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SECTION 300

SECTION 301-GENERAL REQUIREMENTS FOR SURFACES

301.01 DESCRIPTION

This section covers of all types of surface construction.

301.02 MATERIALS

Provide materials for surface construction in accordance with the relevant section or sections of Chapter 900, "Materials."

301.03 EQUIPMENT

A) Distributors and Supply Tanks

Provide distributors and supply tanks capable of uniformly applying bituminous material in accordance with the following:

- At the temperatures specified in the relevant specification sections;
- On variable widths of surface not to exceed 26 ft [7.8 m];
- At rates from 0.010 gal/yd² to 1.000 gal/yd² [0.045 L/m² to 4.525 L/m²]; and
- With constant pressure and uniform temperature.

Ensure the distributor can apply material to vertical faces of asphalt pavement at the joints between paving operations.

Prevent variation that exceeds the specified application rate by more than 0.01 gal/yd² [0.045 L/m²].

Provide a distributor equipped with the following:

- A tachometer,
- Pressure gauges,
- Volume-metering devices or a calibrated tank,
- A thermometer for measuring temperatures of tank contents,
- A power unit for the pump,
- Full circulation spray bars adjustable vertically and laterally,
- A positive shut-off valve, and
- Fittings that prevent bituminous material from dripping.

Frequently check and adjust the angle of the spray nozzles and the height of the spray bar to ensure uniform distribution of the bituminous material. Drilling, clogging, or streaking the bituminous material is not allowed. If any of these conditions occur, stop the operation and correct the problems creating these conditions before resuming distribution.

Regularly check the rate and ensure uniformity of distribution. Provide supply tanks in accordance with AASHTO M 156, Section 3.

B) Compactors

Provide rollers of the following type.

- Vibratory steel-wheel,
- Non-vibratory steel-wheel,
- Pneumatic tire, or

- A combination of the three types.

Provide rollers in good condition, capable of reversing without backlash, and operating at speeds that do not displace the bituminous mixture.

Equip vibratory rollers with working amplitude controls or frequency controls designed specifically for the compaction of the specified bituminous material.

Use rollers of a type, number, and weight to complete the compaction of the bituminous material before its temperature drops below the specified minimum.

Do not use equipment that crushes the aggregate in the bituminous material.

301.04 CONSTRUCTION METHODS

A) Tolerances

Provide the required surface construction in accordance with the following:

(1) Surface Elevation and Smoothness

Finish the surface elevations for new pavement construction and overlays within ½ in [13 mm] of the elevations shown on the approved plans. If the approved plans do not show the elevations for overlays, provide a finished surface in accordance with the surface smoothness tolerances. Ensure the surface smoothness is within ⅛ in in 10 ft [3 mm in 3 m]. Test for surface smoothness by placing a straightedge between two contacts on the finished surface and measuring the distance from the surface to the straightedge.

(2) Width

Finish surfaces to the minimum width shown on the approved plans.

B) Corrections

Correct material dimensions that exceed the specified surface tolerance using only methods approved by the City Engineer at no additional cost to the City or Awarding Public Agency.

C) Surface Protection

Submit a plan to the City Engineer to protect the pavement from damage by the paving operations before starting paving operations. If paving operations spall, crack, chip, rut, or deface the pavement, repair the pavement at no additional cost to the City or Awarding Public Agency.

301.05 TESTING — VACANT

301.06 METHOD OF MEASUREMENT — VACANT

301.07 BASIS OF PAYMENT — VACANT

SECTION 302-TRAFFIC-BOUND SURFACE COURSE

302.01 DESCRIPTION

This section covers construction a surface course of hard and durable particles of sand, gravel, mine chats, crushed stone, or disintegrated granite and placing the surface course material on a prepared subgrade.

302.02 MATERIALS

Provide aggregate materials in accordance with Subsection 903.05, "Aggregates for Traffic Bound Surface Course."

302.03 EQUIPMENT — VACANT

302.04 CONSTRUCTION METHODS

A) Preparation of Subgrade

Complete the subgrade in accordance with Subsection 220.04, before placing surface course material on the subgrade.

B) Shaping and Maintenance

Shape and compact as provided in these Standard Specifications, this Section 300, and the City Standard Details, and as directed by the City Engineer if placing material adjacent to the roadway.

Correct irregularities, such as holes, ruts, waves, and undulations, with material from the working windrow on the subgrade. Continue shaping the surface material until it is compacted and free of irregularities. Place the surface course material to the elevations shown on the approved plans.

Remove excess material and stockpile at a location approved by the City Engineer on the approved plans.

C) Traffic Control

Unless otherwise specified and authorized, avoid closing the road to traffic. Minimize interference with traffic. Maintain warning signs and lights to safeguard against traffic accidents. Place windrows or piles of surface course material on the shoulders and off the traveled roadway at the end of the workday.

302.05 TESTING — VACANT

302.06 METHOD OF MEASUREMENT

For each material quantity of the relevant traffic-bound surface course pay item, the City Engineer will deduct the weight of moisture that is in excess of 5 percent of the oven-dry weight.

302.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) TRAFFIC BOUND SURFACE COURSE TYPE A	Ton [Metric Ton]

Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 303- CHIP SEAL

303.01 DESCRIPTION

This section covers construction of a single or double surface treatment of aggregates and bituminous materials.

303.02 MATERIALS

Provide materials in accordance with the following sections:

Material:	Section:
Cover Aggregates	903.04
Bituminous Binder	908.03

Use the following aggregates for surface treatments unless otherwise specified.

For single bituminous surface treatments, use:

- Cover Aggregate No. 2,
- Cover Aggregate No. 3,
- Cover Aggregate No. 3C
- Precoated Aggregates, or
- Light Weight Cover Aggregates (LWCA).

For double bituminous surface treatments, use:

- Cover Aggregate No. 1, and
- Cover Aggregate No. 2.

303.03 EQUIPMENT

Provide distributors, supply tanks, and compactors in accordance with Subsection 301.03, "Equipment."

Provide self-propelled mechanical spreaders mounted on pneumatic tired traction wheels capable of the following:

- Operating independently of supply trucks;
- Receiving the aggregate from the supply truck directly into the hopper and then into the spreader box;
- Controlling the spreading of aggregate to a rate of 10 lb/yd² to 45 lb/yd² [5 kg/m² to 25 kg/m²];
- Spreading the aggregate from 3 ft to 12 ft [0.9 m to 3.6 m] wide; and
- Spreading the aggregate up to 24 ft [7.2 m] wide, if required by the approved plans.

303.04 CONSTRUCTION METHODS

A) Weather and Seasonal Limitations

Limit the construction of bituminous surface treatment to the following weather and seasonal limitations:

(1) General

Comply with weather and seasonal conditions for constructing bituminous surface treatment in accordance with Subsection 110.17, “Use of Section or Portion of the Work,” and Subsection 112.10, “Acceptance and Final Payment,” for acceptance of the work.

(2) Seasonal Limitations

Apply bituminous surface treatment during the construction periods provided in Table 303:1, "Construction Seasonal Limitations," or on dates requested in writing by contractor and approved by the City Engineer.

Table 303:1
Construction Seasonal Limitations

Asphalt Type	Construction Period
Cutback Asphalt	April 1 through Nov. 15
Asphalt Cement	May 1 through Sept. 30
Emulsified Asphalt	May 15 through Sept. 15

(3) Temperature and Weather Limitations

Apply bituminous surface treatment in accordance with the temperature and weather limitations provided in Table 303:2, "Temperature and Weather Limitations."

Measure the ambient temperatures in the shade, 4 ft [1.2 m] above the ground, and away from artificial heat.

Ensure the temperature and weather conditions allow completion of the work. Before starting bituminous surface treatment, verify that the minimum temperatures specified in Table 303:2 also occurred on the previous calendar day. Suspend work if the ambient temperature is forecast to fall below the specified minimum temperature within 72 hour. Suspend work during adverse weather conditions, such as wind chill, rain, fog, or abnormally high relative humidity, only as determined by the City Engineer.

Table 303:2
Temperature and Weather Limitations

Asphalt Type	Minimum Temperature, °*F [°C]*			Base or Pavement Surface Condition Due to Weather
	Ambient	Surface	Aggregate	
Cutback Asphalt	50 [10]	60 [15]	40 [4]	Dry
Emulsified Asphalt	60 [15]	70 [20]	50 [10]	No visible free moisture present
Asphalt Cement	0 [15]	70 [20]	50 [10]	Dry

(4) Detours and Shoo-Flys

The City Engineer may waive the minimum temperature requirements for construction of temporary bituminous surface treatment for detours, shoo-flys, or other incidental construction.

B) Traffic

Provide traffic control that ensures the following:

- No vehicles travel on the surface treatment before the application and stabilization of cover material;
- Construction operations pose no risk to the health, safety, or property of the traveling public; and
- No unnecessary delay to the traveling public.

C) Preparation of Base

Prepare the base as required by the approved plans before applying bituminous surface treatment.

If reconstructing a base previously sealed or patched with bituminous materials, remove areas with excess bituminous materials from the base course surface before applying the bituminous binder.

D) Protection of Structures

Protect surfaces of structures from discoloration while applying bituminous surface treatments.

E) Heating Bituminous Material

Heat bituminous material uniformly and consistently, using an effective and positive control method. Heat bituminous material in accordance with Subsection 908.03, "Asphalt Materials." Ensure the fluidity of the heated bituminous material and prevent damage due to overheating.

Do not heat bituminous material with steam. Protect the bituminous material or its container from coming into contact with flames. Overheated or damaged bituminous material will be rejected.

F) Application of Tack Coat

Apply a tack coat in accordance with Section 307, "Fog Seal and Tack Coat," if required by the approved plans.

G) Application of Bituminous Binder and Cover Aggregate

Before placing the first application of bituminous binder, clean the base of dirt and loose material.

Ensure the aggregate is immediately available for spreading before starting the application of bituminous binder.

(1) Bituminous Binder

Uniformly apply the bituminous binder. Delineate one edge of the bituminous surfacing before the first application of bituminous binder. At transverse joints, to prevent double or no bituminous binder application created by operation starts and stops, spread building paper over the treated surface before the joint to ensure the specified distribution of bituminous binder at the nozzles when they reach the untreated surface. Remove and dispose of the paper after starting or restarting the bituminous material application.

Apply bituminous material to the full width in one pass for each application if the roadway is closed to traffic and the surface width does not exceed 24 ft [7.3 m].

If the roadway is not closed to traffic and traffic is maintained on one-half of the width, apply

bituminous material on the closed half of the roadway width. During the bituminous material application on the second half of the roadway, ensure that the distributor nozzle nearest the center of the roadway overlaps the previous bituminous application from half to the full width of the nozzle spray.

(2) Cover Aggregate

Apply cover aggregates in accordance with Table 303:3, "Approximate Single Treatment Application Rates," and Table 303:4, "Approximate Double Treatment Application Rates." Immediately after applying the bituminous binder, uniformly spread the cover material at the specified rates. The City or Awarding Public Agency may allow hand-spreading in areas inaccessible to mechanical spreaders.

(3) General Application Requirements

Prevent overlaps, streaks, or gaps in the application of bituminous binder and cover aggregate. Correct overlaps, streaks, and gaps, to meet the requirements of these Standard Specifications, this Section 300, and the City Standard Details, and as approved by the City Engineer at no additional cost to the City or Awarding Public Agency. Ensure the finished surface is free of the following:

- Bleeding,
- Loose chips, and
- Loss of imbedded aggregates.

Apply the bituminous material and cover aggregate at the distribution and coverage rate shown on the approved plans.

Use Table 303:3, "Approximate Single Treatment Application Rates," and Table 303:4, "Approximate Double Treatment Application Rates," to estimate quantities of aggregate and bituminous binder. Rates are based on midpoint requirements of bituminous binder and aggregate.

Table 303:3
Approximate Single Treatment Application Rates

Material	Aggregate Type			
	LWCA	**No. 2**	**No. 3**	**No. 3C**
Aggregate	100 yd^2/yd^3 [110 m^2/m^3]	25 lb/yd^2 [14 kg/m^2]	28 lb/yd^2 [15 kg/m^2]	35 lb/yd^2 [19 kg/m^2]
Bituminous binder (residual asphalt)	0.3 gal/yd^2 [1.4 L/m^2]	0.3 gal/yd^2 [1.4 L/m^2]	0.3 gal/yd^2 [1.4 L/m^2]	0.3 gal/yd^2 [1.4 L/m^2]

Table 303:4 Approximate Double Treatment Application Rates			
Material	**Aggregate Type and Increment**		
	No. 1	**No. 2**	
		First	**Second**
Aggregate	40 lb/yd² [22 kg/m²]	20 lb/yd² [11 kg/m²]	15 lb/yd² [8 kg/m²]
Bituminous binder (residual asphalt)	0.4 gal/yd² [1.8 L/m²]	0.2 gal/yd² [0.9 L/m²]	0.15 gal/yd² [0.7 L/m²]

Apply bituminous binder at temperatures in accordance with Section 908, "Plant Mix Bituminous Bases and Surfaces."

Apply bituminous binder and cover aggregate in the following sequences:

(a) ***Single Treatment***

Apply bituminous binder, and spread No. 2, No. 3, No. 3C, Precoated Aggregates or LWCA cover aggregate at the rates shown on the approved plans.

(b) ***Double Treatment***

For the first application, apply bituminous binder and spread No. 1 cover aggregate over the surface at the rates shown on the approved plans.

For the second application, apply bituminous binder on the surface of the No. 1 cover material, and spread the first application of No. 2 cover aggregate (first increment) over the surface at the rates shown on the approved plans.

For the third application, apply bituminous binder on the surface of the No. 2 cover material (first increment), and spread the second application of No. 2 cover aggregate (second increment) over the surface at the rates shown on the approved plans.

H) Rolling

Roll the entire surface after each application of cover aggregate and ensure it is firmly imbedded into the bituminous binder.

Hand spread additional aggregate to fill irregularities and cover bare spots to prevent tracking bituminous binder during rolling.

Perform final rolling of the surface with at least four passes over the entire surface with a pneumatic-type roller in accordance with Subsection 301.03.B, "Compactors." Operate the roller at a speed of 7 mph [10 km/h] or less.

I) Maintenance

Remove unsatisfactory material. Make repairs with bituminous binder and aggregate, to establish a uniformly dense treatment with maximum retention of the cover aggregate. Maintain until project completion is accomplished in accordance with Subsection 112.10, "Acceptance and Final Payment"

Correct irregularities with additional bituminous binder and aggregate at no additional cost to the

City or Awarding Public Agency.

Apply blotting material free of clay, silt, loam, or other foreign matter for excessive bleeding as provided in these Standard Specifications, this Section 300, and the City Standard Details, and as directed by the City Engineer.

303.05 TESTING — VACANT

303.06 METHOD OF MEASUREMENT

The City Engineer will measure the finished surface area of the *Chip Seal (Single Treatment)* or *Chip Seal (Double Treatment)* complete-in-place. The City Engineer will measure the *Preparation of Base* to the nearest foot [meter] along the centerline when specified on the approved plans.

303.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) CHIP SEAL (SINGLE TREATMENT)	Square Yard [Square Meter]
(B) CHIP SEAL (DOUBLE TREATMENT)	Square Yard [Square Meter]
(C) PREPARATION OF BASE	Linear Foot [Meter]

Include the cost of bituminous binder, cover aggregate, and sand or other approved aggregate (for blotting) in the contract unit price for the appropriate chip seal pay item.

Include the cost of applying every layer of a double treatment, as required by the approved plans, to be included in the contract unit price for *Chip Seal (Double Treatment)*.

The City or Awarding Public Agency will pay for tack coat in accordance with Section 307, "Fog Seal and Tack Coat".

Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 307-FOG SEAL AND TACK COAT

307.01 DESCRIPTION

This section covers preparation and treatment of an existing bituminous or concrete surface with bituminous material.

Original Emulsion. A mixture of asphalt, water, and a small amount of emulsifying agent to maintain a uniform blend.

Diluted Emulsion. An original emulsion diluted with additional water to reduce the viscosity and to allow easier spraying, typically used for fog seals.

Residual Asphalt Content. The amount of asphalt remaining on the pavement surface after all of the water, both in the original emulsion and any additional water, has evaporated.

307.02 MATERIALS

Provide materials in accordance with Subsection 908.03, "Asphalt Materials."

307.03 EQUIPMENT

A) General

Provide distributors, heating equipment, and supply tanks in accordance with Subsection 301.03, "Equipment." Provide a self-contained, self-propelled paver approved by the City Engineer.

B) PMCRS-1s

When Polymer Modified Cationic Rapid Set -1s (PMCRS-1s) is required, ensure the paver has the following:

- a receiving hopper for hot mix asphalt;
- a distribution system to uniformly place and spread the HMA in front of the screed without causing HMA segregation;
- an asphalt emulsion storage tank;
- a system for measuring the PMCRS-1s volume;
- a spray bar; and
- a heated, variable width, vibratory or combination vibratory-tamping bar screed.

When PMCRS-1s followed immediately with the placement of the Hot Mix Asphalt (HMA) is required, ensure the paver is capable of the following:

- spraying the PMCRS-1s evenly across the surface at the rate prescribed by the Standard Specification or as otherwise approved by the City Engineer;
- operating at forward speeds to consistently place the mixture;
- applying the hot mix asphalt overlay;
- leveling the surface of the mat in one pass;
- placing the hot mix asphalt within 5 seconds of the application of the PMCRS-1s;
- spraying and paving at a controlled speed from 30 ft/minute to 90 ft/minute [9 m/minute to 27 m/minute];
- spreading and finishing HMA courses on lanes, shoulders, and similar construction to the widths and thicknesses shown on the approved plans; and
- producing a finished surface that meets the specified evenness and uniform texture without tearing, shoving, or gouging the mixture or causing HMA segregation.

When using PMCRS-1s, prevent wheels and other parts of the paving machine from contacting the PMCRS-1s before applying the hot mix asphalt. Provide a machine with a screed that is capable of crowning the pavement at the center and adjusting the extensions vertically to accommodate the pavement profile.

307.04 CONSTRUCTION METHODS

A) General

Clean the existing roadbed surface before placing tack coat. Paint a thin, uniform tack coat on all surfaces of curbs and gutters, manholes, and other structures that will come in contact with hot mix asphalt. Ensure the tack coat applications minimize damage and inconvenience to traffic and allow one-way traffic without pickup or tracking the bituminous material.

Do not apply tack coat during wet or cold weather, or in windy conditions that would cause the tack coat emulsion to drift. Do not apply tack coat to wet surfaces with free standing water. The City may allow tack coat application to damp surfaces.

The following must be approved by the City Engineer before application:

- Quantity,
- Rate of application,
- Temperature, and
- Areas to be treated.

B) PMCRS-1s

Using a metered mechanical pressure spray bar, uniformly spray the PMCRS-1s at a temperature from 120 °F to 180 °F [49 °C to 82 °C], or as recommended by the material supplier. Ensure the sprayer accurately and continuously monitors the spray rate and applies the membrane uniformly across the width of the overlay. The City Engineer may adjust the spray rate based on the pavement surface conditions and the recommendations of the material supplier.

Apply the bonded HMA in accordance with Section 311.04 over the full width of PMCRS-1s immediately after applying the PMCRS-1s. Place the bonded HMA with a heated vibratory, or combination vibratory-tamping bar screed. Pave continuously to reduce surface imperfections.

C) Fog Seal

Apply the fog seal at a rate of 0.100 gal/yd^2 [0.455 L/m^2] of diluted emulsion diluted at 5:1 water to original emulsion. Alter the application rate or dilution ratio as directed by the City Engineer (based on weather, type of emulsion, and surface type or layer).

D) Tack Coat

Apply the tack coat or NT tack material as shown in Table 307:1, unless otherwise required by the approved plans. Alter the application rate as directed by the City Engineer (based on weather and surface type or layer). Use the highest rate in the table for the surface type or layer (top or bottom).

Table 307:1 Tack Application Rates		
Surface Type/Layer	**Original Emulsion gal/yd^2 [L/m^2]**	**Residual gal/yd2 [L/m2]**
New Asphalt (bottom)	0.060 [0.270]	0.035 [0.160]
Old Asphalt (bottom)	0.085 [0.385]	0.050 [0.225]
Milled (bottom)	0.085 [0.385]	0.050 [0.225]
New Fabric (bottom)	—	0.200 [0.905]
PFC, OGFSC (top)	0.100 [0.455]	0.060 [0.270]
UTBWC (top)	0.200 [0.905]	0.120 [0.545]
PCC (bottom)	0.075 [0.340]	0.045 [0.205]

Ensure that the tack breaks before the application of the next surfacing layer.

Re-apply tack at a rate that ensures proper bonding if the tack loses its adhesive properties or is damaged by traffic before being covered by the next surfacing layer, as directed by the City Engineer at no additional cost to the City or Awarding Public Agency.

(1) Tack Coat Material

CSS-1h or CBC-1h: The application rate must be 0.15 Gallons/Square Yard of diluted emulsion, diluted with water at a ratio of 1:1. This ratio means that one-part water and one-part emulsion is mixed to apply the tack. Therefore, if the total application rate is 0.15 Gallons/Square Yard, then the emulsion rate is 0.075 Gallons/Square Yard. The 1:1 dilution rate must not be changed by the contractor. The emulsion must be measured and paid for by the gallon before dilution. The tack coat application rate may be adjusted slightly based on field conditions, with approval of the City Engineer. The tack coat must be completely cured before placing the hot mix asphalt.

Before the hot mix asphalt is laid, the pavement surface must be cleaned thoroughly to the satisfaction of the City Engineer. Cleaning efforts must be such that PM10 fines are removed.

The tack coat must be applied, with a sprayer approved by the City Engineer. Tests (ASTM D 2995) shall be required to verify the application rate of the distributor truck. All contact surfaces of curbs and gutters, manholes and other structures must be painted with a thin uniform coat of asphaltic material used for the tack coat.

(2) UltraTack

UltraTack sets in 15 to 30 minutes. The application rate must be at a minimum rate of 0.06 Gallons/Square Yard and should not exceed 0.10 Gallons/Square Yard. The UltraTack should **never** be diluted. The product temperature must be maintained at 160°F to ensure smooth flow. The activation temperature of UltraTack is above 150°F. Recently paved surface must be cooled below 150°F before applying UltraTack.

Temperature below 60°F will significantly slow the DRY and SET time and surface temperature at or below 45°F will result in failure.

