavement. The transverse slope of the finished pavement shall be uniform to a degree such that no variations greater than specified surface variance (SV) are present when tested with a 10-foot long straightedge laid in a direction perpendicular to the centerline. Any areas that are in excess of this specified tolerance shall be corrected by abrasive means.

Smoothness parallel to the centerline will be measured with a 10-foot straight edge across all lanes, including shoulders when composed of cement concrete pavement. The overlapping 10-foot straight edge measurement shall be discontinued at the point 6-inches from the beginning or ending of the finished cement concrete pavement, or any point of vertical grade change (vertical point of intersection VPI). The longitudinal slope of the finished pavement shall be uniform to a degree such that no variations greater than specified surface variance (SV) are present when tested with a 10-foot long straightedge laid in a direction parallel to the centerline after adjusting for any horizontal curvature (between vertical point of curvature VPC and vertical point of tangent VPT). Any areas that are in excess of this specified tolerance shall be corrected by abrasive means.

**5-05.3(13) CURING**

Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured in accordance with one of the following methods the Contractor may elect.

**5-05.3(13)A CURING COMPOUND**

Liquid membrane-forming concrete curing compound Type 2 meeting the requirements of Section 9-23.2 shall be applied to the entire area of the exposed surface of the concrete with an approved mechanical spray machine. The spray gun shall be protected from the wind with an adequate shield. It shall be applied uniformly at the rate of one gallon to not more than 150-square feet.

The compound shall be applied with equipment of the pressure tank or pump type equipped with a feed tank agitator which ensures continuous agitation of the compound during spraying operations. The nozzle shall be of the two-line type with sufficient air to properly atomize the compound.

The curing compound shall not be applied during or immediately after rainfall. If it becomes necessary to leave the pavement uncoated overnight, it shall be covered with polyethylene sheeting, which shall remain in place until weather conditions are favorable for the application of the curing compound.

In the event that rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or in the event of damage to the film from any cause, the Contractor shall apply a new coat of curing compound in one or two applications to the affected area at the rate which, in the opinion of the Engineer, will result in a film of curing value equal to that specified in the original coat.

Before placing the curing compound in the spray tank, it shall be thoroughly agitated as recommended by the Manufacturer. The compound shall not be diluted by the addition of solvents nor be altered in any manner. If the compound has become chilled to the extent that it is too viscous for proper stirring or application or if portions of the vehicle have been precipitated from solution, it shall be heated to restore proper fluidity but it shall not be heated above 100°F or manufacturer's recommendations. All curing compound shall have been accepted in accordance to Section 1-05.3 prior to placing in the spray tanks.

The curing compound shall be applied immediately after the concrete has been finished and after any bleed water that has collected on the surface has disappeared, or at a time designated by the Engineer. If hair checking develops in the pavement before finishing is completed, the Engineer may order the application of the curing compound at an earlier stage, in which event any concrete cut from the surface in finishing operations shall be removed entirely from the pavement. If additional mortar is then needed to fill torn areas, it shall be obtained ahead of the spraying operations. All areas cut by finishing tools subsequent to the application of the curing compound shall immediately be given new applications at the rate specified above.

The curing compound, after application, shall be protected by the Contractor from injury until the pavement has reached a minimum compressive strength of 3000-psi. All traffic, either by foot or otherwise, shall be considered as injurious to the film of the applied compound.

The Contractor shall provide on the job a sufficient quantity of white polyethylene sheeting to cover all the pavement laid in 3-hours of maximum operation. This sheeting shall be reserved exclusively for the protection of the pavement in case of rain or breakdown of the spray equipment used for applying the curing compound. The protective sheeting shall be placed over the pavement when ordered, and in the manner specified by the Engineer.

All liquid membrane-forming curing compounds shall be removed from the portland cement concrete pavement to which traffic delineators are to be bonded. Curing compound removal shall not be started until roadway pavement and driveways have attained a minimum compressive strength for traffic to be allowed on it, or for three (3) Days for non-roadway cement concrete other than driveways. The Contractor shall submit a proposed removal method to the Engineer and shall not begin the removal process until the Engineer has approved the removal method.

The Contractor shall assume all liabilities for and protect the Owner from any damages or claims arising from the use of materials or processes described herein.

#### **Alternate curing for cement concrete base:**

On cement concrete base emulsified asphalt CSS-1 or CRS-1 meeting the requirements of Section 9-02.1(6) applied at a rate between 0.15 gallon and 0.25 gallon per square yard of surface. The emulsified asphalt shall not be applied during or immediately after rainfall. If it becomes necessary to leave the pavement uncoated overnight, it shall be covered with polyethylene sheeting, which shall remain in place until weather conditions are favorable for the application of the emulsified asphalt.

In the event that rain falls on the newly coated pavement before the emulsified asphalt has dried sufficiently to resist damage, or in the event of damage to the emulsified asphalt from any cause, the Contractor shall apply a new coat of emulsified asphalt to the affected area at the rate which, in the opinion of the Engineer, will result in a film of curing value equal to that specified in the original coat.

#### **5-05.3(13)B WHITE POLYETHYLENE SHEETING**

The sheeting shall be placed over the pavement immediately after finishing operations are completed, or at a time designated by the Engineer.

The sheeting shall be laid so that individual sheets overlap at least 2-feet, and the lapped areas shall be held in close contact with the pavement by weighting with sand bags or boards to prevent movement by the wind. The sheeting shall extend downward to cover the edges of the pavement and shall be secured to the Subgrade with sand bags or boards or a continuous bank of base material. Any holes occurring in the sheeting shall be patched immediately to the satisfaction of the Engineer. The sheeting shall be maintained against injury and remain in place until the roadway pavement and driveways have attained a minimum compressive strength for traffic to be allowed on it, or for three (3) Days for non-roadway cement concrete other than driveways.

**5-05.3(13)C WET CURING**

Wet curing shall be accomplished by applying a continuous fog or mist spray to the entire pavement surface until the roadway pavement and driveways have attained minimum compressive strength, or for three (3) Days for non-roadway cement concrete other than driveways. If minimum compressive strength for traffic to be allowed is reached prior, a curing compound shall be applied in accordance Section 5-05.3(13)A before opening to traffic.

If water runoff is not a concern, continuous sprinkling is acceptable. Sprinkling shall not begin until the concrete has achieved initial set as determined by AASHTO T 197 or other approved method.

**5-05.3(14) COLD WEATHER WORK**

When concrete is being placed and the ambient air temperature is expected to drop below 35° F (2° C) during the day or night, the Contractor shall protect the concrete from freezing. The Contractor shall provide a Cold Weather Plan prior to placing concrete when ambient air temperature below 35° F may occur or when requested by the Engineer.

Under the Cold Weather Plan, the Contractor shall, at no expense to the Owner, provide a sufficient supply of straw, hay, blankets, or other suitable blanketing material and spread it over the pavement to a sufficient depth to prevent freezing of the concrete. Straw, hay, blankets, or other suitable blanketing material shall be spread over the pavement to a sufficient depth to keep the concrete from freezing. The blanket material shall be covered with a layer of burlap or plastic sheeting, weighted or anchored to prevent the wind from displacing the insulation. The Engineer may require recording thermometers if daytime temperature is below 35°.

The protection shall be maintained for 10 Days or until opening strength is obtained, whichever occurs first. The Contractor shall replace any concrete damaged by freezing at no additional cost to the Owner.

The Contractor shall be responsible for the quality and strength of the concrete thus cured. Any concrete injured by frost action or freezing shall be removed and replaced at the Contractor's expense in accordance with this Section.

**5-05.3(15) CONCRETE PAVEMENT CONSTRUCTION IN ADJACENT ROADWAY LANES**

Unless otherwise shown in the Drawings or in the Contract, the pavement may be constructed in multiple lanes; that is, 2 or more adjacent lanes paved in a single operation. Longitudinal contraction joints shall be used between adjacent lanes that are paved concurrently and construction joints shall be used when lanes are paved separately. Tie bars shall be installed during initial lane construction.

The Contractor shall replace, at no expense to the Owner, any panels on the new pavement that are cracked or broken as a result of the Contractor's operations.

**5-05.3(16) PROTECTION OF ROADWAY CEMENT CONCRETE.**

The Contractor shall protect the pavement and its appurtenances from any damage. Protection shall include personnel to direct traffic and the erection and maintenance of warning signs, lights, barricades, temporary take-down bridges across the pavement with adequate approaches, and whatever other means may be necessary to accommodate local traffic and to protect the pavement during the curing period or until opened to traffic as determined by the Engineer.

The operation of construction equipment on the new roadway pavement will not be allowed until the pavement has developed a compressive strength of 3000-psi as determined from cylinders, made at the time of placement, cured under comparable conditions, and tested in accordance with AASHTO T 22, or by maturity meter for high-early-strength ("HES") cement concrete. Exceptions would be one track from a slip form-paving machine when paving adjacent lanes or light vehicles required for sawing operations or taking cores.

Placement of Shoulder material may commence when the pavement has developed a compressive strength of 1800-psi as determined from cylinders made at the time of placement, cured under comparable conditions, and tested in accordance with AASHTO T 22 as long as construction equipment is not operated on the new pavement.