307.05 TESTING — VACANT

307.06 METHOD OF MEASUREMENT

The City Engineer will measure the volume of Emulsion for *Fog Sea*l, *Tack Coat*, and *NT Tack Material* as delivered, before dilution.

The City Engineer will measure bituminous material by the gallon [liter] or ton [metric ton].

The City Engineer will measure the PMCRS-1s by the gallon of product delivered by the supplier.

307.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) FOG SEAL	Gallon [Liter]
(B) TACK COAT	Gallon [Liter]
(C) NT TACK MATERIAL	Gallon [Liter]
(D) PMCRS-1s	Gallon [Liter]

The City considers the cost of water for dilution to be included in the contract unit price for *Fog Seal* and *Tack Coat.*The City or Awarding Public Agency will pay for the *PMCRS-1s* needed to construct the bonded hot mix asphalt at the contract unit price bid for *PMCRS-1s*.

Payment will be considered full compensation for furnishing all material, equipment, labor and incidentals to complete the work as specified.

SECTION 309 INTERLAYERS FOR HOT MIX ASPHALT OVERLAYS

309.01 DESCRIPTION

This this section covers providing all labor, materials, and equipment; performing all operations required for contractor project quality control; furnishing, overlapping, and placing of pavement interlayer and asphalt binder, if required, in the designated locations as detailed in the approved plans and specified herein; and maintaining the interlayer until placement is completed and accepted.

All terms and definitions outlined in ASTM D4439 shall apply in this Section.

309.02 MATERIALS

Materials must meet the requirement of Oklahoma City Standard Specifications Section 988.

All interlayer material must be from National Transportation Product Evaluation Program (NTPEP) - compliant manufacturers; material tests shall be performed by City Engineer approved independent, certified laboratories, within the last 9 months, and submitted to the City Engineer no less than 3 weeks prior to the start of the project.

For Paving Fabric, Paving Mat, Paving Grid, and Composite Paving Grid, provide asphalt binder

retention or tack coat (paving grids only) application rates (ASTM D 6140), material properties specified herein, and manufacturer's recommendations for asphalt binder application to the City Engineer at the preconstruction meeting. The total minimum asphalt binder or tack coat application rate sprayed in the field must meet the manufacturer's recommendations but must be clearly totaled at the pre-construction meeting as the components of the asphalt binder retention or tack coat application rate and the additional rate based on the anticipated surface condition of pavement. All interlayer material must be recyclable.

All materials must be manufactured in the USA and must be from an ISO9001 manufacturer.

A) Paving Fabric: Type I, II & III:

Materials used for paving fabric must be nonwoven polypropylene or nonwoven polyester. All paving fabrics must meet the requirements of Table 309: 1 and have 50% retained strength after 500 hours of UV exposure when tested in accordance with ASTM D4355. PG asphalt binders must be used for the installation of paving fabrics. Refer to manufacturer's recommendations for asphalt binder application rate.

TABLE 309:1
Paving Fabric

Property	Test Method	Type I	Type II	Type III
Mass per unit area, min (oz/yd2)	ASTM D5261	6.0	4.5	4.1
Grab Tensile Strength, min (lbs.)	ASTM D4632	150	120	101
Grab Tensile Elongation, min (%)	ASTM D4632	50	50	50
Melting point, min (□F)	ASTM D276	320 [1]	320 [1]	320 [1]

[1] 320 is the softening/melting point of polypropylene. See Section IV for more on placement temperature.

B) Paving Mat: Type I & II:

Materials used for paving mat shall be a hybrid of two or more of the following material types: fiberglass, polyester, or polypropylene. Paving mat must meet the requirements of Table 309:2. PG asphalt binders must be used for the installation of paving mats. Refer to manufacturer's recommendations for asphalt binder application rate.

TABLE 309:2 Paving Mats			
Property	**Test Method**	**Type I**	**Type II**
Tensile Strength, min (lb./in)	ASTM D5035	280	140
Ultimate Elongation, max (%)	ASTM D5035	5	5
Melting Point, min (°F)	ASTM D276	320 [1]	320 [1]
Mass/Unit Area, min (oz/yd^2)	ASTM D5261	7.0	4.0

[1] 320 is the softening/melting point of polypropylene. See Section IV for more on placement temperature.

C) Paving Grid: Type I, II, & III:

Materials used for paving grids must be comprised of fiberglass and must meet the requirements of Table 309:3. Some paving grids are self-adhesive, and some require nails for installation. Tack coat required for the installation of the asphalt overlay shall be specified with the paving grid. Refer to manufacturer's recommendations for tack coat type and application rate.

TABLE 309:3 Paving Grids				
Property	**Test**	**Type I**	**Type II**	**Type III**
Tensile Strength, min (lbs./in) [1]	ASTM D6637, Method A, modified	560 x 1,120	560	280
Aperture size, min (in)	Calipered	0.5	0.5	0.5
Elongation, max (%)	ASTM D6637	3	3	3
Mass per area, min (oz/yd^2)	ASTM D5261	16	10	5.5
Melting Point, min (°F) (fabric component, if applicable)	ASTM D276	420 [2]	420 [2]	420 [2]

[1] For Type I, machine, and cross direction respectively. Strengths for Type II and III are in both directions

D) Composite Paving Grids:

Type I, II, & III: Composite paving grids must consist of a fiberglass, polyester, or polyvinyl alcohol (PVA) paving grid integrated with a nonwoven geotextile and meet the requirements of Table 309:4. PG asphalt binders must be used for the installation of composite paving grids. Refer to manufacturer's recommendations for asphalt binder application rate.

TABLE 309:4
Composite Paving Grids

Property	Test	Type I	Type II	Type III
Tensile Strength, Min (lbs./in) [1]	ASTM D6637, Method A, modified	560 x 1,120	560	280
Aperture size, Min (in)	Calipered	0.5	0.5	0.5
Elongation, Max (%)	ASTM D6637	5	5	10
Mass per area, Min (oz/yd^2)	ASTM D5261	16	10	5.5
Melting Point, Min (°F) (fabric component)	ASTM D276	320 [2]	320 [2]	320 [2]

[1] For Type I, machine, and cross direction respectively. Strengths for Type II and III are in both directions.

[2] 320 is the assumed softening/melting point of PVA. See Section IV for more on placement temperature.

E) Pavement Repair and Bridge Deck Waterproofing Strip Membrane:

Materials used for strip membranes shall be comprised of composite self-adhering rubberized asphalt attached to a paving fabric, a paving mat or a paving grid and meet the requirements of Table 309:5.

TABLE 309:5
Paving Repair and Bridge Deck Waterproofing Strip Membrane

Property	Test Method	Type I
Strip Tensile Strength, min (lb./in)	ASTM D882	50
Puncture Resistance, min (lbs.)	ASTM E154	200
Permeance-Perms, max	ASTM E-96 Method B	0.05
Pliability - 1/4" Mandrel 180º Bend at -25 ºF	ASTM D146	No cracks in fabric or rubberized asphalt

309.03 EQUIPMENT

A) Equipment and Installer Certification

A qualified installer for the interlayer proposed on any project must have one or more interlayer crews that have been Nationally Certified by the proposed interlayer's manufacturer and are tasked with installing interlayers 100% of the time.

The qualified installer must use a manufacturer certified installation utility tractor capable of installing roll widths up to 13 feet, has an approved clutch tensioning system, and has adjustable height brooms. The qualified installer must use sanding equipment that is able to adequately spread clean sand up to 4 lb./sy uniformly over lane widths up to 13 feet.

For tack coat installations on Paving Grids only, the qualified installer must supply and/or use a distributor truck that can apply tack emulsions uniformly with a computerized rate control mechanism (accurate to 0.01 gal/sy), at temperatures up to 300 °F, without pooling, and able to spray at the manufacturers recommended application rate. ASTM D2995 must be used to verify the application rate of the distributor truck.

For PG asphalt binder installations for Paving Fabrics, Paving Mats, or Composite Paving Grids, the qualified installer must supply a distributor truck that can apply PG asphalt binders uniformly with a computerized rate control mechanism (accurate to 0.01 gal/sy), at temperatures up to 350 °F, without pooling, and able to spray at any of the manufacturers recommended application rates (greater than 0.10 gal/sy). ASTM D2995 must be used to verify the application rate of the distributor truck.

For the installation of Paving Fabrics, Paving Mats, or Composite Paving Grids, the qualified installer shall not use a 2nd or 3rd tier sub-contractor to perform any portion of the installation (e.g. applying asphalt binder with a PG asphalt binder distributor, and/or installing rolls with an approved fabric laydown unit)

The qualified installer must document the above requirements for the installer and equipment during the submittal process.

309.04 CONSTRUCTION METHODS

A) Ordering, Delivery and Storage

(1) When bidding / ordering the interlayer materials the paving contractor, with close collaboration with the qualified installer, must identify the lane widths and appropriate interlayer product roll widths for the given lane geometry and sequence of milling and paving.

(2) The contractor must provide the installer sufficient time to order the interlayer materials for a specific project, ideally 4 weeks for standard roll widths and 6 weeks for non- standard widths.

(3) For both on-site and off-site storage, the contractor must take all necessary precautions to maintain the integrity of the interlayer in a state equal to what existed at the time of testing and certification. This includes but is not limited to ultraviolet protection, protection against rodents, contaminant chemical abrasion, and any other harmful elements. Interlayer must be stored and handled in accordance with manufacturer's recommendations and must remain in supplier packaging until ready for use. The interlayer must not be removed from

packaging more than 7 days before the next layer of pavement structure is installed over it. The material must be kept covered and off the ground until installation to keep the material and cores dry.

(4) The City Engineer will examine all interlayer rolls for water or physical damage prior to installation. Damaged rolls should be marked, removed from site, and replaced at the contractor's expense.

B) Surface Preparation and Interlayer Placement

Manufacturer's instructions must be followed, including the following:

(1) A pre-pave meeting must be held no less than 14 days prior to paving or milling operations beginning. The pre-pave meeting may be held as part of the pre-construction meeting. The meeting participants must include the certified installer, the paving contractor, the City Engineer, at a minimum.

(2) The surface to be covered by the interlayer must be clean, stable, dirt/dust free and prepared according to the manufacturer's recommendations. On milled surfaces fine particulate should be removed by forced air / blowing equipment (e.g., backpack blowers, air compressors), in addition to mechanical brooms and/or vacuum sweepers. Cleaning equipment must not use water during the cleaning operation and thereby produce a dirt slurry.

(3) On milled surfaces, prior to installing a levelling course or an interlayer, cracks > ¼ inch must be filled with an agency approved material as required by these Standard Specification, City Standard Details, and the approved plans.

(4) Asphalt binder must be applied per manufacturer's recommendations, based on asphalt retention rate for each interlayer product and additional rate for anticipated surface condition of pavement. Asphalt binder must be a performance grade (PG 70-28) binder. PG 64-22 may be used when ambient temperatures are lower than 70 degrees F, with advanced approval by the City Engineer. The asphalt interlayer must be installed at or above the minimum temperatures recommended by City Engineer for asphalt paving. The asphalt binder type that will be used should be submitted to the Project Manager / City Engineer a minimum of 3 weeks prior to the start of the project.

(5) The paving contractor must use a qualified installer for the specific interlayer products being installed AND a manufacturer's representative must be on site for the first two days of installation. The installer must use mechanical or hydraulic interlayer laydown apparatus and/or manual installation methods capable of installing interlayer material with minimal wrinkles.

(6) Where interlayers with maximum elongation of 5% or less are specified on a milled surface, milling must be in accordance with Section 309, or special provision per the approved plans, to allow a pavement macrotexture MTD (mean texture depth) of less than 8.0 millimeters. As an alternative to fine / micro-milling, a leveling course may be placed on the milled surface prior to placing the geosynthetic pavement interlayer.

(7) Longitudinal and Transverse overlaps must follow the manufacturer's recommendations for each interlayer product. All overlaps should exceed a minimum of 2 inches in all cases.

(8) For the installation of Paving Fabrics, Paving Mats, Composite Paving Grids, at ambient temperatures above 70 degrees F, transverse joints should be sanded by hand before the

installation utility tractor crosses the joint. The sand should be distributed evenly across the entire transverse joint using hand or push brooms on each side of the laydown unit.

(9) Any installed interlayer found to be damaged or defective must be repaired per the manufacturer's recommendations or as approved by the City Engineer or removed from the jobsite and replaced by the Contractor at no additional cost to the City or the Awarding Public Agency. Mechanical equipment other than that used for installation and the paving equipment must not be permitted directly on the interlayer surface unless authorized by the City Engineer.

C) Sanding of Interlayer Product

For the installation of Paving Fabrics, Paving Mats, Composite Paving Grids, at ambient temperatures above 70 degrees F, sand must be broadcast over the entire installed interlayer surface using approved sanding equipment (e.g., Salt Dog or agricultural conical spreader) at a maximum rate of 4 lbs./sy. The sand must not conceal the interlayer, otherwise the sand application rate will need to be reduced, and the excessive sand redistributed. If the certified installer recommends that sanding is not necessary, then the contractor must get permission from the City Engineer to not broadcast sand.

D) Asphalt Overlay Placement

If hot mix asphalt (HMA) temperatures exceed 350°F, products with polypropylene fabrics must not be used. HMA must be placed at a minimum of 285°F, to ensure asphalt cement absorption into the pavement interlayers. The first lift of HMA must be at least 1.5 inches (38mm) compacted unless a different minimum thickness is recommended by the manufacturer. The City Engineer may remove pavement interlayer from the approved plans, if field conditions will not allow for this minimum thickness.

309.05 TESTING — VACANT

309.06 METHOD OF MEASUREMENT

Paving Fabric, *Paving Mat*, *Paving Grid*, *Composite Paving Grid*, and *Strip Membrane* shall all be measured in square yards and paid for at the contract square yard price. The quantity for payment will be measured as the actual area covered by the asphalt binder, tack coat emulsion if applicable, and interlayer installed-in-place and accepted. No separate or additional measurement will be made for overlaps or waste unless approved by the City Engineer.

309.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) PAVING FABRIC (TYPE) AND PG ASPHALT BINDER	Square Yard [Square Meter]
(B) PAVING MAT (TYPE) AND PG ASPHALT BINDER	Square Yard [Square Meter]
(C) PAVING GRID (TYPE) AND TACK COAT EMULSION	Square Yard [Square Meter]
(D) COMPOSITE PAVING GRID (TYPE) AND PG ASPHALT BINDER	Square Yard [Square Meter]
(E) STRIP MEMBRANE	Square Yard [Square Meter]

Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 310- MICRO SURFACING

310.01 DESCRIPTION

This section covers the materials, equipment, construction and application procedures for placing Micro Surfacing material, filling ruts, and surfacing existing paved surfaces. The Micro Surfacing must be a mixture of a polymer-modified asphalt emulsion, 100 percent crushed mineral aggregate, mineral filler, water and other additives for control of set time in the field. All ingredients must be properly proportioned, mixed and spread on the paved surface in accordance with this Specification and as approved by the City Engineer.

310.02 MATERIALS

Provide materials in accordance with Section 907 "Thin Surface Courses."

A) Aggregate Storage

Handle mineral aggregate in such a manner as to prevent segregation, mixing of the various materials or sizes, and contamination with foreign materials. The grading of aggregates proposed for use and as supplied to the project must be uniform. Suitable equipment of acceptable size must be furnished by the contractor to maintain the stockpiles and prevent segregation of aggregates. The aggregate must be passed over a scalping screen immediately prior to transfer to the Micro Surfacing mixing machine to remove oversized material.

B) Storage of Bituminous Material

Provide bituminous storage capacity of adequate to meet the requirements of the production rate. Keep all equipment used in the storage and handling of bituminous material in a clean condition at all times and operate in such a manner that there is no contamination with foreign matter.

310.03 EQUIPMENT

Submit all equipment, tools, and machines used in the performance of this work to the City Engineer for approval. Do not attempt any work with equipment that is malfunctioning. The City Engineer may order that the work be discontinued if sufficient equipment and tools are not in use to place the materials satisfactorily.

A) Mixing Equipment

Blend paving mixture with a self-propelled, positive, non-slipping aggregate delivery system (belt over chain) Micro Surfacing mixing machine. Ensure the machine has a continuous flow mixing unit able to accurately deliver and proportion the aggregate, polymer modified emulsion, mineral filler, field control additives and water to a revolving multi-blade, twin shafted mixer and discharge the mixed product on a continuous flow basis. Thoroughly blend the mixture so no uncoated aggregate is visible upon discharge from the mixing unit. Ensure the machine has self-loading material devices to allow continuous Micro Surfacing, thereby minimizing construction joints. Use a machine equipped with opposite side driving stations to optimize longitudinal alignment. Use a machine equipped to allow the operator to have full hydrostatic control of the forward and reverse speed during the application of the Micro Surfacing material. Continuous-run equipment will be required to ensure continuity of mix and reduction of start-up joints.

In some cases and with the City Engineer's approval, truck mounted units may be used for short narrow roadways, crossovers, and irregular areas. Ensure truck mounted units are equipped with a positive, non-slipping aggregate delivery system (belt over chain) and have the capability of applying a minimum of 10 tons of aggregate without recharging the aggregate bin.

(1) Water Pressure System

Use a mixing machine equipped with a water pressure system and nozzle type spray bar to provide a water spray ahead of and outside the spreader box as required

(2) Calibration & Proportioning Devices

Use a machine equipped with individual volume or mass controls or other gauging devices for measuring and proportioning each material added to the mix. Calibrate, properly mark, and positively interlock each material control device. Equip the aggregate feed to the mixer with a revolution counter or similar device so that the amount of asphalt emulsion, aggregate and mineral filler used may be determined at any time. Calibrate each mixing unit prior to commencement of the work. Perform calibrations and verify such calibrations in the presence of the City Engineer. Once calibrated, any aggregate and emulsion flow changes require the approval of the City Engineer. The water and additive may be adjusted in the field to control the mix properties to produce an acceptable mix. With the City Engineer's approval, previous calibration documentation covering the exact materials to be used may be acceptable provided they were made within the last three (3) months.

(3) Emulsion Pump

Use a heated positive displacement type emulsion pump.

Ensure the machine has a hydraulically adjustable (adjustable while applying mixture) type spreader box and positive screed adjustment for yield control. Attach a box to the mixer equipped with ribbon flights mounted on an adjustable shaft to continually agitate and distribute the material throughout the box.

Provide a box equipped with curb bumpers and replaceable runners with a minimum of 5-foot long end runners. Ensure the box is equipped with a sufficient walkway to provide access to either side of the spreader box without walking through the freshly applied material. The box must be capable of laying mix to a width of 14 feet. The equipment must provide sufficient turbulence to prevent the mix from setting in the box or causing excessive build-up or lumps.

To prevent the loss of mixture from the box, attach flexible seals, front and rear, in contact with the road. Use a full width application box equipped with a secondary strike-off located approximately 2 to 3 feet behind the primary strike-off to minimize transverse corrugations. Ensure the secondary strike-off has elevation and width adjustments similar to the primary strike-off, and has a pivot point where it can be tilted for texturing or raised completely off the surface.

The use of burlap drags or other drags necessary to obtain the desired surface texture, must be pre-approved by the City Engineer. Replace drags that have excessive build-up. Keep drags in a completely flexible condition at all times.

B) Auxiliary Equipment

Provide suitable surface cleaning equipment, barricading equipment, hand tools and other support equipment as necessary to perform the work.

310.04 CONSTRUCTION METHODS

Produce, transport, and place the specified materials in accordance with these Standard Specifications and as approved by the City Engineer. Provide a finished micro surfacing with a uniform texture free from excessive scratch marks, tears, or other surface irregularities. Ensure the cured mixture adheres fully to the underlying surface. Based upon a visual examination or test results, the City Engineer may reject any work due to poor workmanship, loss of texture, raveling or apparent instability. Repair any areas found to be deficient at the discretion of the City Engineer and at no additional cost to the City or Awarding Public Agency.

A) Seasonal and Weather Limitations

Not apply Micro Surfacing when weather conditions prolong opening to traffic beyond a reasonable time. Spread the Micro Surfacing mixture only when both the pavement surface and the ambient temperature is at least 50°F and rising, the weather is not foggy or rainy, and there is no forecast of temperatures below 32°F within 48 hours from the time of placement. Paving over ponded water is not allowed. Ponded water may be broomed and removed prior to placement.

B) Surface Preparation

Thoroughly clean the area to be surfaced to remove vegetation, loose aggregate and soil. Protect manholes, valve boxes, and other service entrances from the surfacing material. Unless otherwise approved by the City Engineer, pre-wetting of the surface will be required. Spray water ahead of and outside of the spreader box at an acceptable rate to dampen the surface without any free flowing water ahead of the spreader box.

C) Tack Coat

Normally, tack coat is not required unless the surface to be covered is extremely dry and raveled or is concrete or brick. Apply tack coat at a rate of 0.05-0.15 gal/yd^2 [0.23-0.68 L/m^2] of diluted emulsion diluted at 3:1 water to original emulsion. Allow the tack coat to set sufficiently before the application of Micro Surfacing. If a tack coat is to be required, it must be noted in the approved plans.

D) Application

(1) General

Construct a minimum 500 ft. length test strip for approval by the City Engineer.

Fog spray the surface with water ahead of the spreader box when local conditions warrant. The rate of application of the fog spray may be adjusted as the temperature, surface texture, humidity, and dryness of the pavement change. The fogging operation must be used to dampen the existing pavement surface and no ponding of water is permitted.

Screening aggregates at stockpile is required to eliminate oversize materials in the mix.

Fill ruts, utility cuts, and depressions in the existing surface with preliminary Micro surfacing material where indicated and before final surface course is placed. Ruts greater than ½ in. in depth must be filled independently with a rut filling spreader box, either 5 ft or 6 ft in width. For irregular or shallow rutting ½ in. or less in depth, a leveling course may be used as approved by the City Engineer. Use the same spreader box for the leveling course as used for the surface course. However, use a steel or high density strike-off in lieu of a flexible rubber. Using a rut fill spreader box, crown each individual rut fill to compensate for traffic compaction at a

rate of 1/8 in. per 1 in. of rut depth. Place rut filling and open to traffic a minimum of 24 hours prior to surfacing. All materials, mixture composition, equipment, and construction procedures and requirements must be as specified above.

Ensure the Micro Surfacing is the appropriate consistency upon leaving the mixer. Carry a sufficient amount of material in all parts of the spreader at all times to obtain complete coverage. Avoid overloading the spreader box. Lumpy or unmixed aggregate will not be permitted. Do not use aggregate either spilled from the lay-down machine or existing on the road. Do not leave streaks in the finished surfaces, and do not allow excess buildup, uncovered areas, or unsightly appearance on longitudinal or transverse joints.

Provide suitable width spreading equipment to produce minimum number of longitudinal joints throughout project. Place longitudinal joints on lane lines. Use partial width passes only when necessary. Do not use partial width passes as the last pass of any paved areas. Provide a maximum overlap of 3.0 in for longitudinal joints. Provide maximum difference in joint elevation of 0.25in [6.4mm] when measured by placing a 10ft [3m] straight edge over the joint and measuring the elevation difference.

(2) Mixture

Use Micro Surfacing of sufficient stability so that premature breaking of the material in the spreader box does not occur. Provide a homogeneous mixture during and following mixing and spreading, which is free of excess liquids. Do not spray additional water into the spreader box.

(3) Handwork

For surface areas which cannot be accessed by the mixing machine, use hand squeegees to provide complete and uniform coverage. Lightly dampen the area to be hand worked, if necessary, prior to mix placement. For handwork, exhibit the same finish as that applied by the spreader box as much as possible. Complete all handwork prior to final surfacing.

(4) Lines

Provide straight lines at intersections, curbs, and shoulders to yield a good appearance. Mask off the end of streets, if necessary, to provide a straight line. Longitudinal edge lines must not vary by more than ± 2 in. [± 51 mm] horizontal variance in any 96 ft [29 m] of length.

(5) Cleanup

Remove micro surfacing in all utility access areas, gutters and intersections as specified by the City Engineer. Remove all debris associated with the performance of the work on a daily basis.

E) Aggregate Application Rate

Control the spread rate for all full width Micro Surfacing, not intended as a leveling course, to within plus or minus two pounds per square yard of spread rate based on the weight of dry aggregate. Provide a full width spread rate of 18 pounds (for Type I) and 25 pounds (for Type II) per square yard, unless otherwise pre-approved by the City Engineer. A five-percent (5%) reduction in unit price will be applied for each pound of aggregate per square yard outside the spread rate tolerances established above for each day's placement of material. In lieu of pay reduction, the Contractor may elect to overlay the deficient area at no additional cost to the City or Awarding Public Agency. Do not continue operation and placement of materials outside the spread rate tolerances. Make adjustments as necessary in the placement operation to maintain production

within the tolerances given.

310.05 TESTING — VACANT

310.06 METHOD OF MEASUREMENT

The City Engineer will measure completed Micro Surfacing as the relevant mineral aggregate pay item, by the dry weight (including mineral filler), and as *Polymer-Modified Emulsified Asphalt* by the volume or weight of the original emulsion.

When payment for Micro Surfacing is to be by the ton of aggregate, including mineral filler, and gallon of asphalt emulsion, provide certified scales capable of providing an automated ticket printout for each truck load of material delivered to the Micro Surfacing machine. Payment requests must also include the project number, ticket number, truck number, date and batch weight of material loaded on each ticket.

Subtract the unused portion of emulsion from the total of the bill of ladings to determine total emulsion to be paid.

310.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) POLYMER-MODIFIED EMULSIFIED ASPHALT	Gallon [Liter] or Ton [Metric Ton]
(B) TYPE I MINERAL AGGREGATE	Ton [Metric Ton]
(C) TYPE II MINERAL AGGREGATE	Ton [Metric Ton]
(D) TYPE III MINERAL AGGREGATE	Ton [Metric Ton]

Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 311-HOT MIX ASPHALT / WARM MIX ASPHALT

311.01 DESCRIPTION

This section covers construction of one or more courses of bituminous mixture on the prepared foundation (roadbed or base).

This section covers the compaction of the asphalt mixtures utilizing intelligent compaction (IC) rollers within the limits of the work as described in the approved plans. Intelligent compaction is defined as a process that uses vibratory rollers equipped with a measurement and documentation system that automatically records various critical compaction parameters in real time during the compaction process. Intelligent compaction uses roller vibration measurements to assess the mechanistic properties of the compacted materials to ensure optimum compaction is achieved through continuous monitoring of the operations.

Intelligent compaction must be utilized on all asphalt on the project with the exception of drives,

driveways, tapered transitions associated with shoulders, ramps, acceleration, deceleration, climbing and turn lanes, and short isolated pavement areas requiring handwork.

Asphalt mixture includes Hot Mix Asphalt and Warm Mix Asphalt.

Hot Mix Asphalt (HMA) includes Superpave, Stone Matrix Asphalt (SMA), and Rich Bottom Layer.

Warm Mix Asphalt (WMA) is defined as an asphalt binder and aggregate mixture which, by additive or process, can be produced and placed at a reduced temperature from normal HMA temperatures. WMA requirements are the same as for HMA except where noted and specifically stated on approved plans.

311.02 MATERIALS

Provide asphalt materials in accordance with Section 908, "Plant Mix Bituminous Bases and Surfaces."

The use of RAP in Stone Matrix Asphalt (SMA), Permeable Friction Course (PFC), Rich Bottom Layer (RBL),Open Graded Friction Surface Course (OGFSC), Open Graded Bituminous Base (OGBB), or Rich Intermediate Layer (RIL) mixes will not be allowed.

311.03 EQUIPMENT

A) Mixing Plants

Provide asphalt preparation plants in accordance with AASHTO M 156 and the City's certification requirements.

Avoid exposing reclaimed asphalt paving material to the burner flame or high temperature combustion gases. Ensure plants modified for this purpose meet the manufacturer's requirements for the specific modifications.

Allow the City Engineer access to the mineral filler feeder systems for approval before use.

Provide a closed system for storing and feeding mixtures with mineral fillers that maintains a constant material supply with minimal loss throughout the mix production system. Ensure the mineral filler measuring device provides a consistent percentage of filler. Provide a system that includes flow indicators or sensing devices to automatically stop mix production if mineral filler introduction ceases.

Provide a separate system for mixtures with cellulose fibers to feed fibers into the mixture to obtain a uniform distribution. Ensure the fiber supply system includes low level, no-flow indicators and a file or printout that tracks the feed rate. Include a section of transparent pipe in the fiber supply for observing consistency of flow or feed.

The City or Awarding Public Agency will inspect plants every six months, and after every move, for plants that do not have a current ODOT certification.

B) Scales

Provide digital scales to weigh the bituminous mixture. For approved automatic printer systems with an automatic batching and mixing control system, use the printed batch weights or truck scales. Provide a weigh ticket for each load to record the weights. Provide ODOT certification of scales every six months, and after every move, unless otherwise pre-approved by the City Engineer.

C) Pavers

Provide self-contained, self-propelled asphalt pavers equipped with an activated heated screed, and an automatic control device for placing the mixture to the slopes and grades shown on the approved plans. Ensure the pavers can spread and finish asphalt courses on lanes, shoulders, and similar construction to the widths and thicknesses shown on the approved plans.

Equip the paver with a receiving hopper and a distribution system to uniformly place and spread the asphalt in front of the screed without causing asphalt segregation. Equipment designed to pick up asphalt from windrows will not be allowed.

Ensure the paver can operate at forward speeds to consistently place the mixture.

Use a heated strike-off assembly to produce a finished surface that meets the specified evenness and uniform texture without tearing, shoving, or gouging the mixture or causing asphalt segregation.

D) Trucks and Transports

Ensure trucks hauling asphalt comply with legal load limits. Ensure trucks hauling asphalt have tight, clean, smooth metal beds thinly coated with a minimum amount of soap solution, lime solution, or other material that prevents the mixture from adhering to the beds. Prevent ponds of these anti-adhesive solutions from forming in truck beds.

Refrain from using solutions that contain diesel fuel or other contaminating solvents during material delivery.

Provide trucks with a canvas cover or other material large enough to protect the asphalt from the weather. Insulate the truck beds and fasten the covers so that the mixture remains at the specified temperature until delivery.

Provide transports to haul liquid asphalt materials in accordance with Subsection 908.03, "Asphalt Materials." Keep a record of the following:

- Delivery date,
- Asphalt grade,
- Source,
- Quantity,
- Invoice number, and
- Material hauled in the previous load.

Provide these records to the City Engineer with each pay request.

E) Sampling Device

Provide an aggregate sampling device that can obtain a representative sample from a belt or bin discharge in accordance with ASTM D75/D75M. Allow the City Engineer access to the device for approval before use. Ensure the device obtains the sample before the aggregate enters the dryer drum or drum mixer without stopping plant production.

F) Material Transfer Vehicle

Material Transfer Vehicle (MTV) is defined as equipment that transfers asphalt from the hauling units to the spreading and finishing machine.

Provide an MTV to place Stone Matrix Asphalt (SMA) mixtures. The City Engineer may exempt use of the MTV from portions of a project.

Equip the MTV with remixing augers or paddles to remix continuously asphalt in the transfer device, the paver hopper insert, or the paver's hopper.

MTVs that exceed 20,000 lb [9,100 kg] per axle will only be allowed to cross bridges if the unit's hopper is empty, the vehicle travels at crawl speed, and the wheels are placed over the underlying beam lines. For bridges in poor condition or posted for load limits, the City Engineer may determine additional limitations.

Ensure the MTV, the haul units, and the paver provide a continuous, uniform, non-segregated flow of material. Coordinate the number of haul units, the paver's speed, the plant production rate, and the MTV's speed to avoid stop-and-go operations. Do not raise the wings of the paver-receiving hopper while paving.

In the event of equipment malfunction, continue operations to place quantities in transit or in silos and to safely maintain traffic. Discontinue further operations until equipment is repaired.

Place a 500-ton [450 metric ton] test strip. The City Engineer will evaluate the MTV's performance by measuring the temperature profile of the mat immediately behind the paver screed using a non-contact thermometer at intervals of 50 ft [15 m]. Each temperature profile consists of three surface temperature measurements taken transversely across the mat from 1 ft to 3 ft [0.3 m to 1 m] from the screed during the paving operations. Each profile will include three temperature measurements; one in the middle of the mat and two at the edges (1 ft [0.3 m] inside each edge).

Stop producing asphalt mix if two of the temperature measurements in any profile differ by more than 10 ºF [6 ºC]. Adjust operations before restarting the paving operation. The City Engineer may take additional surface temperature profiles during the project.

Contractors must use a Material Transfer Vehicle (MTV) when laying HMA surface course on an arterial street one half mile in length, or more.

G) Compactor

Use self-propelled, steel wheel, and pneumatic tired compactors. Ensure the steel wheeled compactors weigh at least 10 ton [9 metric ton]. Ensure the pneumatic tired compactors have at least seven pneumatic tires of equal size and diameter. Ensure the total weight of the tires produces an operating weight of at least 3,500 lb [1,588 kg] per tire. Inflate the tires to at least 90 percent of the maximum pressure recommended by the tire manufacturer. Maintain the tire pressure for at least 1 hour after the start of operations and ensure the range in pressure among the tires does not exceed 10 psi [68 kPa].

Supply sufficient numbers of rollers and other associated equipment necessary to complete the compaction requirements for the specific materials. Ensure that at least one IC roller is used. The required position for an IC roller is in the initial phase (breakdown) in the paving sequence. Use any additional IC rollers in the intermediate phase.

Provide the supplier, make, model, and unique identifier of the GPS system to be utilized. Sufficient training for the compactor operator(s) must be supplied by a representative of the manufacturer of the equipment.

(1) Breakdown Roller Global Positioning System (GPS) Requirements

Provide IC breakdown rollers equipped with GPS radio and receiver units to monitor the equipment locations and track the number of roller passes. GPS receivers must utilize the Universal Transverse Mercator (UTM), or the Oklahoma State Plane coordinate system, and

have a survey tolerance of not greater than 3.0 in [76.2 mm] in both the horizontal (x and y) directions. Once declared, utilize the same coordinate system for all rollers for the entire project.

Utilize GPS data in the following format:

TABLE 311:1
GPS Data Format

Data	Format	Example
Time	Military local time zone	hhmmss.ss
GPS	Latitude/Longitude, degrees/minutes, or decimal degrees	ddmm.mmmmmmmm dd.dddddddd
Grid	Feet	0.25 ft

(a) ***Intelligent Compaction Measured Values (IC-MV)***
Provide vibratory type IC breakdown rollers equipped with accelerometers to measure the interaction between rollers and compacted asphalt in order to evaluate the applied compaction effort. The output from the roller is designated as the Intelligent Compaction Measurement Value (IC-MV), which represents the stiffness of the materials based on the vibration of the roller drums and the resulting response from the underlying materials.

(b) ***Temperature Measurement***
Provide IC breakdown rollers equipped with non-contact temperature sensors for measuring pavement surface temperatures.

(c) ***Integrated On-Board Documentation System***
Provide IC breakdown rollers equipped with an on-board documentation system that is capable of displaying real-time color-coded maps of IC measurement values, including the stiffness response values, location of the roller, number of roller passes, pavement surface temperatures, roller speeds, vibration frequencies, and amplitudes of roller drums. Ensure that the display unit is capable of transferring the data by means of a USB port. Ensure the produced data files are compatible with the latest version of Veda IC data analysis software, available at www.intelligentcompaction.com.

H) Hand-Held Rovers

Provide a GPS system (including GPS receivers on equipment and handheld GPS receivers (i.e. Rovers)) that makes use of the same reference system that can be a ground-based base station or network-RTK (network-Real-Time Kinematic), to achieve RTK-GPS accuracy. Examples of combinations are:

- GPS receivers on equipment and hand-held GPS rovers referenced to the same on-ground base station.
- GPS receivers on equipment and hand-held GPS receivers referenced to the same network-RTK.

311.04 CONSTRUCTION METHODS

A) Stockpiling Materials

Deliver and stockpile aggregates in accordance with Subsection 109.17.05, "Stored Materials." Ensure sufficient material is on-site for each day's operation. Provide the City Engineer with daily quality control results.

B) Preparation of Materials

(1) Bituminous Material and Aggregate

Heat bituminous material and aggregate to temperatures in accordance with Subsection 908.03, "Asphalt Materials." Provide a continuous supply of bituminous material to the mixer. Avoid localized overheating.

(2) Dried and Heated Aggregate

Adjust heater unit flames to avoid damaging or depositing soot on the aggregate.

(3) Hot Dry Aggregates

Screen and store the aggregate for plants that control the gradation of hot dry aggregates as follows:

- At least two bins for Type S5 and Type S6 mixtures, and
- At least three bins for all other mixtures.

(4) Lime

Provide hydrated lime or commercial lime slurry as the anti-stripping agent as needed to meet the requirements of Section 908. Add between 0.5% and 2.0% hydrated lime or commercial lime slurry solids by weight of the aggregates treated as shown on the mix design. Incorporate the lime in a manner that thoroughly and uniformly distributes lime onto the aggregate surface or into the mixture. Use approved metering equipment, to ensure the required quantity of lime is used. Fines collected by the baghouse or other dust-collection equipment may be reintroduced into the mixing drum.

(a) ***Hydrated Lime***

Add to the aggregate by one of the following methods unless otherwise shown on the approved plans or mix design:

- Add lime in an approved pug mill mixer with damp aggregate containing water at least 2% above saturated surface dry condition.
- Add lime into the drum-mix plant immediately before asphalt binder addition or in the pug mill of the batch plant before asphalt binder addition. If a batch plant is used, add dry mix aggregates and lime before adding asphalt binder.

(b) ***Commercial Lime Slurry***

Add to the aggregate by one of the following methods unless otherwise shown on the approved plans or mix design:

- Mix commercial lime slurry in a suitable pugmill mixer with the aggregate.
- During mixture production, mix commercial lime slurry with aggregates between the plant cold feeds and the dryer or mixing drum.

C) Plant Startup Requirements for New Construction and Overlays

Use the mix design created for mainline construction to produce enough asphalt to calibrate the plant, testing equipment, and testing procedures before placing the asphalt. The City Engineer will sample and test the asphalt for asphalt cement content, aggregate gradation, air voids, and voids in mineral aggregate (VMA). Compare contractor test results with the City Engineer's; and contractor must make adjustments as necessary.

Use asphalt from the plant startup operation only to meet control strip requirements on temporary construction; do not place asphalt from the startup operations on the mainline. Make adjustments until all requirements are met. If no temporary locations are available, the plant startup mixture becomes the contractor's property at no additional cost to the City or Awarding Public Agency. The City Engineer may waive plant startup requirements if the same plant and location have previously successfully produced the same asphalt mix design.

D) Control Strip Requirements

If the approved plans requires less than 5,000 ton [5,000 metric ton] of an asphalt type, a control strip for that type of asphalt will not be required, unless otherwise indicated on the approved plans.

After meeting the plant startup requirements, construct at least one control strip on a detour to verify the required production mix characteristics and establish rolling patterns. If a detour is unavailable, construct on the shoulder; if a shoulder is unavailable, construct on the mainline. Place an initial asphalt control strip not exceeding 500 ton [500 metric ton]. With the City Engineer, sample and test this mixture for asphalt cement content, aggregate gradation, air voids, VMA, and roadway density. Place additional asphalt after evaluating the results and adjusting production and placement procedures as necessary.

If the City Engineer determines the initial placement of the asphalt control strip to be acceptable in accordance with Subsection 311.04.N(2)(a), "Basis of Acceptance and Payment," the City or Awarding Public Agency will pay for the control strip quantities in accordance with Subsection 311.04.N(2)(a), "Basis of Acceptance and Payment," and allow the contractor to proceed with production paving operations.

Unacceptable asphalt will not be allowed to remain in the mainline or the shoulder. Remove and replace unacceptable asphalt at no additional cost to the City or Awarding Public Agency.

Make adjustments to production and placement procedures if the placement of the initial asphalt control strip produces failing results, and repeat the test process for a second control strip. The City or Awarding Public Agency will make pay adjustments for deviations on the second asphalt control strip at the pay factor rate in accordance with Subsection 311.04.N(2)(a), "Basis of Acceptance and Payment." If required, create additional asphalt control strips on the shoulder until an acceptable mixture is produced (within the 100 percent pay factor range). The City or Awarding Public Agency will make pay adjustments for asphalt control strips after the second asphalt control strip placement in accordance with Subsection 311.04.N(2)(a), "Basis of

Acceptance and Payment."

E) Mixing

Combine aggregates in the mixer in accordance with the mix design. Measure or gauge the bituminous material in accordance with the mix design, and load into the mixer.

Ensure the moisture content of the asphalt is no more than 0.75 percent at the point of mixture discharge. Uncoated or non-uniform mixtures will not be accepted.

Ensure deliveries to the storage silo or roadway are in accordance with the mix design during daily startup or shutdown of plant operations. Empty the plant and fill the cold feed bins with the proper aggregates before changing mixtures.

F) Mat Irregularities

Ensure the mat is free of segregation, non-uniform texture, bleeding, fat spots, and cracking.

G) Tack Coat

If required by the approved plans, provide a tack coat in accordance with Section 307, "Fog Seal and Tack Coat."

H) Temperature and Weather Limitations

Ensure the minimum surface temperature of the foundation is in accordance with Table 311:1.

Table 311:2
Compacted Thickness and Surface Temperature

Lift Thickness, *in [mm]*	**Surface Temperature, °F [C]**		
	Hot Mix Asphalt	**Warm Mix Asphalt (Foamed)**	**Warm Mix Asphalt (Non-Foamed)**
>3 [>75]	40 [4]	35 [2]	35 [2]
2-3 [50-75]	45 [7]	40 [4]	35 [2]
<2 [<50]	50 [10]	45 [7]	40 [4]

Not place asphalt if frost exists in or on the foundation. Stop operations if the material becomes too cold to be leveled and consolidated. If it starts raining, stop plant production immediately. During adverse weather conditions, the contractor may place material already in transit; however, the contractor shall assume the risk of weather related impacts.

Not place SMA if the surface temperature is below 60 °F [16 °C].

I) Spreading and Finishing

Remove foreign material from the surface of the foundation before placing asphalt. Place the asphalt on a dry surface with a paver in accordance with Subsection 311.03.C, "Pavers." Establish the alignment along one pavement edge with a string or wire line.

Do not windrow asphalt. Deliver the asphalt to the paver at the optimum temperature shown on

the mix design ±25 °F [±14 °C] or as approved by the City Engineer, but not to exceed plant mix temperature of 345 °F [174 °C].

Use hand tools to dump, spread, rake, and compact the asphalt to the compacted thickness in areas inaccessible to mechanical spreading and finishing equipment shown on the approved plans.

To ensure a continuous operation, operate the spreading and finishing machine at a uniform forward speed consistent with the plant production rate, hauling capacities, and roller train capability. Maintain a paver speed that will minimize stopping and starting between trucks. If the City Engineer determines that sporadic material delivery is adversely affecting the mat quality, the City Engineer may direct paving operations to suspend until the contractor makes adjustments.

Spread the asphalt mixture uniformly adjacent to curbs, gutters, manholes, and other structures so that the compacted surface is ¼ in [6 mm] above the edges of the structures. Before placing the mixture against these structures, clean and coat them with a thin, uniform tack coat in accordance with Section 307, "Fog Seal and Tack Coat."

Correct unsatisfactory asphalt mat immediately. The City Engineer may suspend the paving operation until the contractor produces a satisfactory result. Remove and replace unsatisfactory asphalt as directed by the City Engineer at no additional cost to the City or Awarding Public Agency.

J) Joints

(1) General

Stagger longitudinal and transverse joints on succeeding layers by 6 in [150 mm].

Construct longitudinal joints within 1 ft [0.3 m] of the lane lines and ensure the longitudinal joints in the top asphalt layer, or in the layer upon which an open-graded friction course will be placed, are at the lane lines.

Bond and seal longitudinal and transverse joints. If making joints between old and new pavements, or between successive days' work, create a continuous bond between the surfaces. Cut back the transverse edge of the previous course to its full depth to expose a fresh surface. Paint the edge with a tack coat and place the asphalt mixture directly against it. Rake the mixture to the depth and grade shown on the approved plans.

(2) Longitudinal Joint Density

Perform a joint density evaluation at each pavement edge that is or will become a longitudinal joint for each lot or sublot at locations where roadway density tests are to be taken. Determine the joint density in accordance with ODOT Test Method OHD L-14. The joint density is considered failing if the density at the joint is more than 3.0 pcf below the density at the random sample location at the same station and the measured (by core or correlation) joint density is less than 90%.

Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if two (2) consecutive evaluations fail unless otherwise approved. Resume production after the City Engineer approves changes to production or placement methods.

K) Compaction

(1) General

Operate compactors (rollers) in accordance with the manufacturer's recommendations.

Perform the initial compaction for each placed layer of asphalt mixture using steel-drum rollers and follow with self-propelled pneumatic-tired rollers. Finish with a steel-drum roller. At least two coverages with the pneumatic-tired roller on each layer is required. The City Engineer may require additional coverages on each layer.

Use rakes and additional fresh material to correct the surface if mat displacement occurs during rolling. Avoid displacing the line and grade of the edges of asphalt. Ensure the mixture does not adhere to the compactors.

Compact the mixture using hot hand tampers, smoothing irons, or mechanical tampers for areas inaccessible to compaction equipment. If approved by the City Engineer, use a trench compactor to transmit compression to depressed areas.

Remove mixture that is defective, loose, broken, or mixed with dirt, and replace with new asphalt, at no additional cost to the City or Awarding Public Agency. Compact to conform to the surrounding area.

Ensure the asphalt immediately behind the paver is at least 250 °F [121 °C] for HMA or 215°F [102°C] for WMA. Before the temperature of the asphalt drops below 140 °F [60 °C], compact thicker layers to the target density and thinner layers to the optimum density in accordance with Subsection 311.04.K(2)(a), "Layers At Least 1½ in [38 mm] Thick," and Subsection 311.04.K(2)(b), "Layers Less Than 1½ in [38 mm] Thick."

(2) Acceptance

The City Engine will accept layers at least 1½ in [38 mm] in nominal thickness on the basis of density in accordance with Subsection 311.04.K(2)(a), "Layers At Least 1½ in [38 mm] Thick."

The City Engineer will accept layers less than 1½ inch [38 mm] in nominal thickness on the basis of compactive effort in accordance with Subsection 311.04.K(2)(b), "Layers Less Than 1½ in [38 mm] Thick."

The City Engineer will accept layers of all thicknesses on a lot-by-lot basis. A lot is every 1,000 ton [1,000 metric ton] of asphalt. The City Engineer may terminate a lot and designate a new one if the contractor makes adjustments to the material or production and placement procedures.

(a) ***Layers At Least 1½ in [38 mm] Thick***

The target density of each lot is 95 percent of the Maximum Theoretical Density, determined by the specific gravity of the asphalt in accordance with AASHTO T 209.

The asphalt density for each lot is the average of three random samples from the lot. At times and locations directed by The City Engineer saw or core samples from the pavement of at least 6 in [150 mm] on the cut side or diameter. The City Engineer will perform tests on the samples or on the mat using a nuclear density gauge that has been correlated with roadway cores in accordance with ODOT Test Method OHD L-14.

City-approved tests in accordance with the following schedule will be the basis for acceptance and pay adjustments, if any:

Table 311:3 Pay Adjustments for Lot Density	
Pay Adjustment Factor (PAF) [a] % of Maximum Theoretical Density	**Average Lot Density**
>97.0 [c]	**Unacceptable [b]**
93.0 – 97.0 [c]	**1.00**
92.0 – 92.9	**1.00 -(0.07)(92.0 -ALD)**
89.1 – 91.9	**0.93 -(0.15)(91.0 -ALD)**
<89.1	**Unacceptable [b]**

[a] Use PAF for Roadway Density in the Combined Pay Factor equation in accordance with Subsection 311.04.N(2)(a), "Basis of Acceptance and Payment."

[b] Unless otherwise directed by the City Engineer, remove and replace unacceptable lots at no additional cost to the City or Awarding Public Agency.

[c] For RIL only, replace 97.0 with 98.0.

(b) ***Layers Less Than 1½ in [40 mm] Thick***

Use test strips and monitor asphalt placement daily to obtain approval for rolling patterns generating optimum compaction. While the target is 95 percent of Maximum Theoretical Density, the City Engineer may base acceptance on the contractor's performance, as approved by the City Engineer, to obtain optimum compaction.

Compaction test strips consist of 500 yd^2 [500 m^2] of asphalt pavement.

Construct enough strips to determine the number, size, and weight of compactors, and the number of coverages made by the compactors to obtain the acceptable density. Use an approved nuclear or non-nuclear density gauge to determine the density of the test strip.

Construct a new compaction test strip if directed by the City Engineer or at least one of the following conditions exists:

- There is a change in the material or mix design;
- There is reason to believe a compaction test strip density is not representative of the material being placed; or
- The foundation material has changed significantly.

Compact the asphalt in accordance with the approved rolling pattern. Ensure the rolling sequence, the type of compactor, and the maximum roller speed are in accordance with Table 311:3.

Table 311:4 Rolling for Compaction		
Rolling Sequence	**Type of Compactor**	**Maximum Roller Speed, ft/s [m/s]**
Initial	Steel-Drum Or Pneumatic-Tired	3.7 [1.1]
Intermediate	Pneumatic-Tired	4.4 [1.3]
Finish	Static Steel- Drum	4.4 [1.3]

Lower the production rate or add rollers to the paving operation to avoid exceeding the maximum roller speeds.

(3) Documentation

Document asphalt pavement work in accordance with Subsection 311.04.K(2)(b), "Layers Less Than 1½ in [38 mm] Thick" if required by the approved plans. Include records of the City Engineer's authorizations and approvals, and the resulting corrective actions. Ensure the records include a detailed description of the equipment, including weight, tire pressure, speed, and the number of coverages. Ensure the roller operators and superintendent (or other contractor representative), sign the records at the end of each day's operation. Immediately after signing, submit the records to the City Engineer for inspection. Submit the records to the City Engineer at the conclusion of work on each day in accordance with Subsection 311.04.K(2)(b), "Layers Less Than 1½ in [38 mm] Thick."

(a) ***Intelligent Compaction***

1. GPS Setup

Prior to the start of production, the contractor and representatives of the GPS and equipment manufacturer must ensure that the equipment is set up and operating properly.

Conduct GPS setup daily during production operations to ensure consistency and accuracy of GPS measurements for all GPS devices prior to the compaction operation.

2. Quality Control During Rolling

In addition to any other QC responsibilities, the contractor is responsible for the following:

- Daily GPS check testing for the equipment and rover(s).
- Establishing target number of passes using data from standard testing devices (i.e. nondestructive density gauges, roadway density cores, and roller(s)).
- Using hand-held GPS rovers to determine the GPS coordinates of the selected roadway density core locations.

- Monitoring the equipment location during paving operations, and the operation of the entire GPS system on the project site.
- Quality control testing to monitor the pavement temperature.
- Downloading and analysis of the data from the roller(s) daily.
- Daily Setting-up, taking down, and securing storage of GPS and equipment components daily.

3. Materials Sampling and Testing

- Construct a test strip in accordance with Subsection 311.04.D of the Standard Specifications. Roll the test section at 100% coverage with optimal number of roller passes to achieve acceptable roadway density.
- Ensure a minimum coverage of 90% of the mat for the total project meets or exceeds the optimal number of roller passes when analyzed using Veda software.
- As a minimum, obtain the data from the equipment two times per day of asphalt compaction operations. Ensure the data is date and time stamped permitting external evaluation at a later time. The data may be requested at any time by the City Engineer.
- Provide access to the raw data and results from the analysis software to the City Engineer within 24 hours of obtaining the data.

4. Documentation

- Provide documentation of the manufacturer and model of the IC rollers used each day of paving. Note the relative positioning of the equipment in the paving operations.
- Upon the completion of the first day's paving, at a minimum, provide the City Engineer with the electronic data, including IC- MV, from the equipment and the data analysis software.
- Export all data from the vendor's software on a daily basis. Following each work day or shift, operators must make daily data files available to the City and Awarding Public Agency for personnel for review.
- At the completion of the project, provide a summary of all equipment data, coverage area and uniformity, and color prints of all compaction data to the City and Awarding Public Agency.

5. Assistance and Training

- *Technical Assistance*

  Coordinate for on-site technical assistance from the equipment representatives during the initial three days of production, and then as needed during the remaining operations. As a minimum, the equipment representative must be present during the initial setup and verification testing of the equipment. The equipment representative must also assist the contractor with data management using the data analysis software including data input and processing.

- On-Site Training

  Coordinate for on-site training for contractor and City or Awarding Public Agency project personnel related to operation of the technology. Contractor's personnel must include the paving superintendent, QC

technicians (if applicable), and equipment operators. At a minimum, training topics are to include:

- Background information for the specific system(s) to be used
- Setup and checks for system(s), GPS receiver, base-station and hand held rovers
- Operation of the system(s) on the equipment (e.g. setup data collection, start/stop of data recording, and on-board display options)
- Transferring raw data from the equipment (e.g. via USB connections)
- Operation of vendor's software in order to open and view raw data files and export all-passes and proof data files in Veda-compatible format.
- Operation of Veda software in order to import the above exported all-passes and proof data files, inspect maps, input point test data, perform statistical analysis, and produce reports for project requirements.

L) Tolerances

(1) Surface

Construct a finished pavement surface as shown on the approved plans and in accordance with Subsection 301.04.A(1), "Surface Elevation and Smoothness."

(2) Width and Thickness

Construct a finished pavement structure in conformance to the widths and thicknesses of individual layers and the total thicknesses of asphalt shown on the approved plans or approved by the City Engineer.

M) Opening to Traffic

Not allow traffic on the pavement until after final rolling and the pavement has cooled sufficiently to ensure traffic will not damage the pavement surface. Use water or other artificial means to assist in cooling, as approved by the City Engineer.

N) Mix Properties

(1) General

Provide quality control personnel to ensure the production of acceptable products. Ensure the quality control personnel oversee the process control of asphalt materials during handling, mixing, and placing operations.

At no time will the City Engineer provide instructions to the contractor or producer as to the setting of dials, gauges, scales, or meters; however, the City Engineer may advise the contractor or producer against continuing any operations or sequences of operations that will result in non-compliance with the approved plans requirements.

(2) Acceptance

The City Engineer will accept and pay for, or reject, each lot of asphalt pavement as defined in accordance with the following:

(a) ***Basis of Acceptance and Payment***

The City Engineer will consider asphalt cement content, air voids, and roadway density to determine acceptance and payment for asphalt pavement.

The City Engineer may use several test methods to determine acceptability of asphalt cement content, air voids, and roadway density (in accordance with Subsection 311.04.K, "Compaction"). The City Engineer will only use one test method, but may perform several tests using that method to measure each characteristic. The City Engineer will calculate the average deviation for each characteristic in accordance with Table 311:4, "Acceptance Schedule," and use the average to determine acceptance and calculate pay factors. For the characteristics of asphalt cement content and air voids, the City Engineer may disregard algebraic signs of the deviations to calculate averages. The City Engineer may address deviations above or below the target for these characteristics.

Perform sieve analyses in accordance with Subsection 908.04, "Composition of Mixtures," or as modified by the special provisions. If a sieve analysis result does not fall within the tolerances specified in the JMF, provide test results that demonstrate that the asphalt mixture meets the following requirements in accordance with Subsection 908.04, "Composition of Mixtures":

- The gradation falls within the broad band; and
- The air voids at N_{des} and VMA fall within the ranges.

The City and Awarding Public Agency reserve the right to require a new mix design if the broad band gradation, air voids at N_{des}, or VMA requirements are not met without additional cost to the City or Awarding Public Agency.

The City Engineer may apply calculated pay factors for asphalt cement content, air voids, and roadway density to all acceptable asphalt pavement. The City Engineer may consider additional pay factors for other characteristics including but not limited to smoothness. The City Engineer will base the total pay adjustments for deficiencies on the following:

- All pay adjustments will be based on the individual pay factors shown in Table 311:2, "Pay Adjustments for Lot Density" and Table 311:4, "Acceptance Schedule."
- Except for smoothness, pay factors will be applied on a lot-by-lot basis.
- For smoothness, pay factors will be applied on an extent-by-extent basis.

Pay adjustments on lots, (all characteristics except smoothness) as each 1,000 ton (1,000 metric ton) lot is complete, will be made for deficiencies in asphalt cement content, roadway density, and air voids using the following formulas. If test results are incomplete at that time, an interim adjustment will be made assuming pay factors of 1.00 for the then unknown characteristics and corrected later when testing is completed.

The City Engineer will determine the total pay adjustment (combined pay factor) for asphalt pavement with deviations, using the following equation:

$$CPF = \frac{4\,RD + 3\,AC + 3\,AV}{10}$$

Where:

CPF = Combined pay factor,
RD = Pay factor for roadway density,
AC = Pay factor for asphalt cement content, and
AV = Pay factor for air voids.

For layers less than 1½ in [38 mm] thick, the City Engineer will use a pay factor of "one" for roadway density. For permeable friction course, open-graded friction surface course, and open-graded bituminous base mixes, that do not have a target roadway density or target for air voids, the City Engineer will use pay factors of "one" for both roadway density and air voids.

(b) ***City Engineer's Acceptance Procedures***

Once a lot has been defined, maintain its identity throughout the mixing and placement process.

The City Engineer may perform varying amounts of the following sampling and testing per lot.

- Asphalt cement content test: one mixture sample randomly selected, split and tested in accordance with Table 311:4.
- Roadway density: three specimens randomly selected and each tested, averaged, and considered as one test in accordance with Table 311:2. Run one maximum theoretical specific gravity test or if applicable run two and average as one test split from the mixture sample.
- Air voids (lab-molded): two specimens split from mixture sample, tested, averaged, and considered as one test in accordance with Table 311:4.

The City Engineer will use Table 311:5 for determining acceptance and calculating pay factors:

Table 311:5
Acceptance Schedule

Characteristics	1 Test	Pay Factor
Deviation from JMF (Without Regard to Sign)		
Asphalt Cement Content (Extraction, Nuclear or Ignition Oven) Target JMF Percent	0.00 – 0.40	1
	0.41 – 0.80	1.40 - (Deviation from JMF)
	>0.80	Unacceptable [b]
Asphalt Cement Content (Digital Printout from Hot-Mix Plant) Target JMF Percent	0.00 – 0.20	1
	0.21 – 0.30	1.80 - 4 x (Deviation from JMF)
	>0.30	Unacceptable [b]
Average of Deviations from Target (Without Regard to Sign)		
Air Void (Lab Molded Samples) [a] Target	0.00 – 1.50	1

(Superpave, SMA) = 4% Target (RBL) = 2% Target (RIL) = 3%	1.51 – 2.50	$!0.16x^2 + 0.24x + 1.00$
	>2.50	Unacceptable b

[a] *X* is the average of deviations.

[b] Unless otherwise approved by the City Engineer, remove and replace unacceptable lots at no additional cost to the City or Awarding Public Agency.

O) Patching

Contractor must patch existing asphalt pavement as shown on the approved plans or as otherwise approved by the City Engineer.

P) Miscellaneous

On Residential Streets and low ADT Urban and Rural Arterials and Collectors, S5 Surface Courses and S6 Surface Courses contractor must use binder grade PG 64-22 OK with 15% Reclaimed Asphalt Pavement (RAP). Design mixes, including acceptable test results indicating a final surface performance grade of PG 64-22 OK will be required prior to approval of a mix by the City Engineer for use in the City of Oklahoma City.

On Major Collector and Arterial Streets, S5 Surface Courses and S6 Surface Courses contractor must use binder grade PG 70-28 OK with no Reclaimed Asphalt Pavement (RAP). Design mixes, including acceptable test results indicating a final surface performance grade of PG 70-28 OK will be required prior to approval of a mix by the City Engineer for use in the City of Oklahoma City.

Natural sand allowed in all mixes containing RAP will be reduced by an amount equal to the natural sand in the RAP, which is assumed to be 30%.

Where PG 70-28 OK or PG-78-28 OK asphalt is specified in the approved plans or proposal, the design mix must be based on > 3 million ESAL's.

It is the intent of these specifications to place a minimum of 0.94 x maximum theoretical density of the job mix design in pounds per cubic foot of Hot Mix Asphalt (HMA) resurfacing per square yard per inch thick of pavement to be surfaced. To allow for tolerance, HMA placed will be accepted for payment up to 1.02 x maximum theoretical density in pounds per cubic foot of the job mix formula per square yard per inch thick as shown on the Typical Section. In other words, the approved plan quantity cannot be exceeded by more than 9% or no additional payment will be made for the overage.

No additional payment will be allowed for HMA placed that exceeds the width or thickness shown on approved plans or approved by the City Engineer. The total weight of HMA placed for each square yard of pavement resurfaced shall be computed by dividing the total weight of HMA placed by the total square yards of pavement as shown to be resurfaced on the Typical Section and plans.

Low hanging tree limbs must be trimmed to allow the placement of hot mix asphalt. The cost of this work shall be included in other items of work.

(1) Warm Mix Asphalt Material Requirements

Upon approval by the City Engineer, Warm Mix Asphalt may be used.

(2) Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)

Use of post-manufactured RAS or post-consumer RAS is **not permitted**.

On Residential, Arterial and Collector Streets, a maximum of 15% RAP is allowed in S3 Base Courses.

311.05 TESTING

A) Pavement Thickness

It is the intent of these specifications that the pavement shall be constructed strictly in accordance with the thickness shown on the plans.

Where any pavement is found not so constructed, the following rules relative to core drilling pavement, replacement of the faulty pavement and adjustment of payment shall govern. All pavements shall be cored and measured for thickness before being accepted by the City as hereinafter provided.

Thickness verification and pay adjustments will apply to the driving lanes, unless otherwise specified in the Plans or Contract. Asphalt used for drives, street returns, shoulders, sidewalks or temporary pavements will be exempt from the thickness verification procedure.

All hot mix asphaltic pavements that will be maintained by the City will be tested according to the following:

(1) Overlay Projects with Designed Thickness Less Than 3 inches Thick:

Asphalt pavement for overlays less than 3" thick will be tested for thickness verification and accepted by the engineer on a "Lot" by "Lot" basis. For asphalt pavements less than 3" thick, a "Lot" is defined as one (1) day of plant production unless more than 2,000 tons of asphalt pavement are placed on the project during one day's production. When one day's production exceeds 2,000 tons, the total tons placed that day will be separated into two equal sized "Lots".

(2) Projects with Designed Thickness of 3 inches and Greater:

Asphalt pavement for projects that are 3" thick and greater will be tested for thickness verification and accepted by the City Engineer on a "Lot" by "Lot" basis. For asphalt pavements 3" thick and greater, a "Lot" is defined as 2,000' of 12' driving lane.

B) Core Drilling for Pavement Thickness Determination and Payment Reduction Calculation

All costs in connection with core drilling the pavement and refilling the core holes shall be borne by the Contractor. Core holes shall be filled and compacted in an acceptable manner with material matching the pavement from which the cores were cut. The coring of the pavement shall be performed by a City approved testing lab.

All asphalt pavements shall be cored and measured for thickness at a minimum of three locations per Lot as the City Engineer selects. The locations will be randomly spaced within the lot and not grouped together. Additional exploratory core locations will be added when the amount of thickness deficiency in any individual core falls within the "No Payment" classification, as further described herein.

The City Engineer will use the applicable Table 311:6 or Table 311:7 for acceptance and calculation of pay reductions due to thickness deficiencies discovered. The resulting Reduction in

Unit Price will be applied on a "Lot" by "Lot" basis as determined from the average Deficiency in Thickness of the three cores in that Lot. However, if any single core within a Lot has a Deficiency in Thickness that is in the "No Payment" range, exploratory cores will be taken to determine the limits of excessive deficiency and that area will be subject to correction or "No Payment" as directed by the City Engineer.

Table 311:6
TOLERANCE IN PAVEMENT THICKNESS
Overlay Projects with Designed Thickness Less Than 3 inches Thick

Deficiency in Thickness (Percent)	Penalty in Percent Reduction in Unit Price
0-5%	NONE
5-6%	5%
6-7%	10%
7-8%	15%
8-9%	20%
9-10%	25%
10-12.5%	50%
12.5-15%	75%
>15%	NO PAYMENT

Table 311:7
TOLERANCE IN PAVEMENT THICKNESS
Projects with Designed Thickness 3 inches and Greater

Deficiency in Thickness (Inches in Decimals)	Penalty in Percent Reduction in Unit Price
0.00" TO 0.25"	NONE
0.26" TO 0.30"	20%
0.31" TO 0.35"	30%
0.36" TO 0.40"	40%
0.41" TO 0.45"	45%
0.46" TO 0.50"	50%
0.51" TO 0.55"	70%
0.56" TO 0.60"	80%
0.61" TO 0.70"	90%
0.71" TO 0.75"	95%
OVER 0.75"	NO PAYMENT

The thickness of the asphalt will be determined by average of 9-point gage jig measurement of the thickness of each core, and the average thickness determined from the three cores for each Lot. In calculating the average thickness of the asphalt in a Lot, the maximum thickness of an individual core will be limited for core measurements that are in excess of the thickness specified on the plans. An individual core thickness will not exceed 5% more than the Designed Thickness for Table 311:6. An individual core thickness will not exceed 0.25" more than the Designed Thickness for Table 311:7.

The average thickness of the three cores per Lot shall determine the percent of Penalty that is used to calculate the Reduction in Unit Price for the tons/square yards so deficient. If the average thickness exceeds the Designed Thickness or is within the acceptable tolerance (i.e., 5% or less deficient for Table 311:6 or 0.25"or less deficient for Table 311:7), the contract unit price will be paid in full for the tons in that Lot. The tons subject to the Reduction in Unit Price will be the equivalent theoretical tons required to construct the designed thickness and lane width for the limits of the lane length as determined for that Lot.

Should any individual core show a deficiency that would result in a Reduction in Unit Price of "No Payment" (i.e., greater than 15% deficient for Table 311:6 or greater than 0.75"deficient for Table 311:7), exploratory cores shall be taken each direction to identify the limits of the lane subject to the "No Payment" reduction. Exploratory cores will be taken at intervals of at least 25', or as directed by the City Engineer, until the thickness of the pavement is within a tolerance that would result in a reduced price in lieu of "No Payment". The tons subject to the "No Payment" Reduction in Unit Price will be the equivalent theoretical tons required to construct the designed thickness and lane width for the limits of the lane length as determined by the exploratory coring.

If, in the opinion of the City Engineer, a deficiency in asphalt thickness subject to "No Payment" is sufficient to impair seriously the service expected from the pavement, the Contractor will be required to remove the deficient area and to replace it with slab of a satisfactory quality and thickness as directed. The Contractor will receive no compensation for materials or labor involved in the removal and replacement of the defective slab. If, on the other hand, in the opinion of the City Engineer, there is no probability of immediate failure, he may allow the Contractor the choice of leaving the defective slab in place and receiving no compensation or payment for same, or of removing and replacing the pavement as provided.