If shown in the Drawings, a continuous barrier of the design shall be constructed and maintained along the edge of the pavement being constructed and adjacent to the portion of the Roadway used for traffic. The barriers shall be left in place until the new pavement is ready to be opened to traffic and shall then be removed by the Contractor. If not shown, see requirements of Section 1-10 for traffic control requirement.

Any damage to the pavement occurring prior to final acceptance shall be replaced or repaired in accordance with Section 5-05.3(22).

**5-05.3(17) OPENING TO VEHICLE TRAFFIC**

The pavement may be opened to traffic when the concrete has developed a compressive strength of 3000-psi (2500-psi for residential driveways) as determined from cylinders, made at the time of placement, cured under comparable conditions, and tested in accordance with AASHTO T 22, or by maturity meter. Maturity meters testing is at the option of the Engineer and require the Contractor to develop the maturity-strength relationship and provide maturity curves along with supporting data for approval by the Engineer. The submittal of maturity curves is required for all "HES" cement concrete and at the option of the Contractor for other mixes. The Contractor shall provide and maintain maturity meter sensors. Sensors shall be as approved by the Engineer.

Fabrication, curing, and testing of cylinders to measure early strength shall be the responsibility of the Contractor. The Contractor shall obtain the services of an independent Laboratory to perform these activities and these laboratories shall be approved by the Engineer. However, at the Engineer's option, fabrication, curing, and testing of cylinders may be performed by the Engineer. If the Engineer agrees to perform testing, the requirements for the Contractor to do so are waived.

At the Contractor's request, or when desired by the Engineer, time for opening pavement may be determined by the Engineer through the use of the maturity test in accordance with ASTM C 1074. The pavement shall not be opened to traffic until the maturity-strength relationship shows the roadway pavement has a compressive strength of 3000-psi (2500-psi for residential driveways) as determined by the Engineer.

If the Contractor's test results conflict with the Owner's the Owner's testing.

The pavement shall be cleaned prior to opening to traffic.

All costs associated with specified above shall be at the Contractor's expense.

**5-05.3(18) RESERVED**

**5-05.3(19) PRE-PAVING MEETING**

The Contractor shall coordinate with the Engineer to have a pre-paving meeting at least five (5) Working Days before the first paving operation. The Contractor shall be prepared to discuss operations as they relate to other entities and the public's safety and convenience, including driveway and business access, garbage truck operations, Metro transit operations and working around energized overhead wires, school and nursing home and hospital and other accesses, other contractors who may be operating in the area, pedestrian and bicycle traffic, emergency services, and as may be applicable. The Contractor shall be prepared to discuss the placement and finishing methods, reinforcement placement, joint placement, and the curing methods for all classes and subclasses (variable mixes) of cement concrete to be used.

**5-05.3(20) RESERVED**

**5-05.3(21) RESERVED**

**5-05.3(22) REPAIR OF DEFECTIVE ROADWAY PAVEMENT SLABS**

Broken slabs, slabs with random cracks, nonworking contraction joints near cracks, edge slumping and spalls along joints and cracks shall be replaced or repaired as specified at no expense to the Owner, and shall be accomplished prior to completion of joint sealing.

New pavement slabs containing more than one crack shall be entirely removed and replaced. Pavement slabs containing a single crack shall be removed and replaced such that the minimum dimension of the removed slab is 6-feet long and full panel width. The portion of the panel to remain in place shall have a minimum dimension of 6-feet in length and full panel width, otherwise entire removal and replacement of the slab is required. There shall be no new joints closer than 6-feet to an existing transverse joint. Saw cutting full pavement depth is required along all longitudinal joints and at transverse locations. Tie bars and dowel bars shall be used in accordance Section 5-05.3(10). Existing pavement slabs containing one or more cracks shall be entirely removed and replaced.

Spalls and edge slumping shall be repaired by making vertical saw cuts at least 3-inches outside the affected area and to a minimum depth of 2-inches. Spall repairs that encounter dowel bars or are within 6-inches of a dowel bar will not be permitted. These spall areas shall be repaired by replacing a half or full panel as permitted by the Engineer. Removal of the existing pavement shall not damage any pavement to be left in place. If jackhammers are used for removing pavement, they shall not weigh more than 30-pounds, and chipping hammers shall not weigh more than 15-pounds. All power driven hand tools used for the removal of pavement shall be operated at angles less than 45-degrees as measured from the surface of the pavement to the tool. The patch limits shall extend beyond the spalled area a minimum of 3-inches. Repair areas shall be kept square or rectangular. Repair areas that are within 12-inches of another repair area shall be combined.

The Contractor shall remove material within the perimeter of the saw cut to the greater of a depth of 2-inches, or sound concrete as determined by the Engineer. The surface patch area shall be sandblasted and all loose material removed. All sandblasting residue shall be removed using dry oil-free air.

When a partial depth repair is placed directly against an adjacent longitudinal joint, a bond-breaking material such as polyethylene film, roofing paper, or other material as approved by the Engineer shall be placed between the existing concrete and the area to be patched.

Patches that abut working transverse joints or cracks require placement of a compressible insert. The new joint or crack shall be formed to the same width as the existing joint or crack. The compressible joint material shall be placed into the existing joint 1-inch below the depth of repair. The compressible insert shall extend at least 3-inches beyond each end of the patch boundaries.

Patches that abut the lane/shoulder joint require placement of a formed edge, along the slab edge, even with the surface.

The patching material shall be mixed, placed, consolidated, finished, and cured according to manufacturer's recommendations. Slab/patch interfaces that will not receive pavement grinding shall be sealed (painted) with a 1:1 cement-water grout along the patch perimeter.



The Contractor shall reseal all joints in accordance with Section 5-05.3(8)B.

Opening to traffic shall meet the requirements of Section 5-05.3(17).

Low areas where grinding cannot feasibly remedy, shall be sandblasted, filled with epoxy bonded mortar, and textured by grinding. The epoxy bonding agent shall meet the requirements of Section 9-26.1(1)B for Type II epoxy.

**5-05.3(23) RESERVED**

**5-05.3(24) RESERVED**

**5-05.3(25) RESERVED**

**5-05.3(26) RESERVED**

**5-05.3(27) RESERVED**

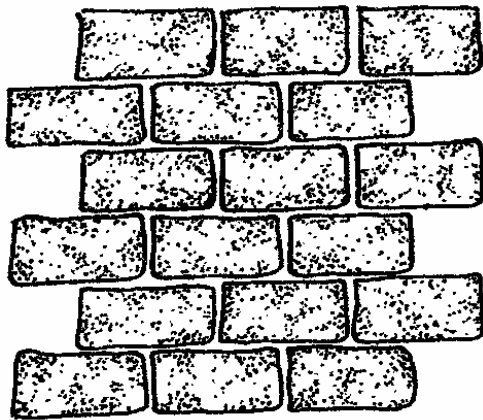
**5-05.3(28) RESERVED**

**5-05.3(29) PATTERNED AND COLORED CEMENT CONCRETE TREATMENT**

Use colored and/or imprinted concrete, including color matching joint material, when specified.

**Patterned Cement Concrete Treatment:**

Patterned cement concrete is defined as additional work necessary to imprint cement concrete with a pattern, and is referenced by "Patterned" and "Running Bond Used Brick" or (other pattern) in the Bid item description and call-outs for locations on the Drawings. Other patterns may be shown in on the Drawings or on Drawing Details in the Appendix of the Contract. The Contractor shall refer to the sketch on the left for "Running Bond Used Brick" pattern details. Nominal size for a typical brick shall be 8 inches long by 4 inches wide. The long edge of brick shall be laid perpendicular to the crosswalk.



The Contractor shall use the "running bond used brick" pattern for crosswalks or at other locations when shown in the Drawings.

Other cement concrete surface treatment patterns shall be at locations, alignments, and of detailed in the Drawings or Drawing Details.

The Contractor shall submit technical data and manufacturer's Specifications for patterned concrete components and a proposed plan for mixing, delivery, placement, finishing, and curing of the patterned concrete. This plan shall be submitted to the Engineer for approval at least 10 Working Days prior to constructing the test panel.

The Contractor shall monitor the water content, weight of cementitious materials, and size, weight, and color of aggregate to maintain consistency and accuracy of the mixed concrete. The Contractor shall schedule delivery of concrete to provide consistent mix times from batching until discharge. No water shall be added after a portion of the batch has been discharged.

Use imprinting tools capable of imprinting the surface of the concrete with a uniform and aligned pattern and/or texture. Use a clear release agent as specified by the imprinting tool manufacturer. These materials shall be approved by the Engineer prior to their use.

Unless approved manufacturer's recommendations differ:

1. The Contractor shall screed concrete to the finished grade and apply release agent. Using methods as recommended by the manufacturer, apply pre-approved imprinting tools to the surface while the concrete is still plastic. Do not lightly broom surface.
2. For sidewalks, unless otherwise specified, score or saw cut the surface to a minimum depth of  $\frac{1}{4}$  the thickness of the slab at intervals of 5 feet. Tool the edges, joints and scored areas in a manner consistent with the imprinting pattern. If the saw cut option is used, the Contractor shall be responsible for performing the saw cut operation at such time as to minimize the possibility of spalling and/or cracking.
3. Within 24 hours, remove release agent with pressure wash and apply a pre-approved sealer, recommended by the coloring manufacturer, at a rate consistent with manufacturer's recommendations.