If the Contractor believes that the cores and measurements taken are not sufficient to indicate fairly the actual thickness of pavement, he may request that additional cores and measurements be taken. The cost of additional cores and measurements will be paid by the Contractor. Cores will not be spaced closer than ten (10) feet.

Deductions for deficient thickness may be entered on any estimate after the information becomes available. No pavement shall be accepted for payment until it has been cored and provisions of Section 311 have been adhered to.

311.06 METHOD OF MEASUREMENT

The City Engineer will measure asphalt pavement as a combined mixture including the aggregate, liquid asphalt, and other materials required in accordance with the mix design.

The City Engineer will measure bituminous material by the gallon [liter] or ton [metric ton].

Intelligent Compaction of Asphalt will be measured for payment on a Lump Sum basis.

311.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) SUPERPAVE, TYPE S3	Ton [Metric Ton]
(B) SUPERPAVE, TYPE S4	Ton [Metric Ton]
(C) SUPERPAVE, TYPE S5	Ton [Metric Ton
(D)SUPERPAVE,TYPE S6	Ton [Metric Ton]
(E) STONE MATRIX ASPHALT	Ton [Metric Ton]
(F) RICH BOTTOM LAYER	Ton [Metric Ton]
(G)SUPERPAVE, TYPE S3 (PATCHING)	Ton [Metric Ton]
(H) SUPERPAVE, TYPE S4 (PATCHING)	Ton [Metric Ton]
(I) RICH INTERMEDIATE LAYER	Ton [Metric Ton
(J) INTELLIGENT COMPACTION OF ASPHALT	Lump Sum

The City will pay for asphalt by the lot, in accordance with Subsection 311.04.N (2), "Acceptance," on the basis of acceptance test results.

The City or Awarding Public Agency will pay for asphalt used for control strip requirements in accordance with Subsection 311.04.D, "Control Strip Requirements," and Subsection 105.03, "Conformity with approved plans and Specifications."

Include the cost of startup operations in the contract unit price for the relevant asphalt pavement pay item.

Include the cost of cutting samples and replacing sample materials in the contract unit price for the relevant asphalt pay item. Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

The City or Awarding Public Agency will pay for tack coat in accordance with Section 307, "Fog Seal and Tack Coat."

The Lump Sum bid price constitutes full and complete compensation for all labor, materials, supplies, equipment, tools and incidentals required to complete the work in a manner accepted by the City Engineer.

SECTION 312-COLD-MILLING PAVEMENT

312.01 DESCRIPTION

This section covers cold-milling and removing pavement surfaces to the specified depth, and removing ridges, ruts, and imperfections.

312.02 MATERIALS — VACANT

312.03 EQUIPMENT

Provide a milling machine that:

- Can plane at least 1½ in [40 mm] deep in a single pass;
- Is self-propelled;
- Has the power, traction, and stability to maintain accurate depth of cut and slope;
- Automatically establishes profile grades along each side of the milling machine by referring to the existing pavement with a ski or matching shoe, or by an independent grade control;
- Automatically controls cross slope; and
- Has an integral loading mechanism to remove the material cut from the pavement surface and discharge it into a truck in one operation.

312.04 CONSTRUCTION METHODS

Mill the existing pavement to the line, grade, and cross section shown on the approved plans, and provide a milled surface that has a uniform texture and a smooth riding surface for traffic. Ensure no deviations are greater than $^{3}/_{16}$ in in a 10 ft [5 mm in a 3 m] section. Make corrections as approved by the City Engineer.

Make passes to remove irregularities and to profile the surface to the depth and cross slope shown on the approved plans. Prevent traffic hazards. At the end of the daily milling operation, ensure that milled surface is smooth. Immediately apply fog seal to the milled areas, in accordance with Section 307, "Fog Seal and Tack Coat," unless overlaying the milled area with bituminous material on the same day.

Dispose of removed materials in accordance with Subsection 104.09, “Removal and Disposal of Salvaged Materials, Structures, and Obstructions.”

A) <u>Proof Rolling</u>

(1) <u>Pavement (Milled and Non-milled)</u>

(a) *<u>Cold Milled Pavement</u>:*

Proof roll the milled pavement surface to detect areas in need of pavement repair. The vehicle provided must have an axle load of 34,000 pounds. Proof Rolling must occur within 48 hours of milling operations. The entire milled surface must be proof rolled at a walking speed so that the construction inspector can mark the areas in need of pavement repair.

(b) *<u>Non-milled Pavement</u>:*

For pavement that has not been milled, the contractor must use a vehicle of equivalent weight and axle loading to perform the proof rolling, as approved by the City Engineer. The other requirements and basis of payment are stated above.

(2) <u>Pavement-Locating Water Valve Boxes and Manholes</u>

Prior to cold milling the pavement, the contractor must locate all water valve boxes and manholes by painting a “V” or “MH” on the top of the adjacent curb and measuring the perpendicular distance from the face of curb. Said measurements must also be painted on the top of curb and be provided to the construction inspector in writing including the adjacent

address. If a water valve box or manhole has been previously covered and cannot be located, the contractor must nonetheless use all reasonable and necessary resources and methodologies to locate, adjust and construct a concrete collar around them per MD 11 or MD 12.

(3) Fine Milling of Hot Mix Asphalt (HMA) or Portland Cement Concrete Pavement

The removal of HMA or concrete pavement must be accomplished using a fine milling machine. The rotary drum must utilize carbide tip tools spaced not more than 5/16 inches apart. The forward speed of the milling machine must be limited to no more than 45 feet/minute.

Protection must be provided around existing catch basin inlets, manholes, utility valve boxes, and any similar structures. Any damage to such structures because of the milling operation is the contractor's responsibility and shall be repaired at the contractor's expense. To prevent the infiltration of milled material into the storm drainage system, the contractor must take special care to prevent the milled material from falling into the inlet openings or inlet grates. Any milled material that has fallen into inlet openings or inlet grates must be removed at the contractor's expense.

The milled surface must provide a riding surface with a uniform textured appearance. The milled surface must be free from gouges, longitudinal grooves and ridges, oil film, and other imperfections that are a result of defective equipment, improper use of equipment, or poor workmanship. The contractor, as directed by the City Engineer, must perform random spot-checks to assure the variation of the top of two ridges must not exceed ¼ inch. The variation of the top of any ridge to the bottom of the groove adjacent to that ridge must not exceed ¼ inch.

Any unsatisfactory surfaces produced are the responsibility of the contractor and must be corrected at the contractor's expense and to the satisfaction of the City Engineer. The depth of removal will be verified by the contractor by taking measurement every 250 feet per each pass of the milling machine, or as approved by the City Engineer. These depth measurements must be used to monitor the average depth of removal.

Where a surface delamination between HMA layers or a surface delamination of HMA on Portland Cement Concrete causes a non-uniform texture to occur, the depth of milling must be adjusted +/- ½ inch or until delamination is eliminated. No additional compensation shall be provided to remedy the delaminated surface. When removing a HMA pavement entirely from an underlying Portland cement concrete pavement, all the HMA pavement must be removed leaving a uniform surface of Portland cement concrete, unless otherwise approved by the City Engineer.

312.05 TESTING — VACANT

312.06 METHOD OF MEASUREMENT

This work will be measured for payment by the number of square yards of area from which the milling of asphalt has been completed and the work accepted. No area deductions will be made for minor un-milled areas such as catch basin inlets, manholes, utility boxes and any similar structures.

Clean the surface upon milling, and maintain the milled surface if left exposed to minimize dust, along with providing an asphalt wedge for pavement protrusions (valve boxes, manholes, etc.) bumps at

each end of the milled street, etc. to the satisfaction of the City Engineer at no extra cost to the City or Awarding Public Agency. Proper signage must be placed to warn citizens of the potential hazards. All resulting pavement failures must be repaired at no cost to the City or Awarding Public Agency.

312.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) COLD MILLING PAVEMENT	Square Yard [Square Meter]

The City or Awarding Public Agency will pay for fog seal in accordance with Section 307, "Fog Seal and Tack Coat" when required by the City Engineer.

This work will be paid for at the contract unit price per square yard for "Fine Milling" to the depth(s) specified. This price shall include all equipment, tools, labor, and materials incidental thereto. Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

No additional payments will be made for multiple passes with the milling machine to remove the bituminous surface.

No separate payments will be made for cleaning the pavement prior to paving; providing protection and doing handwork removal of bituminous concrete around catch basin inlets, manholes, utility valve boxes and any similar structures; repairing surface defects as a result of the Contractors negligence; providing protection to underground utilities from the vibration of the milling operation; removal of any temporary milled transition; removal and disposal of millings; furnishing a sweeper and sweeping after milling. The costs for these items shall be included in the contract unit price for Fine Milling.

SECTION 314-PORTLAND CEMENT CONCRETE PAVEMENT

314.01 DESCRIPTION

This section covers construction of the following types of portland cement concrete (PCC) pavement on a prepared base:

- Plain jointed (doweled or undoweled),
- Continuously reinforced,
- Bonded overlay (over existing PCC or asphalt pavements), and
- Unbonded overlay (over existing PCC or asphalt pavements).

314.02 MATERIALS

Provide materials in accordance with the following sections and subsections:

Materials:	Section or Subsection:
Portland Cement Concrete	901
Fly Ash	902.01
Ground Granulated Blast Furnace Slag	902.02

Provide bent tie bars in accordance with AASHTO M 31/M 31M, "Deformed Billet-Steel Bars for Concrete Reinforcement," Grade 40.

Obtain prior written approval from the City Engineer if using reclaimed PCC materials. The City Engineer will only allow the use of reclaimed PCC materials only on temporary pavement. Provide the materials in accordance with Section 901, "Portland Cement Concrete."

314.03 EQUIPMENT

Ensure the equipment is at the job site before construction begins.

A) Plants and Equipment

Ensure the batching plant includes bins, weighing hoppers, and scales for each size of fine and coarse aggregate. If using cement in bulk, include a bin, hopper, and separate scale for cement. Seal and vent the weighing hoppers to prevent dusting. Ensure gauges and dials function properly.

Give the City Engineer documented evidence that the batching plant produces quality concrete. Ensure the mixing plant is in accordance with AASHTO M 157, "Concrete Uniformity Requirements."

Regularly clean the mixers. Repair or replace the pickup and throw-over blades that are worn one-sixth or more of the original blade width. Provide the manufacturer's design or permanent marks on the blades to show the blade's dimensions and configurations in reference to original height and depth. The contractor will drilling holes with a diameter of ¼ in [6 mm] near the ends and midpoint of each blade as reference points.

Vent storage silos for cementitious materials during filling or use. If using a pressurized air system for discharge, ensure that it has moisture traps to reduce caking of materials during storage.

The City Engineer will inspect the plants every six months or after every move. Provide certification of scales every six months or after every move, unless otherwise approved by the City Engineer.

B) Placing and Finishing Equipment

Provide a slip form paver or fixed form method to spread, strike-off, and finish concrete, unless otherwise approved by the City Engineer.

(1) Slip Form Paver

Provide a slip form paver to spread, consolidate, screed, and float-finish the concrete in one pass of the machine, to minimize hand-finishing. Provide a machine that uses vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface. Ensure the machine vibrates for the full width and depth of the pavement.

Provide vibrating machines with following frequency ratings:

Table 314:1 Vibrator Frequencies	
Vibrator type	**Minimum frequency rating, *Impulses/min***
Surface Vibrators	3,500
Internal Type Tube Vibrators	5,000
Spud Vibrators	7,000
Spud Type Internal Vibrators	3,500

Ensure the spud vibrators do not come into contact with the joint, load transfer devices, subgrade, or side forms.

Prevent sliding forms from spreading using a rigid, lateral connection.

(2) Fixed Form Method

(a) *Finishing Machine*

Provide a finishing machine equipped with at least two oscillating-type transverse screeds for finishing the surface to the tolerances required by the approved plans.

Provide surface pan-type vibrators for pavement thicknesses no greater than 8 in [200 mm] or internal-type vibrators with immersed tubes or multiple spuds to consolidate the full width and depth of the pavement. Attach vibrators to the spreader or the finishing machine, or mount them on a separate carriage. Ensure the frequency ratings are in accordance with Table 314:1, "Vibrator Frequencies."

Ensure the vibrators do not come into contact with the joint, load transfer devices, subgrade, or side forms.

(b) *Vibrating or Rotary Strike-Off Screeds*

Provide forms and vibrating or rotary strike-off screeds to construct radii, inlet basins, gore areas, lane tapers, intersection quadrants, and areas inaccessible to mainline paving equipment. The City Engineer will not allow segregation or grout buildup. To achieve thorough consolidation and uniformity of the pavement, ensure the spud-type hand operated vibrators have a frequency rating of at least 3,500 impulses per minute.

(3) Texturing Equipment

(a) *Burlap Drag*

Provide fabric texturing equipment that consists of a drag of seamless strips of burlap or cotton that produces a uniform, gritty texture. Ensure a strip of fabric with a width of at least 3 ft [1 m] is in contact with the full width of the pavement during texturing. Ensure the drag consists of at least two layers of fabric. Ensure the bottom layer of fabric is 6 in [150 mm] wider than the top.

(b) *Transverse Finish*

Provide a texturing machine that is a vibrating roller or a comb, equipped with steel tines. Ensure the machine is self-propelled and automatically lifts the roller or tine comb bar near the edge of the pavement. The City Engineer will allow hand-texturing in areas

inaccessible to mechanical equipment.

(c) *Longitudinal Tining*

When longitudinally tining concrete pavement, use a mechanically operated tining machine with a single row of metal tines that covers the full width in a single pass at a uniform speed and depth. Provide a tining machine with automatic horizontal and vertical controls to ensure straight and uniform grooves. Ensure the tines produced meet the dimensional requirements of Subsection 314.04.I.(6)(a).

C) Concrete Saw

Provide a concrete saw that is conventional wet cut type or early entry dry cut type. Provide at least one standby saw. Maintain an ample supply of saw blades at the work site during sawing operations. Provide artificial lighting for night sawing.

D) Forms

Provide metal straight-side forms with thicknesses of at least $^{7}/_{32}$ in [5 mm] and lengths of at least 10 ft [3 m]. Construct forms to a depth equal to the concrete thickness shown on the approved plans, and capable of supporting equipment operating on the forms.

Use flexible or curved forms with devices for secure settings capable of withstanding equipment impact and vibration for curves with a radius of 100 ft [30 m] or less.

Ensure the flange braces extend out on the base at least two-thirds of the form height. Remove damaged forms, and use repaired forms that the City Engineer has inspected and approved. Ensure the top face of the form varies no more than ⅛ in in 10 ft [3 mm in 3 m] from a true plane, and alignment varies no more than ¼ in in 10 ft [6 mm in 3 m]. Clean the forms of concrete, grout, and other materials. Before use, cover the forms with a form-release agent.

E) Header Boards

Set header boards, cut to the cross section of the paving slab, parallel to the transverse joint if stopping paving operations and header boards are used. Design the boards to ensure accurate installation of dowels or tie bars as shown on the approved plans.

F) Floats

Provide mechanical or hand operated floats to smooth the concrete after strike-off and consolidation. Ensure the trowel blade of hand-operated floats are rigid, straightedge, from 12 ft to 18 ft [3.6 m to 5.4 m] long, and 8 in to 12 in [200 mm to 300 mm] wide. Ensure the float is capable of working longitudinally or transversely.

A finishing machine with the float pan type finisher may be used instead of a mechanical or hand-operated float if this method obtains the surface tolerances required by the approved plans.

G) Hand Tools

Provide work bridges, 10 ft [3 m] straightedges, and other hand tools to complete the pavement as required by the approved plans. Replace warped floats or straightedges and defective finishing tools.

H) Spraying Equipment

Provide fully atomizing equipment to apply the white-pigmented curing membrane. Ensure it is equipped with a tank agitator that will keep the compound mixed. Ensure the City Engineer can

verify the application rate based on tank capacity. Use pressure tank hand sprayers to apply the curing membrane to vertical surfaces, irregular areas, or edges after form removal.

I) Joint Sealing Equipment

Provide joint sealing equipment in accordance with Subsection 315.03, "Equipment."

J) Milling Machine

Provide a milling machine in accordance with Subsection 312.03, "Equipment."

K) Shot Blasting Equipment

Provide shot blasting equipment capable of collecting used shot and waste material. The City Engineer may allow the use of recycled shot.

314.04 CONSTRUCTION METHODS

A) Preparation of Existing Surface or Grade

(1) General

Trim the grade to the elevation shown on the approved plans after grading and compacting the roadbed. Extend the work at least 3 ft [0.9 m] beyond the edges of the concrete pavement. Ensure that subgrades and bases are in accordance with Subsection 301.04.A, "Tolerances." Ensure that asphalt base, bond breaker, and leveling course are in accordance with Subsection 301.04.A, "Tolerances." Ensure the milled surfaces are in accordance with Section 312, "Cold-Milling Pavement."

Correct the alignment and grade elevations of the forms and string lines immediately before placing the concrete. Reset and check disturbed forms or string lines.

Fill low areas with concrete during paving operations, not with material trimmed from bases or subgrades. Keep the grade smooth and compacted until pavement placement.

Ensure the subgrade or base is uniformly moist when placing the concrete unless waterproof subgrade or base course cover material is required by the approved plans.

(2) Unbonded Concrete Overlays

Construct the bond breaker as specified in the approved plans. When asphalt is specified, construct the base or leveling course in accordance with Section 311, "Hot Mix Asphalt / Warm Mix Asphalt." Clean the pavement surface before placing the asphalt. If required by the approved plans, mill the surface before concrete placement in accordance with Section 312, "Cold-Milling Pavement." After milling, tight blade the surface to remove ridges and loose material. Evenly distribute any remaining fine particles. Notify the City Engineer, if milling operations expose underlying concrete pavement. Spray exposed concrete with tack coat and cover with separator fabric.

(3) Bonded Concrete Overlays

(a) *Bonded Overlays on Concrete Pavement*

Remove medium and high severity pavement cracking before surface preparation and placement of the PCC overlay and replace as indicated. High severity pavement cracks are defined as shattered slabs, D-cracks into the wheel paths, broken slab corners into wheel paths, and cracks wider than ½ in [13 mm] that are faulting, spalled or scaled. Determine

pavement-patching limits as approved by the City Engineer.

1. Surface Preparation

Prepare the entire surface to be overlayed by thoroughly cleaning the surface by milling and then shotblasting, or just shotblasting. The use of water to clean the cold-milled debris from the surface will not be allowed as slurry may develop and weaken the bond between the overlay and the surface. Remove all dirt, oil, laitance, or loose material from the surface and edges. Remove excess joint sealant on the surface; leave joint sealant in the joint slot. Remove pavement markings, raised pavement markers, and adhesives. Dispose of materials removed in the cleaning operation in accordance with Subsection 104.09, "Removal and Disposal of Salvaged Materials, Structures, and Obstructions."

2. Surface Cleaning

Clean the entire surface with an oil-free, compressed air blast before applying the overlay to the surface. The City or Awarding Public Agency will allow the use of water for final cleaning only after the shotblasting operation, as approved by the City Engineer. Remove all freestanding water before placing concrete. After cleaning, the City or Awarding Public Agency will only allow the paving machine and the concrete delivery trucks to use the cleaned surface. Ensure the concrete trucks drive on the prepared surface directly in front of the paving machine. Prevent contamination of the cleaned pavement surface before placing the overlay. If the concrete becomes contaminated during concrete placement, stop production until the contamination is removed.

Do not contaminate the cleaned surface with oil, grease, water, mud, or other foreign objects from a concrete truck. Remove the truck from the cleaned surface, remove the contaminants, and ensure the truck is clean and repaired before returning to the project.

3. Joint Identification

Identify the exact location of both sides of contraction, expansion, and longitudinal joints in the existing pavement for sawing locations.

(b) ***Bonded Overlays on Asphalt Pavement***

Prepare the surface to be overlaid by cleaning and milling. Remove dirt, oil, laitance, and loose material from the surface and edges. Remove pavement markings, raised pavement markers, and adhesives.

B) Handling, Measuring, and Batching Materials

Ensure the batch plant and hauling equipment continuously supply material to the work site. Deliver fine and coarse aggregate to the plant in advance to allow time for sampling and testing. Ensure the concrete plant contains enough material for a full day of paving operations. Deliver and stockpile materials in accordance with Subsection 109.17.05, “Stored Materials.”

Measure and batch materials for concrete in accordance with AASHTO M 157, unless otherwise required by the approved plans. Weigh different aggregate sizes in separate hoppers. Measure the

cementitious material by weight. Use separate scales and hoppers with devices that indicate the complete discharge of the batch.

Use an electronically-controlled automatic batch weight and printer system that indicates the net batch weight of material delivered to the transporting truck. Ensure the weights are printed on a ticket that includes the quantities of admixtures and the volume of water incorporated into the load. Ensure the system is calibrated, inspected, and certified in accordance with Subsection 112.01, "Measurement of Quantities." Ensure the combined weights of the materials, when converted to a volume, are within 2 percent of the volume on the ticket, minus the target air content.

C) Mixing Concrete

Mix and deliver concrete in accordance with AASHTO M 157. Mix the concrete at the work site, in a central-mix plant, or in truck mixers. Obtain the City Engineer's approval as provided in these Standard Specifications, this Section 300, and the City Standard Details, and as for the type of truck mixer. Do not exceed the manufacturer recommended capacity. Place the mixed concrete no more than 1 hour after the water, cement, and aggregate are combined.

Mix the concrete from 45 seconds to 90 seconds if at the work site or a central mixing plant. Mixing time ends when the discharge chute opens. For multiple drum mixers, include the transfer time as part of the mixing time. Remove the contents of the mixer drum before starting the next batch.

Control the mixer's drum speed in accordance with the manufacturer's recommendations. The City Engineer may allow 10 percent overload of the mixer if the concrete does not spill and the concrete test data are satisfactory.

Ensure that a portion of the mixing water enters the drum before the cement and aggregates. Keep a uniform flow of water, and ensure that all water is in the drum within the first 15 seconds of the mixing. Keep the throat of the drum free from accumulations that restrict the flow of materials.

Adjust water to improve workability if transit mixers or agitators deliver the PCC. Increase mixing by 30 revolutions when adding water, and maintain the water to cementitious material ratio.

D) Light and Weather Limitations

Mix, place, and finish concrete when there is enough natural light, unless using artificial lighting approved by the City Engineer.

(1) Concrete Temperature

Ensure the temperature of the mixed concrete is from 50 °F to 90 °F [10 °C to 32 °C] during mixing, delivery, and placement. Protect the concrete quality through all weather conditions.

(2) Base Surface or Foundation Course Temperature

Place the concrete when the base temperature is below 110°F [43°C] when placing an unbonded overlay. Reduce the temperature by spraying a fine water fog on the base. Ensure water does not pond in front of the plastic concrete. For waterproof bases, the City Engineer may also allow the following temperature control measures:

- Apply white curing compound, or
- Apply lime slurry.

Do not place concrete if frost exists in the base.

Place concrete when the base temperature is below 110°F [43°C] if using bonded overlays. Cease paving operations if the base temperature exceeds 110°F [43°C]; do not attempt to reduce the base temperature because water and other agents prevent proper concrete bonding.

E) Setting Forms

If using formed paving equipment, set the forms to line and grade by shimming, or other methods approved by the City Engineer. Correct variations in the foundation course that prevent placing forms to the line or grade shown on the approved plans. Stake forms in place with at least three pins per 10 ft [3 m] section. Place a pin at each side of the joints. Tightly lock form sections, and ensure that there is no movement. Ensure the forms do not deviate from true line by more than ¼ in [6 mm]. The City Engineer will not approve forms that move under the finishing machine. Clean and oil forms before placing the concrete.

F) Placing Concrete

(1) General

Minimize rehandling when placing concrete on the grade. Discharge concrete into a spreading device and mechanically spread onto the grade to prevent segregation. Use truck mixers, truck agitators, or non-agitating hauling equipment capable of discharging concrete without segregation. Between transverse joints, place the concrete continuously without using intermediate bulkheads. Hand spread concrete with appropriate tools; do not use handheld vibrators to spread concrete. Ensure soil or foreign materials are not tracked onto the recently placed concrete.

Ensure concrete cures for at least 3 days before allowing finishing equipment on it for placement of adjacent lanes. Before allowing other equipment onto the pavement, ensure that the concrete attains a strength in accordance with Subsection 314.04.N, "Opening to Traffic."

Ensure continuous forward movement if using a slip-form paver. Coordinate mixing, delivering, and spreading operations to provide uniform progress, minimizing stopping and starting. Stop vibratory and tamping elements if the forward movement of the paver stops.

Consolidate concrete against the grade, face of the forms, and joint assemblies. Minimize the operation of vibrators in a single location to that required for consolidation.

Deposit concrete near expansion and contraction joints without displacing the joint assemblies.

Remove foreign materials that fall onto the completed slab as approved by the City Engineer.

Do not place concrete without an inspector present, unless otherwise approved by the City Engineer.

(2) Continuously Reinforced Concrete Pavement (CRCP)

Use a standard, white, wax-based curing compound on the asphalt at the rate of 1 gal per 150 ft² [1 L per 3.7 m²] to disrupt the bond between the asphalt and the CRCP. Allow the bond breaker to dry before placing the reinforcing steel bars.

(a) *Preparation of Steel Reinforcement*

Remove dirt, oil, paint, grease, mill scale, and loose or thick rust from the reinforcing steel. The City Engineer may consider minor, thin, powdery rust that does not reduce the effective cross section to not be detrimental.

(b) *Placement of Reinforcement for Continuously Reinforced Concrete Pavement*

Place reinforcement on chairs or high chair bars. Ensure the horizontal position is within ½ in [12 mm] of the longitudinal dimensions and within 2 in [50 mm] of the transverse dimensions shown on the approved plans. Place the quantity of longitudinal and transverse members as shown on the approved plans. Ensure the vertical position is within ½ in [12 mm] of the longitudinal and transverse dimensions shown on the approved plans. Handle the reinforcement so that the bars remain flat and undistorted during concrete placement. Ensure the bars are free from kinks or bends that prevent assembly or installation. If using forms, oil before placing reinforcement.

Install the chairs or high chair bars to support reinforcement as shown on the approved plans. Arrange the chairs to ensure the reinforcement is not permanently displaced during placement and consolidation. Ensure the base supports the chairs, and prevents overturning and penetration into the base.

Space high chair bars adjacent to other transverse members to allow for proper concrete placement; especially important at reinforcement laps.

Do not weld chairs to transverse bars.

Provide the City Engineer with a sample of the chair or high chair bar if requested. Show the chairs and layout on the Working Drawings. If the chairs do not support the reinforcement during concrete placement and finishing, take corrective action to ensure the final position of the steel as required by the approved plans.

If the reinforcement consists of loose bars constructed on the grade, secure the longitudinal bars to the transverse bars using wire ties or clips to maintain the horizontal and vertical positions as indicated.

(c) ***Lap Splices in Reinforcing Steel***

Lap the longitudinal reinforcing bars in a staggered pattern as shown on the approved plans. Secure laps in the longitudinal reinforcement by tying, fastening with clips, or otherwise securely fastening to ensure continuous reinforcement.

(3) Unbonded Concrete Overlays

Place concrete on the grade to the minimum thickness shown on the approved plans. The City Engineer may only allow deviations for profile adjustments, cross-section adjustments, or both to be above the nominal thickness. When adjustments are necessary for grade or yield improvement, the thickness must not, in any case, be less than the minimum thickness shown on the approved plans.

G) Test Specimens

Provide concrete necessary for acceptance testing.

H) Joints

Construct joints perpendicular to the surface of the slab of the type, dimensions, and locations shown on the approved plans. Align the joints using guidelines or devices approved by the City Engineer.

Ensure the sawed joints are straight and true to line; repair joints that are not. Seal the sawed joints in accordance with Subsection 315.04, "Construction Methods."

(1) Longitudinal Joints

Saw and seal longitudinal contraction joints. Do not construct joints by any other method. Place deformed steel tie bars of a length, size, spacing, and material as indicated, perpendicular to the longitudinal joint. Place tie bars using mechanical equipment after concrete placement, or secure tie bars using supports to prevent displacement during concrete placement. Repair or replace loose bars at no additional cost to the City or Awarding Public Agency. Bars will not be allowed to be painted, coated, or enclosed in tubes or sleeves.

Saw the longitudinal contraction joint to the depth shown on the approved plans, without damaging the pavement or joint. Clean the sawed areas of dust, chalk, and contaminants and fill with an approved joint-sealing material.

Allow the joint sealant to cure before allowing construction equipment and other vehicles on the pavement. Adjacent surfaces should not vary by more than ⅛ in [3 mm] using a 10 ft [3 m] straightedge.

(2) Transverse Joints

(a) *Expansion or Isolation Joint*

Make the expansion joint filler continuous from form to form. Shape it along the form from the base to the keyway. Provide lengths of joint filler equal to the width of the pavement, or the width of one lane.

Use joint filler that is not damaged or repaired.

Punch pre-molded joint filler to the diameter of the dowels. Unless otherwise approved by the City Engineer, use lengths equal to the width of the pavement. If placing two or more traffic lanes of pavement, use pre-molded filler in sections equal to the width of one lane. Clip or lace joint filler sections together if there is more than one section per joint. Extend the bottom edge of the filler to below the bottom of the slab. Unless otherwise required by the approved plans, ensure the top edge is 1 in [25 mm] below the surface of the pavement. While the concrete is being placed, protect the top of the filler using a metal channel cap of at least 10-gauge material, with flanges at least 1½ in [38 mm] deep.

Withdraw the installing bar after striking off and placing the concrete on both sides of the joint, and leave the pre-molded filler in place. Before removing the installing bar and channel cap, vibrate the concrete and incorporate additional, freshly mixed concrete into depressions left by the installing bar. Expose the filler for the full width of the slab. Clean and re-oil the installing bar before installing the next joint. After removing the side forms, open the ends of the transverse joints at the edges of the pavement for the depth of the slab. Before opening the pavement to traffic, seal or top out pre-molded joints with joint-sealing filler required by the approved plans. Leave a uniform strip of joint-sealing filler slightly below the surface of the pavement.

Use steel templates or other joint-forming dividers to construct concrete curbing joints that cannot be sawed, and install them at the locations indicated during concrete placement.

(b) *Contraction Joints*

Form transverse contraction joints by sawing to the depth as indicated without damaging the pavement or joint. Saw succeeding joints consecutively from the beginning to the end of the day's run, and saw all transverse joints soon enough to prevent uncontrolled transverse cracking.

Clean and dry the sawed area. Keep it free from dust, chalk, contaminants, and spalling. Fill the sawed area with joint sealing material. Ensure the curing period for joints is complete before allowing construction equipment and vehicles on the pavement.

(c) ***Transverse Construction Joints for Jointed Pavement***

Construct transverse construction joints when concrete operations are interrupted for more than 30 min, or as field conditions require during concrete operations. Ensure transverse construction joints are not constructed within 10 ft [3 m] of expansion or contraction joints. If, at the time of interruption, not enough concrete has been placed to form a slab at least 10 ft [3 m] long, remove the concrete to the preceding joint and dispose of in accordance with Subsection 104.09, "Removal and Disposal of Salvaged Materials, Structures, and Obstructions."

Provide a rigid header with holes or slots for dowel bars with the same spacing and dimensions of an expansion joint. Submit alternative header construction methods to the City Engineer for approval.

(d) ***Transverse Construction Joints for Continuously Reinforced Concrete Pavement***

Install a transverse construction joint at the end of each work day or when paving operations are interrupted for more than 30 min, or as field conditions require during concrete operations. Form the joint by placing the concrete against a header board. Extend the longitudinal reinforcing steel through the header board and support from the base to prevent deflections.

Cover the reinforcement that extends beyond the header board with sheets of plywood or other material so that workers can walk on the steel without displacing it and concrete does not spill on the base during screeding operations.

Make construction joints and lap splices as shown on the approved plans.

Use hand vibrators to consolidate pavement areas adjacent to the sides of transverse construction joints and refinish the surface. Extend these areas at least 10 ft [3 m] from the joint. Ensure the adjacent surfaces do not vary by more than ⅛ in [3 mm] using a 10 ft [3 m] straightedge.

(3) Lightweight Early-Entry Saw Joints

The City Engineer may allow the construction of transverse joints using a lightweight, early-entry saw.

Ensure the blade is ⅛ in [3 mm] thick and the sawed joint is at least 1½ in [38 mm] deep. Saw joints in accordance with the manufacturer’s recommendation. Begin sawing the joint when the concrete is hard enough to cut without raveling, chipping, spalling, or tearing. The City Engineer will inspect the sawed faces to ensure that early cutting does not cause joint undercutting. Delay sawing if undercutting is deep enough to cause structural weakness or excessive joint roughness. Saw the joints consecutively at the spacing required by the approved plans. Immediately after sawing, clean the cut and adjacent concrete surface. Re-spray damaged membrane-cured surfaces. Inspect the lightweight early-entry saw joints the next day. If a crack is not evident within 24 hour, re-saw the joint to a depth of T/3. Clean and seal joints in accordance with the manufacturer's recommendations, unless otherwise required by the approved plans.

Saw joints directly over existing transverse and longitudinal joints for bonded concrete overlays, and using the following methods:

- Overlay sections equal to or less than 4 in [100 mm] thick; saw the joints ½ in [12 mm] deeper than the overlay concrete; and
- Overlay sections thicker than 4 in [100 mm]; saw joints to a depth of T/3.

Saw the joints without causing excessive raveling, chipping, spalling, or tearing. Clean and seal joints in accordance with the manufacturer's recommendations, unless otherwise required by the approved plans.

(4) Load Transfer Devices

The placement method of load transfer devices is optional.

Hold or mechanically place load transfer devices as shown on the approved plans. Place dowels parallel to the surface and centerline of the slab and vary no more than ⅜ in [9 mm] from the position shown on the approved plans. Cap expansion joint dowels as shown on the approved plans. Check the placement of mechanically injected dowel bars using a SOILTEST Model CT-4950A Micro-Covermeter, or an approved equivalent.

I) Final Strike off, Consolidation, and Finishing

(1) General

Perform strike off, consolidation, and finishing in the following sequence:

- Strike off and consolidate,
- Float and remove laitance,
- Straightedge, and
- Finish the final surface.

Do not apply water to the concrete surface to assist in finishing operations, unless the City Engineer approves otherwise. If the application of water is approved, apply as a fog spray using approved spray equipment.

(2) Finishing at Joints

Compact the concrete adjacent to the joints using mechanical vibrators to prevent voids between the concrete and the joint material, load transfer devices, and joint assembly units.

(3) Slip-Form Paving

Use the slip-form paver to strike-off, consolidate, and initially finish the concrete. At the beginning of the day's paving operation, straightedge the construction joint and the initial slab longitudinally and transversely until the machine produces slab smoothness in accordance with Subsection 301.04.A, "Tolerances."

Ensure the edge of the pavement slab meets the elevations as indicated, and test using a 10 ft [3 m] straightedge perpendicular to the centerline of the roadway. Ensure the outer 6 in [150 mm] of the pavement does not deviate more than ¼ in [6 mm] from the bottom of the straightedge. Test for compliance throughout the paving operation.

Correct valleys or depressions that do not drain, at no additional cost to the City or Awarding

Public Agency. Limit hand-finishing to correction of surface defects.

(4) Fixed-Form Paving

(a) *Machine Finishing*

Strike-off and screed freshly placed concrete using a finishing machine. Ensure the machine consolidates the pavement and creates a uniform texture. Keep the tops of the forms clean. To prevent an irregular finish, ensure the machine travels on the forms without lifting, wobbling, or moving unnecessarily.

Maintain a uniform ridge of concrete in front of the screed during the first pass of the finishing machine. Use a vibrator in accordance with Subsection 314.03.B, "Placing and Finishing Equipment," to vibrate the full width of concrete paving slabs.

(b) *Hand Finishing*

The City Engineer will allow hand-finishing methods under the following conditions:

- If the paving equipment breaks down, the concrete deposited on grade and in transit; and
- In narrow or irregular areas.

Hand finish in accordance with Subsection 301.04.A, "Tolerances." Use a portable screed to strike-off the freshly placed concrete.

Use a screed at least 2 ft [0.6 m] longer than the maximum width of the slab. Use a vibrator or other equipment to consolidate the freshly placed concrete.

Move the screed on the forms, in the same direction as the paving operation, with combination of longitudinal and transverse shearing motions. Ensure the ends of the screed do not rise from the side forms during strike-off. Repeat this process to produce a uniform surface and texture, free of porous areas.

(c) *Floating*

Use a float to smooth and true the concrete after consolidating and striking-off the concrete.

Use long-handled floats to smooth and fill-in porous areas. Maintain the crown in the pavement. After floating, remove excess water and laitance with a straightedge. Lap successive passes one-half the length of the float blade.

(5) Straightedge Testing and Surface Correction

Use a 10 ft [3 m] straightedge to test the smoothness of the concrete surface while the concrete is still plastic and after floating and removing excess water. Hold the straightedge against the surface parallel to the road centerline. Advance the straightedge in successive stages of no more than one-half the length of the straightedge. Fill depressions with freshly mixed concrete, then strike-off, consolidate, and refinish. Cut and refinish high areas. Ensure that the adjacent surfaces across joints are smooth. Continue straightedge testing and surface corrections until the entire surface conforms to the grade and typical section shown on the approved plans.

(6) Texturing

Use a texture burlap drag before the pavement final finish to produce a uniform surface of gritty texture on the entire pavement surface. For pavement at least 16 ft [4.8 m] wide, mount the burlap drag on a bridge. Clean the drag of encrusted mortar; Replace permanently encrusted drags with new ones.

(a) ***Final Groove Finish***

Mechanically groove and texture the driving lanes and ramps in a longitudinal direction when dragging is complete, as approved by the City Engineer. Grooves on shoulders will not be required, unless required by the City Engineer or otherwise required by the approved plans.

Tine the surface as specified herein, on any roads or streets with a posted speed limit of 45 mph or less or obtain written approval from the appropriate local official to provide an alternate finish. At least 14 days before beginning paving, submit the proposal with documentation of local impact to the City Engineer. Written approval from the City Engineer replaces the need for a change order, price adjustment, or both.

1. ***Transverse Finish***

Construct transverse grooves perpendicular to the centerline of the pavement. Transverse grooving consists of creating transverse grooves from ⅛ in to $^{3}/_{16}$ in [3 mm to 4.8 mm] wide, from ⅛ in to $^{3}/_{16}$ in [3 mm to 4.8 mm] deep, and spaced on a rake as shown on the approved plans.

Repeat the grooving pattern across the pavement. Form the grooves in the plastic concrete without tearing or bringing the coarse aggregate to the surface. Ensure the machine automatically lifts the roller or tines near the edge of pavement. Ensure the overlap between grooving passes is less than 3 in [75 mm].

Use hand-groove methods in areas inaccessible to mechanical grooving equipment.

Identify the location of transverse contraction joints and ensure the nearest grooves are from 1 in to 3 in [25 mm to 75 mm] from the contraction joints before tining transverse grooves.

2. ***Longitudinal Finish***

Construct longitudinal grooves parallel to the centerline of the pavement when specified in the approved plans. Longitudinal tining consists of creating longitudinal grooves from ⅛ in to 3/16 in [3 mm to 4.8 mm] wide, from ⅛ in to 3/16 in [3 mm to 4.8 mm] deep, and spaced from ½ in to 1 in [12 mm to 25 mm] apart. Ensure the tining operation is done at such a time and manner that the desired surface texture is achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets. Start the grooves at least 6 in [150 mm] from the edge of the pavement. If the concrete pavement has concrete curbs, start the grooves at least 12 in [300 mm] from the face of curb. Ensure a 2 in to 3 in [50 mm to 75 mm] wide strip of pavement, centered about any intermediate longitudinal joints in the concrete pavement surface, is protected from longitudinal surface tining for the length of the concrete pavement surface.

Use hand-tining methods in small, isolated areas inaccessible to mechanical grooving equipment. Alternates to longitudinal tining may be allowed with the approval of the City Engineer.

(b) ***Edging at Forms and Joints***

Round the edges of the pavement along the sides of the slab to the radius as shown on the approved plans after the final finish, but before the concrete sets. Produce a well-defined and continuous radius and obtain a smooth, dense mortar finish. At the joints, broom the surface to eliminate tool marks adjacent to the joints without damaging joint edges.

Test the joint smoothness before the concrete has set and make corrections in accordance with Subsection 314.04.H, "Joints."

J) Curing

Cover and cure the entire surface of the newly placed concrete immediately after completing the texturing operations so marring of the concrete will not occur, in accordance with one of the following methods:

- Cotton or burlap mats,
- Impervious membrane method,
- White polyethylene sheeting, or
- Curing for cold weather.

Failure to provide sufficient cover material, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concrete operations. Concrete may not be left exposed for more than 30 min between stages of curing or during the curing period.

(1) Cotton or Burlap Mats

Cover the pavement surface with mats. Use mats long enough or wide enough to extend beyond the edges of the slab by at least twice the thickness of the pavement. Saturate the mats with water. Secure the mats to keep in contact with the surface. Ensure the mats are moist for 72 hour after concrete placement, unless otherwise required by the approved plans or approved by the City Engineer.

(2) Impervious Membrane

Uniformly spray the pavement with white-pigmented curing compound in accordance with Subsection 901.07.C, “Liquid Membrane Curing Compounds” immediately after texturing operations and before the concrete sets. If the pavement is initially cured with cotton or burlap mats, apply the curing compound after removing the mats. Avoid applying the curing compound during rain.

Use a mechanical sprayer, in accordance with Subsection 314.03.H, “Spraying Equipment” to apply the curing compound at a minimum rate of 1 gal per 200 ft^2 [1 L per 5 m^2]. If the temperature on the roadway is more than 100 °F [38 °C], apply the curing compound at a minimum rate of 1 gal per 150 ft^2 [1 L per 3.75 m^2].

Ensure the compound is thoroughly mixed and the pigment is uniformly dispersed. The City Engineer will allow hand spraying irregular widths, shapes, and surfaces exposed by removed forms. Ensure the curing compound is not applied to the inside faces of joints.

Ensure the curing compound creates a film that will harden within 4 hour of application. Use additional compound to repair damage to the membrane that occurs during the curing period.

Apply curing compound to the sides of the slabs upon removing the side forms.

Apply the curing compound immediately after texturing operations for bonded overlays at a

minimum rate of 1 gal per 100 ft² [1 L per 2.5 m²], or as recommended by the manufacturer, to prevent moisture loss.

(3) White Polyethylene Sheeting

Cover the surface and sides of the pavement with polyethylene sheeting. Use sheeting long enough or wide enough to extend beyond the edges of the slab by at least twice the thickness of the pavement. Overlap adjacent sheeting units at least 18 in [450 mm]. Secure the sheeting to keep it in contact with the surface. Ensure the sheeting remains in place for 72 hour after concrete placement, unless otherwise required by the approved plans or approved by the City Engineer.

(4) Curing for Cold Weather

Maintain the quality and strength of the concrete during cold weather. Replace frost-damaged concrete at no additional cost to the City or Awarding Public Agency.

K) Removing Forms

Avoid damaging the pavement while removing forms. Cure the sides of the slab in accordance with Subsection 314.04.J(2), "Impervious Membrane." Repair honeycombed areas.

L) Sawing and Sealing Joints

Saw and seal joints in accordance with Subsection 315.04, "Construction Methods." Provide joints as shown on the approved plans.

M)Protection of Pavement

Protect the pavement from damage due to any traffic. If damage occurs to the pavement before the area is open to traffic, repair or replace the damaged sections at no additional cost to the City or Awarding Public Agency.

N) Opening to Traffic

Not allow traffic on the pavement for at least 14 days after concrete placement, unless otherwise approved by the City Engineer. The City Engineer may approve opening the pavement to traffic when it reaches the strength requirement in accordance with Subsection 901.01, "Mix Design and Proportioning." With the approval of the City Engineer, the contractor may use maturity meters for the basis of form removal or opening roadways to traffic, at no additional cost to the City or Awarding Public Agency. Submit an approved plan for the use of maturity meters.

O) High-Early-Strength Concrete Pavement

Use high early-strength concrete pavement in accordance with Section 901, "Portland Cement Concrete." Do not allow traffic on the pavement until it reaches the strength requirement in accordance with Subsection 901.01, "Mix Design and Proportioning."