**Colored Cement Concrete Treatment:**

Colored cement concrete is defined as additional work necessary to color cement concrete with a color, and is referenced by "Colored" and a Federal Standard 595B "F (color code)" in the Bid item description and call-outs for locations on the Drawings.

All coloring agents shall produce a color conforming to the Federal Standard 595B. The color shall be as indicated in the Contract. Color pigments shall be of high quality iron oxides conforming to ASTM C 979. The dosage shall not exceed 10 percent by weight of cementitious material in the concrete mix design. Color admixtures for integrally colored concrete shall be

certified by the manufacturer as meeting the requirements of ASTM C 979 - *Pigments for Integrally Colored Concrete* and shall be packaged such that one dose is the proper dosage for one cubic yard of concrete.

The Contractor shall submit technical data and manufacturer's Specifications for colored concrete components and a proposed plan for mixing, delivery, placement, finishing, and curing of the colored concrete. This plan shall be submitted to the Engineer for approval at least 10 Working Days prior to constructing the test panel.

The Contractor shall monitor the water content, weight of cementitious materials, and size, weight, and color of aggregate to maintain consistency and accuracy of the mixed colored concrete. The Contractor shall schedule delivery of concrete to provide consistent mix times from batching until discharge. No water shall be added after a portion of the batch has been discharged.

When more than one concrete pump is used to place concrete, the Contractor shall designate the pumps to receive colored concrete. The designated pumps shall receive only colored concrete throughout the concrete placement operation.

Consistent finishing practices shall be used to ensure uniformity of texture and color.

The curing compound used for curing colored concrete surfaces shall be clear or match the color of the colored concrete and shall be manufactured specifically for colored concrete. Curing compounds containing calcium chloride shall not be used. The time between completing surface finishing and applying curing compound shall be the same for each colored concrete component.

Unless approved manufacturer's recommendations differ:

1. Apply color admixtures and dry shake additives at the manufacturers recommended dosage rate. This rate is to remain constant for all batches of concrete produced. Prior to placing concrete, protect adjacent surfaces and structures from spatters. Once a portion of the batch has been placed, no additional water shall be added to the remaining batch.
2. To integrally color the concrete, introduce the color additive into the mixer drum in a manner recommended by the manufacturer. The quantity of concrete being delivered shall be no less than one-third the capacity of the mixer drum. Batch the concrete in full cubic yard increments.
3. After the concrete is placed, apply a color matching hardener evenly to the plastic surface by the "dry shake" method as recommended by the manufacturer.

#### **Color Matching Joint Material:**

When specified for any location, use a color matched caulking compound designed for joint sealing.

Install pre-molded resilient joint filler where the sidewalk line intersects a building, walk, permanent structure or other location designated by the Engineer, to within 1-inch of the top of the slab. Caulk the top 1-inch of the joint with color matching caulking compound.

#### **Test Panels:**

Prior to the start of work, the Contractor shall show evidence of successful completion of similar installations. The Contractor shall construct a job site test panel for each individual color and pattern or combination of color and pattern specified in the Contract at least 10 Working Days before placing patterned and/or colored concrete. The test panel(s) shall be 5 feet x 5 feet, minimum, and constructed at a location selected by the Engineer.

As many test panels will be constructed as are necessary to produce sample panels that meet the approval of the Engineer. The permanent work shall be consistent with the appearance of the approved test panel(s) as determined by the Engineer. The test panel(s) shall not be incorporated into the work and shall be disposed of in conformance with the Contract when ordered by the Engineer.

The test panel approved by the Engineer shall be used as the standard of comparison in determining acceptability of concrete surfaces.

#### **5-05.3(30) EXPOSED AGGREGATE CEMENT CONCRETE TREATMENT**

Using exposed aggregate concrete when specified. Exposed aggregate finish on concrete surfaces shall conform to the details shown on the Drawings and the cement concrete requirements of the referencing Specification Section and either Section 5-05 for flat work and Section 6-02 for structures.

Exposed aggregate cement concrete is defined as additional work necessary to expose aggregate on the surface of cement concrete.

Exposed aggregate is an architectural finish on concrete surfaces, it shall not be used on new sidewalks, walkways, or any pedestrian access unless otherwise approved by SDOT. It may be used for repair of existing exposed aggregate concrete sidewalks only. It may be used for vertical or sloped features and within architectural landscaping such as within traffic inlands.

**Exposed Aggregate Finish:**

Exposed aggregate architectural finish on concrete surfaces shall conform to the details shown on the Drawings and the following provisions.

- If provided, the exposed aggregate finish shall match the texture, color, and pattern of the referee panel or existing exposed aggregate surface. If provided, location of referee panel will be provided in the Contract documents
- If provided, facing aggregate shall match the variegated colors and color distribution found in the natural aggregates location provided in the Contract documents
- If cement concrete for exposed aggregate is to be colored, see Section 5-05.3(29).

**Cast-in-place Concrete Surfaces;** unless otherwise specified in the Contract:

Coarse aggregate for exposed aggregate finish for cast-in-place concrete surfaces shall be river gravel, exclusive of crushed gravel and rock, conforming to the applicable course aggregate requirements of the cement concrete specified. The matrix of cement and fine aggregate shall be removed from the surface of the concrete by water jetting, coarse brooming, abrasive blasting, or a combination of these procedures to expose coarse aggregates to a depth of approximately 1/4 inch to 1/2 inch from the formed or floated surface. Removal methods shall not dislodge or loosen the coarse aggregate from embedment in the concrete matrix. At the option of the Contractor, a commercial quality, water-resistant set retarder manufactured for the intended use may be used. Exposed aggregate finish shall have cement film, discoloring agents, dirt, dust, grease, loose concrete, and other foreign material removed and shall be uniform in appearance.

**Precast Concrete Surfaces;** unless otherwise specified in the Contract:

Facing aggregate for exposed aggregate finish for precast concrete surfaces shall be river gravel, exclusive of crushed gravel and rock, with maximum dimension of each rock between 2.5 inches and 5 inches. Precast panels may be cast with facing aggregate up or down on the casting bed, at the option of the Contractor. The aggregate facing mix shall be separately prepared, applied to the form or fresh concrete, and its integrity maintained during the casting process, so that the facing shall be cast integrally with the concrete wall panel, and the entire panel is homogeneous and structurally monolithic. The facing rock shall be placed finger width apart in a pattern of randomly distributed colors and sizes. Matrix shall be removed from the front face of the panel to expose the facing aggregate to a depth of one inch to 1-1/2 inches. Exposed aggregate finish shall have cement film, discoloring agents, dirt, dust, grease, loose concrete, and other foreign material removed and shall be uniform in appearance.

Cast-in-place concrete surfaces with finish shall be cured by the water method. Seals and curing compounds shall not be used.

**Test Panels:**

Prior to the start of work, the Contractor shall show evidence of successful completion of similar installations. The Contractor shall construct a job site test panel for each individual exposed aggregate surface specified in the Contract at least 10 Working Days before placing exposed aggregate (and colored if applicable) concrete. The test panel(s) shall be 5 feet x 5 feet, minimum, and constructed at a location selected by the Engineer.

As many test panels will be constructed as are necessary to produce sample panels that meet the approval of the Engineer. The permanent work shall be consistent with the appearance of the approved test panel(s) as determined by the Engineer. The test panel(s) shall not be incorporated into the work and shall be disposed of in conformance with the Contract when ordered by the Engineer.

The test panel approved by the Engineer shall be used as the standard of comparison in determining acceptability of concrete surfaces.

**5-05.4 MEASUREMENT**

Roadway Cement Concrete (surface and base) will be measured by the square yard for the completed pavement. The area will be determined from measurements taken as listed below.

1. The width measurement will be the width of the pavement shown on the typical cross-section in the Standard Plans or Drawings, additional widening where called for, or as otherwise specified in writing by the Engineer.
2. The length will be measured along the center of each Roadway or ramp.

If Bid item is included in the Bid form, dowel bar will be measured per each for the actual number of bars used in the completed Work, else no measurement will be made.

If Bid item is included in the Bid form, Tie bar with drill hole will be measured per each for the actual number of bars used in the completed Work, else no measurement will be made.

The calculation for portland or hydraulic cement concrete compliance adjustment is the area of concrete represented by the Composite Pay Factor (CPF) for compressive strength and air content. A Deficiency Adjustment is applied independently for thickness deficiency adjustment.

Measurement for "Portland Cement Reduction Incentive/Disincentive Adjustment - Roadway" will be calculated based on the in-place quantity of all sidewalk, curb, driveway, alley, and roadway concrete. Depth will be determined by the specified thickness and shall exclude thickened edges. Measurements will only be made when this Bid item is included in the Bid Form.

Measurement for "Patterned Cement Concrete, (pattern)" will be by the square yard of area where imprinting tools is applied.

#### 5-05.5 PAYMENT

Payment will be made in accordance with Section 1-04.1, for each of the following Bid items that are included in the Proposal:

1. "Roadway Cement Concrete, Variable Mixes, (thickness)", per square yard.
2. "Roadway Cement Concrete, HES (time), (thickness)", per square yard.
3. "Roadway Cement Concrete, (thickness)", per square yard.
4. "Roadway Cement Concrete, W/25% pozzolans, (thickness)", per square yard.
5. "Roadway Cement Concrete Base, Variable Mixes, (thickness)", per square yard.
6. "Roadway Cement Concrete Base, HES (time), (thickness)", per square yard.
7. "Roadway Cement Concrete Base, (thickness)", per square yard.
8. "Roadway Cement Concrete Base, W/25% pozzolans, (thickness)", per square yard.

The unit Contract price per square yard for "Roadway Cement Concrete" shall be full compensation for all costs incurred to carry out the requirements of Section 5-05, except for those costs included in other items, which are included in this subsection and are included in the Proposal. If no Bid items for "Dowel Bar" and "Tie Bar with Drill Hole" are included in the Bid form; this work shall be included in the unit Contract price per square yard for "Roadway Cement Concrete"

9. "Dowel Bar", per each,

The unit Contract price per each for "Dowel Bar" shall be full payment for furnishing, and installing dowel bars and any costs for drilling holes, placing dowel bars with baskets, furnishing and installing parting compound and all other costs associated with completing the installation of dowel bars.

10. "Tie Bar with Drill Hole", per each.

The unit Contract price per each, "Tie Bar with Drill Hole" shall be full payment for furnishing, and installing tie bars and any costs for drilling holes, and all other costs associated with installation of tie bars.

11. "Cement Concrete Compliance Adjustment", by calculation.

Payment for "Cement Concrete Compliance Adjustment" will be calculated by multiplying the unit Contract unit cost for the cement concrete Bid Item(s), times the areas for adjustment, times (100% less the percent of the Composite Pay Factor (CPF)), and subtract the Contract unit cost for the cement concrete, times the areas for adjustment, times the Deficiency Adjustment Factor (DAF) listed in Section 5-05.5(1)A. Both of these adjustments will be negative amounts; thus deductions.

$$\text{Adjustment} = \text{Unit Price} \times \text{quantity area}^1 \times (\text{CPF} - 1) + \text{Unit Price} \times \text{quantity area}^2 \times \text{DAF}$$

Calculate for each area<sup>1</sup> (lot, subplot not included in a lot, and/or other areas as determined by the Engineer), and for each area<sup>2</sup> (primary units or secondary units as determined by the Engineer) where a thickness deficiency exist.

12. **Reserved**

13. "Patterned Cement Concrete Treatment, Roadway, (pattern)", per square yard.

The Bid item price for "Patterned Cement Concrete" shall include all costs for additional work as described in Section 5-05.3(29) and necessary to imprint cement concrete with a pattern referenced in the Bid item description.

#### Miscellaneous items:

All mix designs, submittals, plans, joints filling and saw cutting, cure boxes, curing, protection, and associated labor, materials, and equipment are included in associated Bid items of work.

The cost of construction and removal of the test panel(s) is to be included in the price bid for the specified exposed aggregate, colored and/or imprinted cement concrete Bid item(s).

#### 5-05.5(1) PAVEMENT THICKNESS

Cement concrete pavement shall be constructed in accordance with the thickness requirements in the Drawings and Specifications. Tolerances allowed for Subgrade construction and other Specifications, which may affect thickness, shall not be construed to modify such thickness requirements.

A primary unit of pavement is defined as the area of pavement placed in each Day's paving operations or a complete intersection. Within such primary unit of pavement, there may be an area or areas, which are deficient in thickness by more than 0.60-inch. This deficient area or areas will be defined as a secondary unit or units. If secondary units are found to exist, the primary unit area will be reduced by the secondary unit area included therein. At a time determined by the Engineer, thickness measurements will be made in each primary unit of pavement. Impact-echo tests or cores will be taken at the discretion of the Engineer. If taken, the exact location and number of thickness measurements within each primary unit, both longitudinally and transversely, will be determined by the Engineer. Tests will not be taken within 18 inches of joints.

If thickness deficiencies greater than 0.60-inch are found to exist, supplemental thickness measurements will be made in accordance with Section 5-05.5(1)B. Pavement thickness variations, if any, from the thickness requirements in the Drawings and Specifications will be determined by comparing the actual thickness measurement with the thickness specified at the location where the measurement was made. Such variation will be determined to the nearest 0.02-inch as either excess or deficient thickness.

Additional impact-echo tests or cores may be requested by the Contractor to isolate the area that has a thickness deficiency. These impact-echo tests or cores will be used to create a secondary unit. All costs for the additional impact-echo tests or cores including grouting the core holes will be the responsibility of the Contractor.

If no impact-echo tests or core at taken by the Engineer for a primary unit, no "Deficiency Adjustment" will be made for that primary unit.

#### **5-05.5(1)A THICKNESS DEFICIENCY ADJUSTMENT**

If no thickness measurements in a primary unit are deficient by more than 0.60-inch plus 3% of the specified thickness when measured using the Impact-Echo Method in accordance with ASTM C-1383, or 0.60-inch when measured using the cores in accordance with AASHTO T 24 and AASHTO T 22, all thickness measurements in the primary unit will be averaged to the nearest 0.02-inch to determine the average thickness deficiency, if any. For the purpose of determining the average thickness deficiency, an excess thickness variation of more than 0.50-inch will be considered to be 0.50-inch greater than the specified thickness.

For each primary unit of pavement which is deficient in average thickness by not more than 0.60-inch plus 3% of the specified thickness when measured using the Impact-Echo Method, or 0.60-inch when measured using the cores, the Contractor shall pay to the Owner, or the Owner may deduct from any moneys due or that may become due the Contractor under the Contract, a sum computed by multiplying the deficiency adjustment from the following table by the unit Contract price by the area of the primary unit.

Primary unit for thickness measurements are independent of lot, sublots, or representative areas for compressive strength and air measurement. Determination of primary units, and secondary units, will be as determined by the Engineer.

<b>Average Thickness Deficiency (in) by Echo</b>	<b>Average Thickness Deficiency (in) by Core</b>	<b>Deficiency Adjustment (per square yard)</b>
$\leq 0.10 + (.03 \times D)$	$\leq 0.10$	-0.02
$> 0.10 + (.03 \times D) \ \& \ \leq 0.20 + (.03 \times D)$	$> 0.10 \ \& \ \leq 0.20$	-0.04
$> 0.20 + (.03 \times D) \ \& \ \leq 0.30 + (.03 \times D)$	$> 20.0 \ \& \ \leq 0.30$	-0.09
$> 0.30 + (.03 \times D) \ \& \ \leq 0.40 + (.03 \times D)$	$> 30.0 \ \& \ \leq 0.40$	-0.16
$> 0.40 + (.03 \times D) \ \& \ \leq 0.50 + (.03 \times D)$	$> 40.0 \ \& \ \leq 0.50$	-0.25
$> 0.50 + (.03 \times D) \ \& \ \leq 0.60 + (.03 \times D)$	$> 50.0 \ \& \ \leq 0.60$	-0.36

D = specified thickness (in)

#### **5-05.5(1)B THICKNESS DEFICIENCY REJECTION**

When a thickness deficiency greater than 0.06-inch is encountered, the Engineer will determine from supplemental thickness measurements the limits of the secondary unit area. Thickness measurements will be made in each panel of pavement adjacent transversely and longitudinally to the panel of the original measurement. This procedure will continue, regardless of unit boundaries, until such secondary unit area is bounded by panels with a thickness deficiency of 0.60-inch or less. Cores taken to isolate the secondary unit will not be used to compute average thickness of the primary unit.

Panels are the areas bounded by longitudinal and transverse joints and pavement edges. If longitudinal or transverse joints are eliminated by the Contract, or for any other reasons, the limits of panels will be determined by the Engineer as if such joints had been constructed.

The secondary unit area will be made up of entire panels only. The entire panel will be considered to be of the thickness shown by measurement.

After the Engineer has determined the limits of the secondary unit area, a further determination will be made whether any panels within this area are usable and may be left in place. Following this determination, the Contractor shall remove and replace at no expense to the Owner such panels as the Engineer may designate in accordance with the following:

If the area to be removed is not bounded by longitudinal or transverse joints, the Contractor shall saw, at no expense to the Owner, weakened plane joints at the locations designated by the Engineer. The Subgrade shall be lowered to meet the full thickness requirements. The replaced pavement will be tested for thickness by means of additional measurements and will be subject to all of the requirements of this Section.

Usable panels may be removed and replaced as outlined above at the option of the Contractor, or these panels will be permitted to remain in place, provided that no payment will be made for any panels which are left in place, and that a further penalty will be assessed in the amount of 25-percent of the Contractor's unit Bid price for all such panels. The Owner may deduct such amount from any moneys due or that may become due the Contractor under the Contract.

The cost of all thickness measurements made to determine the secondary unit areas, including filling the core holes with concrete, will be deducted at the rate of \$200.00 per core from any moneys due or that may become due the Contractor under the Contract.

All additional Work required and any delay to the Contractor's operations as a result of this Specification shall not be cause for additional pay or extension of time.

## **SECTION 5-06 PERVIOUS CEMENT CONCRETE SIDEWALK**

### **5-06.1 DESCRIPTION**

Section 5-06 describes work consisting of constructing pervious cementitious sidewalk and walkway applications including excavation, subgrade preparation, geotextile, and aggregate discharge subbase, that shall allow surface water to permeate through the pervious surface into the supporting materials to allow infiltration or detention of surface waters.