P) Protection Against Rain

Protect the surface from rain. Repair or replace damage due to rain, at no additional cost to the City or Awarding Public Agency.

Q) Tolerances

(1) Surface

Construct a finished pavement surface as shown on the approved plans and in accordance with

Subsection 301.04.A(1), "Surface Elevation and Smoothness."

(2) Width

Construct a finished pavement width as shown on the approved plans and in accordance with Subsection 301.04.A(2), "Width."

(3) Thickness

Determine the thickness of the pavement after grinding operations using the average of three caliper measurements of cores, tested in accordance with AASHTO T 24/T24M. Thickness will be in accordance with Subsection 314.04.R, "Acceptance of Pavement."

R) Acceptance of Pavement

While the Contractor is fully and exclusively responsible for producing an acceptable product, acceptance responsibility rests with the City Engineer.

Determination of acceptability and pay factors for gradation, air content, strength, and thickness will be made in accordance with Table 314:2, "Acceptance Schedule." The pay adjustments for the characteristics will be based on the following equations:

$$CPF = \frac{4\,(S+T) + G + AC}{10}$$

Combined Pay Factor for optimized gradation concrete;

$$CPF = \frac{4T + 2(S + OG + AC)}{10}$$

$$PA = (CPF - 1)(Q_c \times CUP_c + Q_p \times CUP_p)$$

Where:

CPF = Combined pay factor,

S = Pay factor for strength,

T = Pay factor for thickness,

G = Pay factor for gradation,

AC = Pay factor for air content,

PA = Pay adjustment,

OG = Pay factor for optimized gradation,

Q_c = Cubic yards [cubic meters] of concrete in a 2,500 yd² [2,500 m²] lot (partial lots prorated),

Q_p = Square yards [square meters] of concrete in a 2,500 yd² [2,500 m²] lot (partial lots prorated), and

CUP_p = Contract unit price of concrete placement ($/yd² [$/m²]).

Note: CUP_c and Q_c include only the concrete material. CUP_p and Q_p include all other

labor and materials required in the concrete pavement(reinforcing steel, dowels, curing compound, etc.).

Pay adjustments will be based on the individual pay factors shown in Table 314:2 on a lot to lot basis. A lot will normally be defined as 2,500 yd² [2,500 m²]. To ensure the overall quality of the material and workmanship, the City Engineer may reduce the size of a lot when multiple concrete placements occur. If test results are incomplete at that time, the City Engineer will make an interim adjustment assuming pay factors of 1.00 for the then unknown characteristics and will correct later when testing is complete. The total adjustment in pay for the four characteristics (gradation, air content, strength, and thickness) in the Table 314:2 will be the sum of the pay adjustments on individual lots.

Random samples will be used to test concrete and will test for all control test characteristics except smoothness on a lot to lot basis in accordance with the following requirements. Determination of acceptability and pay adjustments for smoothness, when applicable, will be covered by separate specifications. However, the City Engineer will reject any load of mixture that is visually unacceptable for reasons of being too wet, excessively segregated, or otherwise obviously deficient. Furthermore, the City Engineer may extensively test sections of completed pavement that appear to be seriously inadequate based on visual observation or knowledge of other deficiencies. The City Engineer may not use the results of such tests for pay adjustment purposes, but will use them to determine whether the section is totally unacceptable and must be removed. The City Engineer may reject pavement slabs with unsound concrete, uncontrolled cracking, malfunctioning sawed joints, spalling, honeycombing, surface irregularities, insufficient thickness, or other deficiencies associated with poor quality pavements.

(a) ***City Engineer's Acceptance Procedures***

Once a lot has been defined, maintain its identity throughout the mixing and placement process. The City or Awarding Public Agency will use pay factors, determined from random sampling and testing of a lot at the appropriate locations, in computing its pay adjustment.

The City Engineer will use Table 314:2 for acceptance and calculating pay factors.

Table 314:2 Acceptance Schedule		
Characteristics	**1 Test**	**Pay Factor [a]**
Gradation [c] - Deviation from the target (without regard to signs):		
Coarse or fine aggregates % passing No. 200 sieve Target Spec. Range, %	0	1
	0.01–0.60	$1-0.10x$
	0.61–1.80	$1.03-0.15x$
	>1.80	Unacceptable [b]
Air content [c] - Deviation from the target (without regard to signs):		
Target = 6.0%	0–1.50	1
	1.51–3.00	$-0.10x^2+0.29x+0.79$
	>3.00	Unacceptable [b]
Strength [d] – Deviation from minimum strength of target (considering signs):		
Target = 3,000 psi	0–1,000 psi	Pay Factor = (Actual Strength/Specified Strength)
	>1,000 psi	Unacceptable [b]
Thickness [e] – Deviation from minimum (considering signs) (English):		
% Deficient	0–2.0	1
	2.1–4.0	$1.10-0.05(PD)$
	4.1–6.0	$1.30-0.10(PD)$
	6.1–8.0	$1.60-0.15(PD)$
	>8.0	Unacceptable [b]
Optimized Gradation [f] - Deviation from the target (without regard to signs):		
Combined aggregates % retained on any sieve above Target Spec. Range, %	0	1.00
	0.01 - 1.00	$1 - 0.10x$
	1.01 - 2.00	$1.03 - 0.15x$
	> 2.00	$1.13 - 0.20x$
[f] One specimen and one test for each combined gradation per lot.		

To determine the combined aggregate deviation used for optimized gradation concrete, the City Engineer will use the largest deviation from the target range of any individual sieve or gradation equation.

[a] Where x is the Average of Deviations and PD is Percent Deficient.

[b] Unless otherwise approved by The City Engineer, products testing in this range are unacceptable and must be removed and replaced at no additional cost to the City or Awarding

Public Agency.

[c] Gradation and air content – 1 specimen and 1 test for each characteristic per sublot.

[d] Strength – 3 cylinders per lot averaged and considered as 1 test in Table 314:2.

[e] Thickness – After grinding operations, determine the thickness of the pavement using the average of 3 cores at times and locations directed by the City Engineer.

To determine the average thickness for a lot, the City Engineer may only consider the minimum thickness plus 2 percent for core thicknesses greater than 2 percent thicker than the minimum thickness (e.g. if the minimum thickness shown on the approved plans equals 10 in [250 mm], the City Engineer may only consider 10.2 in [255 mm] for the average thickness determination for a core thickness of 10.3 in [257.5 mm]).

The City Engineer may not include in its average thickness determination measurements that are more than 8 percent thinner than the minimum thickness shown on the approved plans, or the measurements from exploratory cores. If the measurement of any core is thinner than the minimum thickness shown on the approved plans by 8 percent or more, take exploratory cores at intervals of at least 10 ft [3 m], parallel to the centerline until the City Engineer finds a core that is less than 8 percent thinner than the minimum thickness.

Fill core holes with concrete as required by the approved plans.

(b) ***Unacceptable or Rejected Work***

Replace rejected slabs with new pavement at no additional cost to the City or Awarding Public Agency. When replacing rejected slabs, remove a width of at least one lane and a length of at least 15 ft [4.5 m]. If the removal is within 15 ft [4.5 m] of any transverse joint, remove the slab to the joint. If a deficient unit does not warrant removal, as directed by the City Engineer, the City or Awarding Public Agency will not pay for the deficient unit.

314.05 TESTING — VACANT

314.06 METHOD OF MEASUREMENT

The City Engineer will measure PCC placement, of the type shown on the approved plans, by the area of accepted and complete-in-place pavement.

314.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) P.C. CONCRETE PAVEMENT (PLACEMENT)	Square Yard [Square Meter]
(B)DOWEL JOINTED P.C.C. PAVT. (PLACEMENT)	Square Yard [Square Meter]
(C) CONT. REINF. P.C.C. PAVT. (PLACEMENT)	Square Yard [Square Meter]
(D) BONDED P.C.C. OVERLAY (PLACEMENT)	Square Yard [Square Meter]
(E) FULL DEPTH P.C.C. PATCH (PLACEMENT)	Square Yard [Square Meter]
(F) PARTL. DEPTH P.C.C. PATCH (PLACEMENT)	Square Yard [Square Meter]

Include the cost of placing concrete pavements, including relevant labor and material, and the cost of reinforcing steel, load transfer devices, joint fillers, and joint sealants in the contract unit price for the relevant "Placement" pay items. Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

The City and Awarding Public Agency considers the cost of coring and filling core holes to be included in the contract unit price for the relevant portland cement concrete pavement pay items.

The City or Awarding Public Agency will pay adjusted prices for deficient units of pavement in accordance with Subsection 314.04.R, "Acceptance of Pavement."

SECTION 315--CONCRETE JOINT SEALING

315.01 DESCRIPTION

This section covers sawing, cleaning, and sealing joints in existing portland cement concrete pavement.

315.02 MATERIALS

Provide materials in accordance with Subsection 901.08, "Joint Fillers and Sealer."

315.03 EQUIPMENT

Provide the following equipment:

A) Concrete Saw

Provide concrete saws capable of sawing concrete joints to the dimensions shown on the approved plans. No hand held saws allowed.

B) High-Pressure Water Pumping System

Provide high-pressure water pumping systems capable of flushing concrete slurry from sawed joints.

C) Sand Blasting Unit

Provide compressed air sand blasting units capable of cleaning joint surfaces as specified. Ensure the units include traps to remove free water and oil from the compressed air.

D) Air Compressor

Provide air compressors capable of delivering compressed air with a pressure of at least 90 psi [620 kPa]. Ensure the compressors include traps to remove free water and oil from the compressed air.

E) Extrusion Pump

Provide air-powered extrusion pumps to apply joint sealer. Ensure the pump output is capable of delivering the volume of the joint sealer to the joint as specified.

F) Injection Tool

Provide a mechanical injection device to insert the sealer into the joint.

G) Joint Sealer Kettle

Provide a double-bottom oil-bath indirect-flame type kettle if the joint sealant requires heating. Ensure the kettle is capable of mixing, heating, delivering, and maintaining the specified temperature.

315.04 CONSTRUCTION METHODS

A) Sawing Joints

Saw the joints to the dimensions shown on the approved plans. Produce a joint of uniform width with cut faces on both sides along its full length. Provide a walk behind saw mounted on wheels. Hand held saws are not allowed.

B) Flushing Joints

Remove the slurry from the joint area after sawing by flushing it with a high-pressure water system and other necessary equipment.

C) Cleaning Joint Faces

(1) General

Clean the sawed faces of the joints of foreign material before installing the joint sealer or filler

Do not blow-dry the joints with compressed air or use portable hand saws to clean joint faces.

(2) Sandblasting

Sandblast joint faces after they dry. Attach the sandblaster nozzle to a mechanical aiming device to direct the sandblast at a 45° angle and maintain sandblasting at less than 2 in [50 mm] from the joint faces.

Blow out the joints after sandblasting using filtered (oil and moisture free) compressed air at least 90 psi [620 kPa] and 120 ft^3/min [3.4 m^3/min]. Use a blow tube that fits into the joint. Repeat the sandblasting and blowing until no residual dust or coating remains in the joint.

(3) Joint Contamination

Clean the joints of any contaminates (due to traffic or weather) before sealing joints.

D) Backer Rod

Install a backer rod before applying sealant if indicated in the approved plans or recommended by the sealant manufacturer. Use a backer rod of the type recommended by the sealant material manufacturer. Install backer rod to the dimensions shown on the approved plans.

E) Sealing Joints

Clean and seal joints on the same day.

(1) Approval of Joints for Sealing

The City Engineer will examine joints prepared for sealing. The City Engineer will not approve joints for sealing if the joints are contaminated or wet.

(2) Installation of Joint Sealers and Fillers

The City Engineer may require that a representative of the joint filler manufacturer, joint sealer manufacturer, or both be on the job site at the beginning of the joint-sealing. The contractor must demonstrate to the City Engineer the manufacturer’s installation standards.

(3) Application of Joint Sealers

Apply the joint sealer using a City Engineer approved mechanical injection tool.

Apply the joint sealer when the joint temperature is above 40°F [4°C] and joints are clean and dry.

Inject sealers into the joint. Ensure that the sealers bond to the joint face surfaces. For surfaces of joint sealers that require tooling, use an approved mechanical device to make a concave surface from ¼ in to ½ in [6 mm to 12 mm] below the pavement surface. Complete the tooling before a skin forms on the surface of the sealer. Do not use soap or oil as a tooling aid.

Tooling is not required for self-leveling joint sealers

(4) Bonding Failures

Repair sealants that fail to bond to sawn concrete joint surfaces, at no additional cost to the City or Awarding Public Agency.

F) Traffic

Ensure the freshly applied joint sealant is no longer sticky before allowing traffic on it.

315.05 TESTING — VACANT

315.06 METHOD OF MEASUREMENT

The City Engineer will measure the length of concrete joint sealing after the joint sealant is in place.

315.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) CONCRETE JOINT SEALING	Linear Foot [Meter]

The per linear foot payment for *Concrete Joint Sealing* shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these Standard Specifications and the approved plans. Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 316--DOWEL BAR RETROFIT

316.01 DESCRIPTION

This section covers restoration load transfer in existing portland cement concrete (PCC) pavement by installing epoxy coated dowel bars across transverse joints or cracks.

316.02 MATERIALS

A) Dowel Bars

Provide epoxy-coated dowel bars in accordance with Subsection 923.08, "Epoxy Coated Reinforcement Bars," of the dimensions shown on the approved plans. Provide tight-fitting,

nonmetallic end caps that allow the bar to move ¼ in [6 mm] at each end.

B) Foam Core Board

Provide foam core board ¼ in [6.25 mm] thick, constructed of closed cell foam, and faced with poster board material on each side.

C) Dowel Bar Chairs

Provide nonmetallic dowel bar chairs to keep the dowel bars from moving during concrete placement. Place dowel bar chairs at the locations shown on the approved plans, within the vertical and horizontal tolerances.

D) Portland Cement Concrete Patching Material

Provide PCC patching material to backfill retrofit slots in accordance with Section 901.16, "Dowel Bar Retrofit Mortar." Mix, place, and cure PCC patching material in accordance with the manufacturer's recommendations. The PCC patching material may be extended by using aggregate in accordance with Subsection 901.05, "Fine Aggregate," and Subsection 901.06, "Coarse Aggregate," excluding the gradation requirements. Provide and use a PCC mix design for the patching material (including additives) that develops a compressive strength of at least 4,000 psi [27.6 MPa] in 6 hour.

Provide curing compound in accordance with Subsection 901.07, "Curing Agents."

316.03 EQUIPMENT — VACANT

316.04 CONSTRUCTION METHODS

A) Slot Sawing

Use a gang saw capable of sawing at least three slots in the pavement at one time. Center the slots over the cracks and transverse joints, and align the slots so that the longitudinal axis of each dowel bar is parallel to the pavement centerline and the surface of the lower of the two panels. Ensure the vertical and horizontal alignment does not exceed ¼ in [6.35 mm].

B) Concrete Removal

Remove concrete from the slot area with a jackhammer no larger than the 30 lb [13.6 kg] class. If this jackhammer damages the pavement, discontinue its use and replace with a lighter jackhammer. Before installing the dowel, sandblast exposed surfaces and cracks in the slots, and clean slots of saw slurry and loose material. Dispose of loose material in accordance with Subsection 104.09, "Removal and Disposal of Salvaged Materials, Structures, and Obstructions."

C) Foam Core Board

Place the foam core board to maintain the continuity of the existing transverse joint or crack. Size the foam core board to fit tightly around the dowel bar and to the bottom and sides of the slots. Caulk existing transverse joints or cracks with approved sealant at the bottom and sides of the slots, as specified, to prevent patch mix from entering the joint or crack. Remove excess caulking to create a smooth, level joint or crack surface. Install the foam core board so that it remains in position and tight to all edges during patch material placement. The Contractor may use tabs to hold the foam core board in place and may cut or remove existing joint sealant to accommodate the tabs. If the foam core board shifts during the placement of concrete patching material, remove and replace at no additional cost to the City or Awarding Public Agency.

D) Dowel Bars

Cover the dowel bars with a thin coat of form release oil before beginning the placement of concrete patching material over the dowel bars. The City Engineer will not allow oil to contaminate concrete surfaces to be overlaid or the surfaces of the slots.

Place the dowel bar assembly (with chairs and foam core board attached) across the transverse joint or crack as specified. Ensure that chairs hold the dowel bars in place and provide at least ½ in [12.5 mm] clearance between the bottom of the dowel and the bottom of the slot. Remove and replace dowel bars that shift during the placement of concrete patching material, at no additional cost to the City or Awarding Public Agency.

E) Existing Concrete Surfaces

Ensure existing concrete surfaces in the slots are clean and dry, or prepared in accordance with the manufacturer recommendations. Remove excess water from the slots before placing the concrete patching material.

F) Concrete Placement

Place concrete patching material into the slot, and vibrate to completely encase the dowel bar. The vibrator head's diameter must not exceed 1¼ in [37.5 mm]. Obtain the City Engineer's approval before placing concrete in ambient temperatures below 50 °F [10 °C].

G) Damage

Repair damage to the existing pavement caused by contractor operations, at no additional cost to The City or Awarding Public Agency.

H) Slot Surface

Trowel-finish the top surface of the filled slot flush with the existing concrete surface, and allow the surface to cure. If the approved plans requires diamond grinding, leave the top surface of the fill slot not more than ¼ in [6.25 mm] higher than the existing concrete surface. Do not under fill the slots. Apply curing compound before the final set of the mortar in the concrete patching material.

Saw the new joint within 24 hour, or as approved by the City Engineer.

316.05 TESTING

A) Testing Concrete Patching Material

Test the concrete patching material once for each 4 hour of production, or at least once a day. Ensure the concrete patching material has a compressive strength of at least 4,000 psi [27.6 MPa] in 6 hour. The contractor may test for compressive strength up to 24 hour after making the cylinders. If the compressive strengths are not met, cease production, and resubmit a concrete mix design that corrects the problems. Do not open lanes to traffic until the patch material achieves a compressive strength of at least 3,000 psi [20.7 MPa].

316.06 METHOD OF MEASUREMENT — VACANT

316.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) DOWEL BAR RETROFIT	Each

Payment will be considered full compensation for furnishing all materials, labor, equipment, supplies, tools and incidentals, and for performing the work in accordance with this specification.

SECTION 325--DIAMOND GRINDING CONCRETE PAVEMENT

325.01 DESCRIPTION

This section covers grinding portland cement concrete (PCC) pavement to restore drainage and riding characteristics to the pavement surface.

325.02 MATERIALS — VACANT

325.03 EQUIPMENT

Provide power-driven, self-propelled grinding equipment designed to smooth and texture PCC pavement with diamond blades. Provide a machine with an effective wheel base of at least 12 ft [3.6 m]. Ensure the front of the machine has a set of pivoting tandem bogey wheels, and the rear wheels travel in the track of the cut pavement. Place the center of the grinding head no more than 3 ft [0.9 m] ahead of the center of the back wheels.

Provide equipment that can cut or plane at least 4 ft [1.2 m] wide to avoid a seam in the wheel path of a travel lane. Ensure the machine's shape and dimension do not encroach on traffic movement outside the work area. Do not use equipment that causes excessive ravels, aggregate fractures, spalls, or cracks, or disturbs transverse and longitudinal joints.

325.04 CONSTRUCTION METHODS

A) Grinding Pavement

Grind the surface of pavement areas shown on the approved plans. Grind longitudinally, beginning and ending at lines transverse to the pavement centerline. Ensure the ground pavement surfaces of adjacent sides of transverse joints and cracks are on the same plane. The City Engineer may allow less than 100 percent grinding within specified areas if minor depressions occur in the pavement.

Make multiple passes as necessary to achieve acceptable results.

Ensure the pavement surface grinding produces a uniform, finished surface. Eliminate joint and crack faults. Maintain a constant cross-slope between the edges of grinding operations to provide positive lateral drainage. Transition the grinding of auxiliary or ramp lanes from the mainline edge to provide positive drainage and a smooth riding surface.

Feather-grind adjacent lanes or paved shoulders to maintain motorist safety and proper drainage for pavement grinding deeper than ¼ in [6 mm].

(1) Surface Texture and Grooving

Grind the pavement surface until it has a uniform appearance, with a texture composed of longitudinal ridges and grooves. Create surface grooves from 0.09 in to 0.15 in [2 mm to 4 mm] wide, spaced up to ⅛ in [3 mm] apart. Ensure the ridge peaks are at least $^{1}/_{16}$ in [1.5 mm] higher than the bottom of the grooves.

(2) Slurry Removal

Remove and collect grinding slurry or residue by vacuum or other continuous methods. Dispose of the grinding slurry and residue in accordance with applicable laws, rules, and regulations. Do not distribute the slurry evenly on the side-slopes unless the City Engineer approves of the disposal method. Ensure that slurry does not enter drainage inlets and watercourses. Prevent the slurry from flowing across lanes used by traffic, or into gutters or other drainage facilities. Conduct a final sweeping before opening the pavement to traffic.

(3) Pavement Smoothness

(a) *Profiling Pavement Surface*

Profile ground surfaces in accordance with ASTM E 1274. Provide a profilograph with wheels variably spaced. Ensure a pavement with a profile index of 5 in [125 mm] or less per mile using a 0.2 in [5 mm] blanking width. Profile ground surfaces in two passes; one at 3 ft [0.9 m] and one at 9 ft [2.7 m] from the edge of each driving lane. Average the profilograph readings from the two passes to obtain the profile index for each lane.

If the profile index exceeds 5 in [125 mm] per mile, grind individual high points in excess of 0.3 in [8 mm] across the entire lane width.

Perform additional grinding along lines parallel to the pavement edge to reduce the profile index to the specified values after grinding individual high points. Grind in neat, rectangular sections with uniform surfaces.

(b) *Straight Edge Tolerance*

Use a 10 ft [3 m] straightedge to measure surface smoothness. Ensure the maximum distance from the bottom edge of the straightedge does not exceed

⅛ in in 10 ft [3 mm in 3 m]. Perform additional grinding at locations in excess of ⅛ in in 10 ft [3 mm in 3 m]. Ensure that the elevation difference between passes does not exceed ⅛ in [3 mm].

B) Concrete Joints

Saw and seal joints in accordance with Section 315, “Concrete Joint Sealing.” after completing diamond grinding.

325.05 TESTING — VACANT

325.06 METHOD OF MEASUREMENT

The City Engineer will measure the diamond grinding of PCC pavement by the final approved textured surface area regardless of the number of passes necessary to achieve acceptable results, including minor areas of un-textured pavement within this area.