### **5-06.2 MATERIALS**

Materials shall meet the requirements of the following Sections:

Portland Cement and Blended Hydraulic Cement	9-01
Fine Aggregate for Portland Cement Concrete	9-03.1(2)
Aggregates for Pervious Pavements	9-03.1(5)
Crushed Gravel (Mineral Aggregate)	9-03.11
Premolded Joint Filler for Through, Construction and Expansion Joints	9-04.1(2)
Curing Materials and Admixtures	9-23
Water	9-25
Construction Geotextiles	9-37

Portland cement shall be Type II, Type IP, or Type IS.. Blended hydraulic cement shall conform to the requirements of Section 9-01.2(4).

Allowable Pozzolans:

1. Fly ash, if used, shall be Class F as specified in Section 9-23.9.
2. Ground granulated blast furnace slag, if used, shall be as specified in Section 9-23.10.
3. Microsilica fume shall not be allowed.

See Sections 9-01 and 9-23 for additional constraints.

Fine aggregate for pervious concrete shall be Class 1 as specified in Section 9-03.1(2).

Coarse aggregates for pervious concrete shall conform to the requirements of Section 9-03.1(3).

Unless otherwise specified or shown on the Drawings, aggregates for the discharge subbase gravel shall meet the requirements of Mineral Aggregate Type 24 per 9-03 or substitute material approved by the Engineer. Aggregates for the discharge subbase gravel shall meet the requirements of Mineral Aggregate Type 24 per 9-03 or substitute material approved by the Engineer.

Premolded joint filler for isolation joints shall conform to the requirements of Section 9-04.1(2).

Curing materials shall be sheet materials as specified in Section 9-23.1.

Hydration stabilizing admixtures shall meet the requirements of ASTM C494, Type B or Type D.

Microfibers shall conform to the requirements of ASTM C 1116, Type III and shall be ½ inch in length.

Unless otherwise specified or shown on the Drawings, geotextile shall be nonwoven and shall meet the requirements of Tables 1 and 2 of Section 9-37.2 for Moderate Survivability and Class C.

### **5-06.3 CONSTRUCTION REQUIREMENTS**

#### **5-06.3(1) PERVIOUS CONCRETE MIX DESIGN**

The Contractor shall propose a mix design for pervious concrete and shall submit the mix design to the Engineer for acceptance prior to constructing the test panels. Pervious concrete shall not be placed in the test panels without a mix design that has been reviewed and accepted by the Engineer.

##### **5-06.3(1)A MIX DESIGN CRITERIA**

The Contractor shall include the following elements and results of the described procedures in the proposed mix design:

1. The cementitious content, including pozzolans if used, shall be a minimum of 500 pounds per cubic yard.
2. The mix shall incorporate a hydration stabilizing admixture.
3. The mix shall incorporate ½ inch microfibers at a rate of 1.5 pounds per cubic yard.
4. The mix shall be designed to have a total void content greater than 15 percent and less than 30 percent, in place, as constructed. (Void content of the mix will be determined from a minimum three (3) samples of four (4) inch diameter core samples from a finished test panels of the proposed mix design using the following method; see Section 5-06 .3(4) A1.)
5. The water / cement ratio shall be between 0.27 and 0.35.
6. Fine aggregate may be added to the mix, but shall not exceed three (3) cubic feet per cubic yard.
7. No more than 25 percent of portland cement in the mix, by weight, may be replaced by fly ash, ground granulated blast furnace slag, or a combination of both.

##### **5-06.3(1)B JOB MIX FORMULA (JMF)**

Once accepted by the Engineer, the mix design shall become the Job Mix Formula (JMF) and shall not be modified in any way. The JMF shall be determined from information submitted under Section 5-06.3(2) and from results of test panels testing as described in Section 5-06.3(7)B. The JMF shall include the following:

1. Batch weights of all constituents.
2. Portland cement type and brand.
3. Pozzolan type and source.
4. Microfiber brand.
5. Admixture type and brand.
6. Aggregate source(s) and gradation(s).
7. Fresh density of the pervious concrete.
8. Unit weight of the hardened pervious concrete.

Modifications to the JMF will not be allowed and any modified mix placed in the Work will be rejected. Proposed modifications to the JMF shall be submitted as a new mix design and shall require a new test panels to validate the proposed mix design and determine the new JMF. If accepted by the Engineer, the new mix design shall become the JMF. Only one (1) JMF shall be valid at any time. Admixture dosages may be modified as needed to maintain mix properties.

##### **5-06.3(2) SUBMITTALS**

In accordance to Section 1-05.3, the Contractor shall submit the following items to the Engineer for acceptance prior to placing any pervious concrete pavement or test panels:

1. The source of all materials proposed for use in constructing pervious concrete sidewalks.
2. Batch weights for all constituents of one (1) cubic yard of the proposed pervious concrete mix.
3. The specific gravity (SSD) of all aggregates to be used in the proposed pervious concrete mix.

4. The proposed gradation of coarse and fine (if used) aggregates used in pervious concrete.
5. The designed volume in cubic feet of 1(one) cubic yard of the proposed pervious concrete mix.
6. The target voids content of the cured proposed cured pervious concrete mix.
7. The design water / cement ratio of the proposed mix design.
8. The fresh density of the proposed pervious concrete mixture as determined using the jigging procedure outlined in ASTM C29.
9. The proposed gradation of aggregates to be used in the discharge subbase gravel.
10. Catalogue cuts for all proposed admixtures and geotextiles.
11. Chemical analyses of the portland cement and pozzolans, if used, for the current lot to be used in the production of the proposed pervious concrete mix. The Contractor shall maintain this submittal throughout the duration of the project as lots change.
12. Manufacturer certification(s) that the current lot of portland cement and pozzolans, if used, conform to the requirements of Section 5-06.2. The Contractor shall maintain this submittal throughout the duration of the project as lots change.
13. Current certification by the National Ready Mix Concrete Association (NRMCA) for the batch plant to be used in the production of pervious concrete.
14. Current certifications by the NRMCA for the trucks to be used in transporting pervious concrete from the batch plant to the point of placement.
15. Current certifications by the NRMCA for the Contractor's personnel who will be installing sidewalk for "Pervious Concrete Installer" and "Pervious Concrete Technician", as applicable.

#### **5-06.3(3) EQUIPMENT**

The Contractor shall provide all equipment necessary for handling materials and performing all parts of the Work. Vibrators shall not be used for placement of pervious concrete.

#### **5-06.3(3)A BATCHING PLANT**

Pervious concrete shall be mixed in a batch plant meeting the provisions of Section 6-02.3(4)A.

#### **5-06.3(3)B MIXER TRUCKS**

Pervious concrete shall be transported to the location of placement by a rolling drum mixer truck with current (within 12 months) certification by the NRMCA. Non-agitating trucks shall not be used for the transport of pervious concrete.

#### **5-06.3(3)C SIDE FORMS**

Pervious concrete sidewalks shall be constructed using side forms. Slip form paving will not be allowed. Forms for pervious concrete sidewalks shall be made of steel or wood and shall be in good condition, clean and be capable of being anchored in place so that they will be true to grade, line and slope. Forms that are bent, warped, unclean or otherwise deemed inadequate by the Engineer, shall not be used. If pervious concrete is to be placed against a curb or other existing structure, the curb or structure shall be used as a side form for the pervious concrete sidewalk paving.

Prior to inspection by the Engineer, the Contractor shall inspect all forms for line, grade and slope. No pervious concrete shall be placed until the forms are inspected and accepted by the Engineer.

#### **5-06.3(3)D FINISHING EQUIPMENT**

Finishing equipment for pervious concrete sidewalk paving shall be designed for the intended work, shall be clean and in good operating condition.

Vibrating screeds shall not be used for striking off the pervious concrete. Equipment used for striking off the pervious concrete shall leave a smooth surface at the planned grades and shall not cause excess paste to be left on, or drawn to, the surface. The strike off apparatus shall be set up to allow the forms to be overfilled by ½ to ¾ inch, or as necessary, to allow for compaction of the pervious concrete to grade.

If rollers are used to compact, the rollers shall be of sufficient weight and width to compact the pervious concrete to grade without marring the surface. Rollers used for compacting pervious concrete shall not cause the surface to close or otherwise clog and shall produce a surface that is free of ridges or other imperfections. Rollers used for producing contraction joints shall be designed and manufactured for the purpose, shall have sufficient weight to produce the joint and shall not otherwise damage or mar the surface.

Tamps, hand finishing equipment and tools for joints shall be in good repair and adequate for the intended use.



**5-06.3(3)E JOINT SAWING EQUIPMENT**

Equipment for sawing joints in pervious concrete sidewalks shall be power driven concrete saws. Concrete saws shall not tear, spall or otherwise damage the pervious concrete. The Contractor shall maintain concrete saws in good operating condition and shall keep an adequate supply of blades on hand. Measures to collect dust and slurry during sawcutting operations shall be implemented by the Contractor. There shall be an adequate number of concrete saws and equipment on the project so that sawing may occur at a rate to prevent random cracking of the pervious concrete sidewalk; including contingency in the event of a breakdown.

**5-06.3(3)F SMOOTHNESS TESTING EQUIPMENT**

The Contractor shall provide a 10 foot straight edge to be used for measuring the profile of the pervious concrete sidewalk. The straight edge device shall be designed so that it may be easily moved from location to location without marring the surface of the freshly compacted pervious concrete. The 10 foot straight edge shall be accepted by the Engineer prior to placing pervious concrete.

**5-06.3(4) MEASURING AND BATCHING MATERIALS**

Measuring and batching materials for pervious concrete sidewalks shall conform to the requirements of Section 5-05.3(4)A.

**5-06.3(4)A ACCEPTANCE**

For acceptance, pervious concrete sidewalk will be divided into lots as determined by the Engineer. A single lot will typically be represented by the lesser of: one (1) day's production or 360 square yards of pervious concrete in place. Where the Contractor has more than one crew placing pervious concrete, lots may be associated with each crew. Representative lot size will be determined to the nearest square yards. If no sample is taken on a Day that Day's quantities may be included in the next or previous Day's lot(s). Acceptance of a lot of pervious concrete sidewalk will be based on the following criteria:

1. **Grade:** Pervious concrete sidewalk shall be true to planned grades plus or minus ½ inch and shall not deviate from grade more than ¼ inch in ten (10) feet. Where abutting existing facilities such as sidewalks, walkway, curbs, driveways or other pavements, the pervious concrete sidewalk will be flush and provide a transition that will not deviate in more than ¼ inch in ten (10) feet.
2. **Line:** Pervious concrete sidewalk margins shall be true to planned lines plus or minus ½ inch at any point.
3. **Slope:** Pervious concrete sidewalk shall be sloped as shown on the Drawings. Slope shall be consistent to within 1/4 inch in ten (10) feet.
4. **Conformance to JMF:** The pervious concrete used shall conform to the JMF within the limits as set forth in Section 6-02.3(5)C and as determined from the accepted test panel.
5. **Thickness** (test panel only or when determined by the engineer): Three (3) core samples of four (4) inches in diameter may be taken from each test panel or lot for acceptance in accordance with ASTM C42. The Contractor shall provide measures to collect slurry and debris during coring operation in order to avoid sealing adjacent pavement. Each Core Sample shall be equal to the minimum section depth or more as specified in the Drawings (minimum 5 inches). After core's length and diameter is measured, trim cores to uniform depth as specified in Section 5-06.3(4) A1 for determining the weight. Core holes shall be filled by the Contractor with concrete meeting the JMF and shall match adjacent pavement texture and grade.
6. **Unit Weight** (test panel only or when determined by the engineer): The unit weight of each core sample taken for acceptance will be determined using the method described in Section 5-06.3(4)A1. The unit weight of the core sample for each lot shall be within eight (8) pounds per cubic foot of the unit weight as accepted in the JMF.
7. **Infiltration Rate:** The infiltration rate of each lot will be tested at four (4) random locations within the lot as described in Section 5-06.3(4)A2. The average of all four (4) tests shall be greater than 100 inches per hour.
8. **Fresh Density:** The fresh density will be measured using the jigging procedure outlined in ASTM C29 at the point of placement shall be within or equal to five (5) pounds per cubic foot of the fresh density indicated by the JMF.
9. **Manufacturer's Certificate of Compliance:** Each load of pervious concrete transported to the location of placement shall have an original Manufacturer's Certificate of Compliance as specified in Section 6-02.3(5)B delivered with the load. Photo copies, carbon copies or facsimiles are not acceptable.
10. **Appearance:** Each lot of finished pervious concrete sidewalk will be inspected for appearance by the Engineer. The pervious concrete sidewalk shall have a consistent surface texture, shall have no more than five (5) percent of the surface area within each panel (joint to joint) filled with paste, shall not be raveled, shall be free of ridges or other surface imperfections, shall have joints that are in the specified location and are constructed per specification, and shall be free of cracks.

Quality Assurance Testing: Before final acceptance by the Engineer, the Contractor shall pressure wash the pervious concrete sidewalk. Pressure washing shall be provided and completed by using portable washer equipment working at a

minimum of 3000 psi at 1.0 gpm. The nozzle shall be held a maximum of three (3) inches off the concrete surface. The Contractor shall pressure test three (3) locations per lot or as determined by the Engineer. Any sections of pervious concrete that breaks up, ravel, or does not infiltrate shall be removed and replaced with acceptable pervious concrete to the nearest joints. The Engineer will determine the acceptability of the concrete after pressure washing.

The Contractor shall decide, after placing the pervious concrete, when to perform the quality assurance pressure wash testing for the acceptance.

#### 5-06.3(4) A1 VOID CONTENT OF THE MIX; LAB TEST:

The test panels will not be accepted unless each of the cores has a void content between 15 and 30 percent.

Determine the bulk specific gravity ( $G_B$ ) of the core using the method described in ASTM D1188. Core samples shall be trimmed to 4-1/2 inches in depth to provide increased uniformity of test results. Trimming shall be squared and from the bottom of each pavement core samples.

Dry the core samples at a temperature not to exceed 65 C (150° F) until a constant mass ( $\pm 0.1\%$ ) is obtained and allow to cool to ambient temperature. Remove paraffin coating from core samples.

Weigh the core and record weight to the nearest 0.1 g.

Use the pycnometer apparatus as described in ASTM D2041.

Place core samples in calibrated pycnometer and cover completely with water. If the core sample is too large to be placed into the pycnometer, it may be broken into pieces and placed into the pycnometer together or the pieces may be evaluated separately.

Place the lid on pycnometer and fasten it on a mechanical agitation device.

Turn on the agitation device and slowly apply a vacuum to the pycnometer until the vacuum reaches  $3.7 \pm 0.3$  kPa ( $27.5 \pm 2.5$  mm Hg). The vacuum should be reached in less than 2 minutes.

After the vacuum is achieved, maintain vacuum and agitation for a period of  $15 \pm 2$  minutes.

Slowly release the vacuum and determine the weight of the sample and pycnometer as described in paragraph 9.5.1 or paragraph 9.5.2 in ASTM 2041.

Calculate specific gravity ( $G_{mm}$ ) as described in paragraph 10.1.1 or paragraph 10.1.2 in ASTM 2041, as appropriate.

If multiple procedures are run for separate pieces of the core, the weighted average of all of the runs will be the specific gravity ( $G_{mm}$ ) of the core as a whole.

$$G_{mm} = \text{sum}(G_{mm1} \times Wt_1 + G_{mm2} \times Wt_2 + \dots + G_{mmi} \times Wt_i) / Wt_{\text{total}}$$

The percentage of air voids will be calculated as:

$$\text{Voids} = \frac{G_{mm} - G_B}{G_{mm}} \times 100\%$$

Where:

V = Voids in the Sample (%)

$G_{mm}$  = Specific Gravity of the Core Material Less Air Voids

$G_B$  = Bulk Specific Gravity of the Core as determined by ASTM D1188

This Void Content lab test information shall be part of the Mix Design submittal.

#### 5-06.3(4) A2 INFILTRATION RATE OF THE MIX; FIELD TEST :

Pervious concrete mix shall also have an infiltration rate equal to or greater than 100 inches per hour, in place, as constructed. The locations for conducting the infiltration tests shall be determined by the Engineer. The Contractor shall coordinate and schedule inspections with the Engineer a minimum of five (5) Working Days in advance. The infiltration rate will be measured in the following manner:

The testing procedure shall be as follows:

- a) Place a pre-measured amount of water into the container. Water shall be free of suspended solids. The volume of water shall be determined to 2 significant figures.
- b) Pour the water onto the surface in one spot. Control the discharge rate by manually adjusting the angle of the spout so that the diameter of the pool of water is between 10 to 30 inches is maintained. Empty the container holding the spout over the spot until the pool of water vanishes.

A 16-inch to 24-inch inch diameter tube (typically PVC 3-inch to 6-inch in height) and plumper's putty may be used to control the diameter of the pool ("controlled method") as desired by the Engineer. When using the controlled method, the height of the water in the tube should be maintained at approximately ¼ inch.

- c) Start the stopwatch when the water initially touches the concrete surface and stop it when the pool disappears from the surface.
- d) Measure the longest dimension (d1) of the dampened area. Measure the width (d2) of the pool perpendicular to d1. (use inside diameter of tube for controlled method)
- e) Repeat this procedure at a minimum of 4 separate locations.

Infiltration Rate (IR) shall be calculated as follows:

$$IR = (V \times 3,326,400)/(p \times d1 \times d2 \times t) \text{ inches per hour.}$$

- IR is Infiltration Rate
- V is the volume of water in gallons (typically 1 gallon or more)
- d1 and d2 are the dimensions that were measured in inches.
- p is approximately 3.14159
- t is the time in seconds

#### **5-06.3(4)B REJECTION**

Pervious concrete sidewalk that does not meet the acceptance criteria put forth in Section 5-06.3(4)A will be rejected by the Engineer on a lot by lot basis. At the discretion of the Engineer, a localized area of pervious concrete sidewalk not meeting the requirements of items 1, 2, 3 and 8 of Section 5-06.3(4)A may be broken into a subplot bounded by planned joints.

Pervious concrete sidewalk that has been rejected by the Engineer, or the Contractor, shall be removed and replaced at no additional cost to the Owner.

#### **5-06.3(5) MIXING PERVIOUS CONCRETE**

Pervious concrete shall be batched and centrally mixed at a semi-automatic or automatic batching plant with a current (within 2 years) certification from the NRMCA. Pervious concrete shall not be shrink mixed or transit mixed.

The mixing time, after all materials have been delivered to the drum, shall not be less than 50 seconds or more than 90 seconds. The pervious concrete aggregates shall be uniformly coated with paste and shall be of the required consistency. After mixing, the pervious concrete shall be delivered to a truck meeting the requirements of Section 5-06.3(3)B for transport to the job site. Pervious concrete shall be placed no more than 90 minutes from the time water is added to the cement. Pervious concrete shall not be retempered.

#### **5-06.3(5)A LIMITATIONS OF MIXING PERVIOUS CONCRETE**

Pervious concrete shall not be mixed, placed, compacted or finished when the natural light is inadequate, as determined by the Engineer, unless an adequate and accepted lighting system is in operation.

Mixing and placing concrete shall be discontinued when a descending air temperature in the shade away from artificial heat reaches 50°F and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 45°F.

Mixing and placing pervious concrete shall only occur when the ambient air temperature, as measured at the placement location away from the shade and away from artificial cooling sources, is less than 80°F.

The temperature of pervious concrete shall not be less than 60°F when placed and shall at no time be greater than 90°F.

Pervious concrete shall not be mixed with aggregates less than 32°F.

#### **5-06.3(6) AGGREGATE DISCHARGE SUBBASE**

Pervious concrete sidewalk shall be constructed on an aggregate discharge subbase over the prepared subgrade. The aggregate discharge subbase shall be constructed to the lines, grades and thickness shown on the Drawings. Aggregate discharge subbase shall be as specified in Section 5-06.2

Aggregate discharge subbase material shall be a minimum of 6-inches placed over the preplaced geotextile as specified. Geotextile shall be as specified in Section 5-06.2. Aggregate discharge subbase shall be placed in lifts not to exceed 12 inches non-compacted. The aggregate discharge subbase shall be compacted to the satisfaction of the Engineer. The compaction equipment shall be of sufficient weight and dimensions so as not to break or degrade the aggregate. In areas that are not accessible to equipment, other mechanical means may be used to compact the aggregate discharge subbase. Equipment used for compaction of the aggregate discharge subbase shall be accepted by the Engineer prior to use.

The aggregate discharge subbase shall be true to grade and slope plus or minus 0.5 inches after compaction. Where the grade is low, the surface of the aggregate discharge subbase shall be scarified to a depth of two (2) inches, additional material added and recompacted. If there are high areas, the material shall be removed and the area recompacted.

The Contractor shall take care to protect the aggregate discharge subbase from damage and contamination. Damage to the aggregate discharge subbase shall be repaired to the satisfaction of the Engineer at no additional cost. Contaminated aggregate discharge subbase shall be removed and replaced to limits as determined by the Engineer. The aggregate discharge subbase shall be inspected and accepted by the Engineer prior to placing any pervious concrete sidewalk.

#### **5-06.3(6)A SUBGRADE PREPARATION**

Subgrade for pervious concrete sidewalk shall be excavated, graded and compacted as specified in Section 8-14.3(2) except that the subgrade shall be compacted to a relative density of 92 percent of optimum density of the subgrade soil as determined by ASTM D 698. Prior to placing the geotextile fabric, the surface of the subgrade shall be scarified to a depth of ¼ to ½ inch. Once scarified, materials or equipment shall not be stored or permitted within the prepared subgrade area so as to avoid re-compaction of the scarified areas and diminishing the infiltration rate of the subgrade.

Geotextile shall be placed on the prepared subgrade prior to placing aggregate discharge subbase as shown in the Drawings. Care shall be taken to provide full coverage and to prevent the geotextile from being torn. Damaged geotextile shall be repaired as indicated by the manufacturer and to the satisfaction of the Engineer. Overlaps of the geotextile shall be a minimum 1 foot or to the manufactures recommendation, whichever is greater.

#### **5-06.3(7) PLACING, SPREADING, AND COMPACTING PERVIOUS CONCRETE**

Standard methods of placing, spreading, and compacting shall be as described herein. However, the contractor may submit for review and approval by the Engineer, alternative methods of work that deviate from the standard methods described in this specification. Such methods shall be demonstrated through the test panels trial and will require final acceptance by the Engineer. Alternate methods that are rejected through the test panels will be discontinued. Methods described in this specification shall be used.

#### **5-06.3(7)A CONTRACTOR'S QUALIFICATIONS**

The Contractor shall employ no less than one (1) NRMCA certified Pervious Concrete Craftsman who shall be on site, overseeing each placement crew during all pervious concrete placement, or the Contractor shall employ no less than three (3) NRMCA certified Pervious Concrete Installers, who shall be on site working as members of each placement crew during all pervious concrete placement, or the Contractor shall employ no less than three (3) NRMCA certified Pervious Concrete Technicians and one (1) Pervious Concrete Installer, who shall be on site working as members of each placement crew during all concrete placement unless otherwise specified. For those crews having personnel with NRMCA certified Pervious Concrete Technician certifications, the placement crew shall also successfully pass a Performance Evaluation required under NRMCA Pervious Concrete Installer certification.

The pervious cement concrete sidewalk test panels installed at the project site may be utilized as the "mock-up" placement required for the NRMCA "mock-up" Performance Evaluation exam for Pervious Concrete Installer certification. If the "mock up" placement installed for NRMCA certification does not meet the project specifications, the "mock up" placement shall be removed at the Contractor's expense and a new pervious concrete sidewalk test panels shall be installed, tested and submitted for acceptance.

Documentation of NRMCA certifications for the Contractor's personnel shall be submitted per Section 5-06.3(2) prior to proceeding with production placement of the pervious concrete sidewalks.

If, in the opinion of the Engineer, personnel used for installing pervious concrete sidewalk are unqualified, inattentive to quality, or unsafe, they shall be removed or reassigned from installation of pervious concrete sidewalk at the written request of the Engineer.

#### **5-06.3(7)B TEST PANELS**

Production placement of pervious concrete shall not occur until the Contractor has completed a test panels of pervious concrete sidewalk that meets all of the acceptance criteria herein and is accepted by the Engineer. The Contractor should allow time in his schedule for the construction and acceptance of the test panels.

The Contractor shall construct test panels of pervious concrete sidewalk with a minimum area of 225 square feet. Test panels may be placed non-contiguously. The width of the test panels shall be equal to the nominal width of the sidewalk to be placed. The test panels shall be equivalent and representative of the production pervious concrete sidewalk in all aspects including subbase depth and preparation. The Engineer shall observe and accept each element of pervious concrete sidewalk construction. Construction and evaluation of the test panels will occur as follows:

Notify the Engineer at least ten (10) Working Days before installing pervious concrete sidewalk test panels

Coordinate the location of the test panels with the Engineer.

Install the test panels in accordance with the Specifications and Drawings.

Notify the Engineer when each element of the test panels is ready for inspection.

Remove, replace, and dispose of any unsatisfactory portions of test panels as determined by the Engineer and at no additional cost.

Failure to install acceptable test panels of pervious concrete will indicate an unqualified installer.

Production sections of this Work shall not be placed until achieving a complete test panels that fully complies with the Drawings and Specifications and has written acceptance issued by the Engineer.

The completed test panels shall be used to validate the pervious concrete mix design and establish the JMF. Unless others determined by the Engineer, three (3), four (4) inch, cores will be cut in accordance with ASTM C42 and these cores will be used to validate the mix design under the design criteria set forth in Section 5-06.3(1)A and the acceptance criteria of 5-06.3(4)A. The average unit weight of the cores as determined by ASTM D1188 shall be within eight (8) pounds per cubic foot of the average of the three (3) cores. The average unit weight of the cores shall be the unit weight used for the JMF. Core holes shall be filled by the Contractor with concrete meeting the proposed JMF and shall match adjacent pavement color, texture and grade.

Three (3) infiltration tests will be conducted in the test panels for acceptance. Each of the infiltration tests shall meet the minimum infiltration rate requirement noted in Section 5-06.3(4)A.

The completed and accepted test panels shall be maintained and protected throughout the duration of the Work and may not be demolished and disposed of without written permission from the Engineer. If the test panels are incorporated into the Work, it shall remain in place accepted as a single lot.

### **5-06.3(7)C PLACING, SPREADING AND COMPACTING**

Prior to placing pervious concrete, the Engineer will inspect and accept all formwork and subbase/subgrade. All surfaces that will contact the finished pervious concrete shall be damp with no standing water. Pervious concrete shall not be placed on standing water or frozen materials.

Pervious concrete sidewalk shall be placed on the prepared subbase as close to its final position as possible in a continuous operation so as to minimize evaporation. Where necessary, the pervious concrete may be spread with square edged shovels or rakes prior to strike off. The pervious concrete shall be struck off or screeded to a depth sufficient to allow for compaction to grade. Pervious concrete shall be placed in a single lift. Contractor's personnel shall take care to avoid foot traffic in the pervious concrete to prevent non-uniform compaction and to keep contaminating material from the mix. Foot traffic on fresh concrete shall not be allowed after it has been struck off.

Within 20 minutes of discharge from the truck, the concrete shall be compacted, finished and covered for curing. The compacted effort shall be sufficient to compact the fresh pervious concrete to grade, not draw excessive paste to the surface and to leave a smooth finish. In areas where the roller cannot be brought to bear, hand tamping, or other methods accepted by the Engineer, may be used to compact the pervious concrete. Edges and plastic formed joints shall be finished by hand tooling with a ½ inch radius edging tool. Defects shall be repaired immediately.

Pervious concrete shall be placed continuously. Where placement has been halted for a period of 15 minutes, a header shall be placed between the forms and a construction joint formed. Construction Joint shall be located at the same spacing of where a contraction joint would be. The pervious concrete shall be compacted and finished to the header before placement may continue. Upon resuming placement, the header may be carefully removed and a construction joint formed at that location. Any sloughing or sagging of the previously placed pervious concrete at the header location shall be corrected prior to placing new pervious concrete against the joint.

### **5-06.3(8) JOINTS**

Joints shall be of three (3) types: construction, contraction, isolation. Construction joints shall be formed at the end of a day's work or when necessary to stop production for any reason. Contraction joints shall be used to control random cracking. And, isolation joints shall be used where the pervious concrete abuts existing facilities or where shown on the Drawings. Wherever possible, the angle between intersecting joint shall be between 80 and 100 degrees.

### **5-06.3(8)A CONSTRUCTION JOINTS**

Construction joints shall be located as near as possible to the location of a planned contraction or isolation joint. Construction joints are to be formed by placing a header between the forms, at right angles, to the full depth of the finished pervious concrete, and set to the height of the forms. Pervious concrete shall be placed against the header and compacted and finished as normal, including edging. Upon resuming paving, the header shall be carefully removed and new pervious concrete placed directly against the existing pervious concrete. The new pervious concrete shall be compacted and finished against the hardened pervious concrete as if it were a form. If an isolation joint is planned at this location, then the premolded joint filler shall be placed against the existing pervious concrete and the new pervious concrete shall be placed against the premolded joint filler. The joint shall be tooled on both sides of the premolded joint filler.

### **5-06.3(8)B CONTRACTION JOINTS**

Contraction joints shall be placed every 20 feet unless otherwise shown on the Drawings. Contraction joints shall be have a depth of 1/3 the thickness of the pervious concrete and have a width of no more than 1/8 inch. Contraction joints may be formed in the plastic concrete using a roller designed for this purpose or by other methods accepted by the Engineer. Plastic formed contraction joints shall be tooled on both sides of the joint with a radius of ½ inch.

At the option of the Contractor, contraction joints may be saw cut after the pervious concrete has hardened. If saw cutting the contraction joints, saw cutting shall occur as soon as the concrete is sufficiently cured so that it may be cut without raveling or dislodging aggregate from the finished surface. Measures to collect dust and slurry during sawcutting operations shall be implemented by the Contractor. To minimize drying, curing materials shall be removed only as needed to make cuts and shall be replaced immediately after cutting.

#### **5-06.3(8)C ISOLATION JOINTS**

Isolation joints shall be placed where the pervious concrete abuts existing structures or where shown on the Drawings. Isolation joints shall continue through the depth of the pervious concrete using a 3/8 inch premolded joint filler. Isolation joints may be formed by inserting the premolded joint filler into the plastic concrete or by forming a construction joint and affixing the premolded joint filler against one side of the joint and placing fresh pervious concrete against it. Isolation joints and filler shall be flush with the surrounding pervious concrete and shall not deviate from the acceptance criteria for smoothness as shown in Section 5-06.3(4)A. The edges of the pervious concrete on either side of the premolded joint filler shall be hand tooled with a 1/2 inch radius.

#### **5-06.3(9) RESERVED**

#### **5-06.3(10) RESERVED**

#### **5-06.3(11) RESERVED**

#### **5-06.3(12) SURFACE SMOOTHNESS**

The surface of the pervious concrete sidewalk will be checked immediately after compaction for grade and slope using the 10 foot straightedge specified in Section 5-06.3(3)F. Where the surface is found to be out of specification as determined by the criteria specified in Section 5-06.3(4)A, it shall be immediately corrected by recompacting, removing excess pervious concrete, or by adding pervious concrete; as necessary.

If it is necessary to correct grade or slope by removing excess pervious concrete, the surface shall be recompacted and the edges retooled. If the grade or slope is to be corrected by the addition of pervious concrete, the surface shall be lightly scarified and the new material added. The surface shall be recompacted to grade and the edges retooled. Any corrections to the surface shall occur before the pervious concrete has set or has dried. Pervious concrete sidewalk that is out of specification with regard to grade or slope will be rejected to the nearest joints.

Pervious concrete sidewalk that has been corrected shall not be distinguishable from the adjacent, undisturbed pervious concrete sidewalk. If in the opinion of the Engineer, the corrected pervious concrete sidewalk is distinguishable from the adjacent Work, the repaired area will be rejected to the nearest joints.

#### **5-06.3(13) CURING**

Immediately after the pervious concrete sidewalk has been compacted and checked for grade and slope, the sheet curing material as specified in Section 9-23.1 shall be applied. If the surface appears dry, lightly mist the surface with water prior to applying the sheet curing material. The sheet curing materials shall be fixed in place by method(s) that shall not damage the pervious concrete sidewalk and is accepted by the Engineer. The pervious concrete shall be placed, struck off, finished and the curing materials in place within twenty (20) minutes of the time the pervious concrete is discharged from the truck. This time may be shortened if conditions exist that promote excessive drying. Forms and sheet curing material(s) shall remain in place for a minimum of ten (10) Days.

With the exception of saw cutting equipment, all traffic shall be kept off of the pervious concrete sidewalk during the curing period. For saw cutting contraction joints, only the amount of sheet curing material necessary to accomplish the saw cutting shall be removed and the surface of the exposed pervious concrete sidewalk shall be kept moist for the entire duration of the exposure.

Any testing for acceptance shall not occur until the end of the curing period.

#### **5-06.3(14) COLD WEATHER WORK**

When concrete is being placed and the ambient air temperature is expected to drop below 50° F during the day or night, the Contractor shall, at no expense to the Owner shall be protected from the concrete from freezing. The Contractor shall provide a Cold Weather Plan prior to placing concrete when ambient air temperature below 50° F may occur or when requested by the Engineer.

Under the Cold Weather Plan, the Contractor shall, at no expense to the Owner, provide a sufficient supply of straw, hay, blankets, or other suitable blanketing material and spread it over the pavement to a sufficient depth to prevent freezing of the concrete. Straw, hay, blankets, or other suitable blanketing material shall be spread over the pavement to a sufficient depth to keep the concrete from freezing. The blanket material shall be covered with a layer of burlap or plastic sheeting, weighted or anchored to prevent the wind from displacing the insulation. The Engineer may require recording thermometers if daytime temperature is below 50°.

The protection shall be maintained for 10 Days. The Contractor shall replace any concrete damaged by freezing at no additional cost to the Owner.

The Contractor shall be responsible for the quality of the concrete thus cured. Any concrete injured by frost action or freezing shall be removed and replaced at the Contractor's expense in accordance with this Section.

**5-06.3(15) RESERVED**

**5-06.3(16) PROTECTION OF PERVIOUS CONCRETE SIDEWALK**

As part of the Construction Stormwater Erosion Control Plan (CSECP), rain runoff, surface water of any kind and sediment shall be prevented from entering the area of pervious pavement construction, including excavation, until the pervious concrete application has cured and the adjacent areas that sheet flow/drain onto the pervious pavement are permanently stabilized from erosion and plantings are established. Once pavement is placed, protective covers shall continually be maintained until adjacent areas are permanently stabilized and pavement has been accepted.

The Contractor shall take every precaution to protect the pervious concrete sidewalk from damage, including the introduction of foreign materials to the surface, throughout the course of the work. Pervious concrete sidewalk that is damaged or has been adversely impacted by the introduction of foreign materials shall be rejected and replaced to the nearest joint.

**5-06.3(17) RESERVED**

**5-06.4 MEASUREMENT**

Bid items of Work completed pursuant to the Contract will be measured as provided in Section 1-09.1, Measurement of Quantities, unless otherwise provided for by individual measurement paragraphs herein this Section.

Measurement for "Pervious Concrete Sidewalk" will be by the square yard for the surface of pervious concrete walk placed. Deduction will be made for blocked out areas, castings or other discontinuities in the sidewalk nine (9) square feet or larger.

**5-06.5 PAYMENT**

Compensation for the cost necessary to complete the work described in Section 5-06 will be made at the bid item prices Bid only for the Bid items listed or referenced as follows:

**"Pervious Concrete Sidewalk"**, per square yard.

The Bid Item price for "Pervious Concrete Sidewalk" shall include all costs for the work required to construct the pervious concrete sidewalk as specified in this Section, including but not limited to; performing mix designs, testing, excavation, and subgrade preparation; and, furnishing and installing geotextile, aggregate discharge subbase, and pervious concrete.

Payment of the volume of earthwork involved in excavating Material above the top surface of the sidewalk will be made in accordance with Section 2-04.5 "Common Excavation" as defined in Section 2-04.1(2).

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