If the City Engineer determines the need for feathering is not caused by the Contractor, the City Engineer may measure the area of feathering as *Diamond Grinding Concrete Pavement*.

325.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) DIAMOND GRINDING CONCRETE PAVEMENT	Square Yard [Square Meter]

The City or Awarding Public Agency will pay for sawing and sealing joints in accordance with Section 315, "Concrete Joint Sealing." Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

Include the cost of feathering in the contract unit price for *Diamond Grinding Concrete Pavement*. The City Engineer will not separately measure *Diamond Grinding Concrete Pavement* for pavement unless otherwise specified.

SECTION 326--PRESSURE GROUTING PAVEMENT

326.01 DESCRIPTION

This section covers pumping a fly ash cement grout under portland cement concrete (PCC) pavement or asphalt pavement to fill the voids beneath the pavement and form a hard, insoluble mass.

326.02 MATERIALS

Provide materials in accordance with Subsection 933.09, "Slurry Grout."

326.03 EQUIPMENT

A) Grouting Equipment

(1) Measuring and Proportioning Equipment

Provide equipment capable of measuring and proportioning grout components by weight. Use prepackaged materials as approved by the City Engineer.

(2) Batch Mixing Tank

Provide a watertight batch mixing tank with a high speed mixer to blend the materials into a homogenous mixture. Ensure the mixer includes a rotor operating in close proximity to a stator, creating a high shearing action with a mixing speed from 800 rpm to 2,000 rpm. Ensure the mixing pump continuously circulates the materials through the mixer and the mixing tank.

(3) Holding Tank

Provide a holding tank with a paddle-type agitator placed between the batch mixing tank and the grout pump for continuous operation. Ensure the agitator maintains complete circulation of the grout to keep it in suspension and remove air bubbles from the mix.

(4) Grout Pump

Provide a grout pump with a single action plunger pump with a high-speed backstroke. Provide a pump with precise pressure and capacity control valves, to independently preset maximum pressure and flow. Ensure a pump capacity range from 0 gal/min to 30 gal/min [0 L/min to 110 L/min] and a pressure range from 0 psi to 100 psi [0 kPa to 689 kPa].

(5) Discharge Line

Provide a discharge line with a positive cutoff valve at the nozzle end. Ensure the nozzle remains securely sealed in the cored holes to prevent leaks.

(6) Pavement Monitoring Device

Provide pavement-monitoring equipment that determines movement, to prevent lifting pavement or overfilling cracks. Use a standard Benkelman Beam, or other equipment approved by the City Engineer.

B) Coring Equipment

Provide coring equipment capable of cutting 2 in [50 mm] diameter holes through the pavement. Prevent damage to the pavement from excessive down pressure on the core. Use an air compressor and rock drills or other devices capable of drilling the injection holes through the pavement.

Air-driven or hydraulic impact drills will not be allowed.

326.04 CONSTRUCTION METHODS

A) General

Protect the pavement from breaking and cracking.

Replace concrete slabs and pavement damaged during pressure grouting operations, at no additional cost to the City or Awarding Public Agency.

B) Weather Limitations

Pressure grout when the ambient temperature is at least 35 °F [2 °C] and rising. Ensure a pavement temperature of at least 35 °F [2 °C] during pressure grouting.

C) Coring Holes

Drill 2 in [50 mm] diameter core holes through the pavement for PCC pavements as indicated. The City Engineer may modify the pattern and spacing of the holes.

Drill core holes at an angle of 45° towards the bottom of the crack, deep enough to penetrate the cavity for hot mix asphalt pavements. Drill at least two core holes for each 12 ft [3.6 m] wide travel lane, and one hole for every 4 ft [1.2m] of shoulder width. Drill the core holes from 4 in to 12 in [100 mm to 300 mm] from the crack. Place the holes along one side of the crack or alternate along both sides of the crack. The City Engineer may modify the hole pattern and spacing. The City Engineer will approve the location of the core holes, and determine if additional holes are necessary to fill the cracks.

Temporarily plug irregular or unsatisfactory holes, or fill them with grout at no additional cost to The City or Awarding Public Agency. Drill core holes and grout in the same day, unless otherwise approved by the City Engineer.

D) Clearing Holes

Clean the holes of debris to provide a passage for the grout after drilling the core holes to the specified depths, and within 10 min before injecting the grout.

E) Grouting

Ensure the flow rate at the pump head does not exceed 7 gal/min [26.5 L/min] while injecting grout. Secure the nozzle of the grout discharge hose in the core hole to provide a seal and maintain the grout pressure.

Prevent the nozzle end from extending below the bottom of the concrete for PCC pavement. Continue injecting grout into each core hole until the slab corner lifts from

0.032 in to 0.036 in [0.825 mm to 0.925 mm], or until the pressure at the discharge nozzle exceeds 60 psi [414 kPa]. If no slab lift or no pressure buildup occurs, continue injecting grout until the amount of clear grout flowing up through joints or cracks equals the amount of grout injected. Repeat this procedure in other holes to fill voids. If necessary, temporarily plug adjacent core holes during grout injection operation.

Continue injecting grout into the core holes until the cracks are filled for hot mix asphalt pavement. Continue pumping until the amount of clear grout flowing up through joints or cracks equals the amount of grout injected. Repeat this procedure in other holes to fill voids. If necessary, temporarily plug adjacent core holes during grout injection operations.

During pumping, watch the pavement monitoring device to prevent excessive lifting of the pavement or rising of the adjacent shoulders. Correct lifted joints as directed by the City Engineer. If lifted pavement joints create unsafe conditions for the traveling public, close lanes and make repairs. Complete repairs and joint corrections at no additional cost to the City or Awarding Public Agency.

F) Permanently Sealing Holes in Concrete Pavement

Remove grout from the core holes and fill the holes with a stiff sand-cement mortar made of one part portland cement to three parts fine aggregate (by volume), or a commercial premixed rapid set mixture, as approved by the City Engineer.

Repair filled holes that ravel or become damaged at no additional cost to the City or Awarding Public Agency.

G) Regrouting

Drill new core holes and regrout slabs as directed by the City Engineer.

Drill new core holes and re-grout cracks for hot mix asphalt pavement that may require additional filling, as directed by the City Engineer. Provide excess grout to hand-finish into cracks to fill the voids as directed by the City Engineer.

H) Clean Up

Remove deposits of grout on the pavement or shoulder. Clean the pavement surface before allowing traffic on the completed sections. Remove other debris, bags, and spillage from the right-of-way each day.

I) Opening to Traffic

Restrict traffic from the grouted areas for 3 calendar days, or as approved by the City Engineer.

326.05 TESTING — VACANT

326.06 METHOD OF MEASUREMENT

The City Engineer will not include the weight of water or sand in the measurements of Portland Cement or Fly Ash.

326.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) CORED HOLES	Each
(B) PORTLAND CEMENT	Ton [Metric Ton]
(C) FLY ASH	Ton [Metric Ton]

The cost of water and sand to be included in the contract unit price for *Portland Cement* or *Fly Ash*. Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 330--PAVEMENT AND BRIDGE DECK SMOOTHNESS

330.01 DESCRIPTION

This section establishes procedures for determining acceptability and pay adjustments as they relate to smoothness requirements of pavements and bridge decks. The equipment and testing applicable to this section must be provided and/or operated by the party or parties specified in Appendix A of this provision.

Except as noted herein, these special provisions apply to all types of portland cement and asphalt concrete pavements, as well as bridge decks constructed as part of this project, or as specified on the approved plans.

330.02 MATERIALS — VACANT

330.03 EQUIPMENT

A) Equipment and Installer Certification

Provide an approved profiler as described below. Ensure the equipment is certified by the Oklahoma Highway Construction Materials Technician Certification Board, and is capable of running on Portland cement pavements having a compressive strength of 2,500 psi without causing any damage to the pavement.

B) Profilograph

(1) California Profilograph

Use a California profilograph supported on multiple wheels arranged in a staggered pattern so that no two wheels cross the same bump simultaneously and without a common axle. Mount the strip chart recorder on a lightweight frame 25 ft long. Measure the relative smoothness of the pavement or bridge deck by recording the vertical movement of a sensing wheel at least 6" in diameter attached to the midpoint of the frame. Record the graphical traces of the profilogram on a 1" to 1" scale for the vertical motion of the sensing wheel. Ensure the profilogram is driven by the chart drive on a scale of 1" of chart paper equal to 25 ft of longitudinal movement of the profilograph.

(2) Light Weight Profilometer

Provide lightweight profilometer equipment meeting the following requirements:

a. Mounted on a lightweight, motorized vehicle such as an all-terrain vehicle, golf car, or other City Engineer approved vehicle,

b. Capable of running on concrete that has not achieved its design strength without causing damage,
c. Contains an onboard, precision accelerometer that measures movement of the light weight profilometer,
d. Contains an infrared or laser type non-contact vertical distance sensor mounted on the vehicle,
e. Measures and provides the information as specified in subsection 330.04.B, "Evaluation,"and
f. Measures the road profile in accordance with ASTM E950-98, Class I.

(3) High Speed Profilometer

Provide high speed profilometer equipment meeting the requirements of AASHTO M 328-14 *Standard Equipment Specification for Inertial Profiler.*

C) Calibration

Calibrate the profilograph or profilometer within the following limits:

(1) Horizontal measurements must be within ±5 feet per 1,000 feet of distance tested.

(2) Vertical measurements must be the same as those of the calibration blocks measured.

Submit a profilograph or profilometer calibration report to the City Engineer after every calibration using the appropriate form provided by the City Engineer. Calibrate the profilograph or profilometer the day of the testing prior to collecting the smoothness data. Repeat the calibration as directed by the City Engineer.

D) Provision and Operation of the Profilograph/Profilometer

If specified, provide a profilograph or profilometer operator, certified by the Oklahoma Highway Construction Materials Technician Certification Board, to perform profilograph or profilometer measurements, and to interpret and analyze the produced profilograms.

330.04 CONSTRUCTION

A) Surface Testing

Notify the City Engineer by phone 24 hours before performing any surface testing. If the City Engineer is unable to be reached by phone, notify the City Engineer in writing by email. Surface testing performed without proper notification or coordination with the City Engineer will not be accepted.

Provide traffic control for smoothness measurements regardless of the provider or operator of the equipment. If specified, use an acceptable and approved profilograph or profilometer to measure pavement smoothness. Collect profilometer readings or profilograph traces beginning at a location 25 ft prior to the beginning point of a project, including any exception areas, and through all bridges and changes in the pavement types to a location 25 ft beyond the ending point of a project, including any exception areas. The surface will be tested as soon as possible after the completion of the work. If milling is not required for overlay projects, the surface will be tested immediately before construction and as soon as possible after completion of the work to determine the percent reduction in the profile index in accordance with Table 330:2. However, the contractor may request in writing the elimination of the before construction testing requirement. Elimination of such testing will also eliminate the contractor's option of using Table 330:2 for pay purposes.

For full depth asphalt pavement, test the next to last lift and perform any corrective action on bumps and dips by fine milling of the HMA in accordance with Subsection 312.04.B or as approved by the City Engineer prior to placing the final lift. Test the final lift to determine the pay adjustment.

For concrete pavement where a longitudinal construction joint is within 6 inches of the wheel path, provide an additional test along the joint for the purpose of determining corrective action. The pay adjustment will be based on the test within the wheel path.

The City Engineer will include smoothness deviations at construction and expansion joints when calculating the profile index and when identifying bumps.

Remove objects and foreign material on the surface before testing. Remove any protective covers before testing. Properly replace protective covers after testing. While testing for smoothness, produce a final trace. Produce a second trace for segments on which allowable surface corrections have been made. The second trace must contain a minimum of 50 feet on either end of the corrected area and it must have the correct stationing.

Propel the profilograph at a speed no greater than 3 mph. Gather data at lower speeds if the pavement or bridge deck is rough or profilograms are not being produced clearly.

Operate the profilometer at a constant speed as recommended by the manufacturer, but no greater than 20 mph for a light-weight profilometer.

The testing sequence of the pavement or bridge deck to be tested will be one pass per driving lane in the wheel path farthest from the edge of a pavement or bridge deck. The profilograph/profilometer must be within the planned driving lane when making a pass.

Provide the profilogram evaluations to the City Engineer, including at a minimum:

- Company name,
- Operator name,
- Federal/state project number,
- Job piece number,
- Route number/name,
- Lane description (NB, SB, EB, WB)
- Lane location (left, center, right)
- Pass description (1st, 2nd, etc.)
- Correct time and date,
- The electronic files from which the profilograms were derived, and
- An evaluation summary extended to include pay adjustments per segment and totaled, in spreadsheet format, within 14 days after the final trace is run.

A continuous graphical trace may consist of a single trace or multiple traces including the minimum overlap, and may be submitted as an electronic file to the City Engineer.

Take additional profiles only to define the limits of an out-of-tolerance surface variation. The City Engineer reserves the right to verify the testing, the evaluation, or both. The City Engineer’s test

results will be considered final. If the contractor's test results contain significant errors, the City or Awarding Public Agency may assess the cost of the verification efforts.

B) Evaluation

For pay adjustment purposes, evaluation of the surface testing results will be limited to the following specifications:

(1) Profile Index

An "extent" is defined as a segment of driving lane of pavement or bridge deck 528 ft long or the entire length of bridge, including approach slabs, whichever is less. Use ProVAL or other City Engineer approved computerized profilogram reduction system to calculate a profile index for an extent. Other computerized profilogram reduction systems must be submitted in writing to the City Engineer for approval. Calculate the index by summing the vertical deviations using a zero-blanking band (0.2 for bridge decks) as indicated on the profile trace. The City Engineer may require additional field surveys to establish bump locations. Convert the measurements from inches into inch per mile. When the quantity represented is less than a full extent in length, the contractor may combine the quantity with an adjacent full extent or treat it as a separate extent.

(2) Bumps

Bumps may appear as high points on the profile trace and correspond to high points on the pavement or bridge deck surfaces. Unacceptable bumps are defined as bumps with vertical deviations greater than 0.60 in, without using a blanking band, in a 25 foot span.

(3) Exceptions

The following areas will be considered as exceptions:

- Shoulders,
- Ramps,
- Two-way, left turn lanes,
- Acceleration, deceleration, climbing, and turn lanes less than 528 ft,
- Tapered transitions associated with shoulders, ramps, acceleration, deceleration,
- Climbing and turn lanes,
- Pavement with horizontal centerline curves with radii less than 1,000 ft and the superelevation transitions of these curves,
- In overlays only, areas in roadway within a 10 ft radius of existing inlets, street returns, and utility covers (this exception does not apply to full depth pavements), and
- Pavement areas requiring handwork (this exception does not apply to areas placed by hand for the contractor's convenience).

These exception areas will not require testing for smoothness, however the requirements for tolerances defined in subsection 301.04 of the Standard Specifications will remain in effect. For the above exceptions, the profile index, calculations and associated adjustments specified in this special provision will not apply.

(4) Special Evaluation Requirements

The City Engineer will evaluate bridge approach slabs in accordance with bridge deck smoothness requirements. There will be no exceptions made for any portion of bridge decks or approach slabs. The profile measurements for the entire length of the bridge deck and approach slabs will be used for the determination of the pay adjustments.

The City Engineer will exclude the following from the profile index calculation used for determining pay adjustments for new pavements and overlays:

- For a secondary street, the 25 feet that ties into an existing primary street as determined by the City Engineer,
- The 25 ft that ties into existing bridges or approach slabs (this does not apply to new bridge construction), and
- The 25 ft at the beginning and ending stations of the project (this does not apply to multiple adjoining projects in a single contract).

These excluded areas will be tested for smoothness, and the requirements for mandatory correction of bumps as defined in this special provision and tolerances defined in subsection 401.04of the Standard Specifications will remain in effect. Such corrections (including grinding) will not affect pay adjustments of individual extents or a possible incentive for overall smoothness.

C) Surface Correction

Ensure all ground surfaces exhibit good workmanship and are neat in appearance. Ensure all ground final surfaces are in accordance with subsection 325.04.A.(1) of the Standard Specifications. Fog seal the surfaces of ground asphalt pavements. Cores for thickness determination, as applicable, will be taken subsequent to all corrective work. Perform all corrective actions, including identifying locations needing correction, and all work associated with the correction, at no additional cost to the City or Awarding Public Agency.

Grind the concrete in the vicinity of the joint as part of the corrective process when correcting bridge decks and approach slabs. Do not grind metal expansion joints. Do not reduce the concrete cover over reinforcing steel to less than 2 inches. Retexture the surfaces of corrected areas in accordance with Subsection 409 of the Standard Specifications.

(1) Pavements

Unless otherwise permitted in writing by the City Engineer, correct all new pavement surfaces to acceptable limits as specified below:

- Reduce pavement extents having indices in excess of acceptable limits in Table 330:1 (greater than 46.9 in/mi), not including areas defined in Subsection 330.04.B.(3) “Exception” or 330.04.B.(4) “Special Evaluation Requirements,” to a Profile Index of 35.0in/mi or less.
- Reduce surfaces having individual bumps in excess of 0.60 inch in a 25 foot span, including any areas defined as “Exception” (subsection 330.04.B.(3)) or “Special Evaluation Requirements” (subsection 330.04.B.(4)), to a Profile Index below 0.60 inch in 25 foot span.

- When an unacceptable pavement extent or bump is permitted to be excluded from correction in writing by the City Engineer, the location will be considered a "ground area" for the purposes of incentive determination in accordance with 330.06 "BASIS OF PAYMENT" of this provision.

(2) Bridge Decks and Approach Slabs

Unless otherwise permitted in writing by the City Engineer, correct all new bridge decks and approach slabs to acceptable limits as specified below:

- Reduce extent of bridge decks and approach slabs having indices in excess of acceptable limits in Table 330:3 Class I to a Profile Index of 36.0 in/mi or less, or Table 330:3 Class II to a Profile Index of 40.0 in/mi or less as applicable.
- Reduce surfaces having individual bumps in excess of 0.60 inch in a 25 foot span to a Profile Index below 0.60 inch in 25 foot span.

330.05 TESTING — VACANT

330.06 METHOD OF MEASUREMENT — VACANT

330.07 BASIS OF PAYMENT

There will be no separate payment for providing and/or operating a profilograph or profilometer. Include such costs, and any other costs related to smoothness measurements or evaluations, in the price for *Contractor's Quality Control* when the proposal contains a pay item for quality control and acceptance. Otherwise include such costs as incidental in the prices of other items.

Failure to provide the information listed in subsection 330.04.A for profilogram evaluations will result in a $500 pay deduction per instance to be applied on the pay adjustment.

The pay adjustments shown in the following tables are for extents of 528 feet in length. Pay adjustments for extents of different lengths will be reduced or increased proportionally. (i.e. adjustment for a 792 feet extent is equal to the pay adjustment from the Table multiplied by 1.5).

The pay adjustments shown in the following tables are for extents of 12 feet in width. Pay adjustments will not be made for extents of different widths.

A) Pay Adjustment for Pavements

The City Engineer will base pay adjustments for smoothness of pavements on the initial profile indices determined before corrective actions.

The City Engineer will base smoothness pay adjustments for pavement sections removed and replaced or overlaid as approved by the City Engineer on the profile indices determined after the corrective actions, but before grinding. The City or Awarding Public Agency will not increase pay for pavements with grinding. The smoothness pay adjustment will be determined for each extent in accordance with Table 330:1 or, when applicable, Table 330:2. In the event that the pay adjustment from Table 330:2 results in less pay than that established by using Table 330:1, the adjustment will be derived from Table 330:1.

Table 330:1 SMOOTHNESS PAY ADJUSTMENTS Pavements			
Profile Index (in/mi)[2] (greater than 45 mph)	**Adjustment[1] ($ / Extent)**	**Profile Index (in/mi) [2] (45 mph or less and ramps)**	**Adjustment [1] ($ / Extent)**
15.0 or less	1,250	19.0 or less	1,250
15.1 to 25.0	3,125 - 125*x*	19.1 to 29.0	3,625 - 125*x*
25.1 to 35.0	0	29.1 to 39.0	0
35.1 to 41.0	14,000 - 400*x*	39.1 to 45.0	15,600 - 400*x*
41.1 to 46.9	32,450 - 850*x*	45.1 to 50.9	35,850 - 850*x*
47.0 or more	-7,500 [3]	51.0 or more	-7,500 [4]

Where "*x*" is the profile index (in/mi.)

[1] These pay adjustments are for 10" thick asphalt and 8" thick P.C. concrete pavements. Pay adjustments for pavements or overlays of different thicknesses will be reduced or increased proportionally, based on the typical section for the extent. (i.e. pay adjustment for a 12" P.C. concrete pavement is equal to the adjustment from the Table multiplied by 1.5).

[2] Except as noted in subsection 330.04.B.(4) pay adjustments for roadways (including ramps and service roads) will be based on posted speed limits.

[3] Correct pavement extents with profile indices greater than 46.9 in/mi to 35.0 in/mi or less at no additional expense to the City or Awarding Public Agency. The required correction will not increase payment unless deficient sections are removed or overlaid. Failure to correct to 35.0 in/mi will result in zero payment for the affected extents.

[4] Correct pavement extents with profile indices greater than 50.9 in/mi to 39.0 in/mi or less at no additional expense to the City or Awarding Public Agency. The required correction will not increase payment unless deficient sections are removed or overlaid. Failure to correct to 39.0 in/mi will result in zero payment for the affected extents.

TABLE 330:2 SMOOTHNESS PAY ADJUSTMENTS Overlays - No Milling Required	
Total Nominal Thickness > 1.5 inches	
Reduction in Profile Index (%)	**Adjustment ($ / Extent) [1]**
90.0 or more	140
90.0 through 60.0	10*x* - 760
60.0 through 50.0	40*x* - 2,560
Less than 50.0	Unacceptable
Total Nominal Thickness <:: 1.5 inches	
Reduction in Profile Index (%)	**Adjustment ($ / Extent) [1]**
85.0 or more	140
85.0 through 55.0	10*x* - 710
55.0 through 45.0	40*x* - 2,360
Less than 45.0	Unacceptable

Where "*x*" is the reduction in the Profile Index (%)

[1] The above adjustments are for 1" thick asphalt or concrete overlays. Adjustments for overlays of different thicknesses will be reduced or increased proportionally, based on the typical section for the extent (i.e. adjustment for a 2" overlay is equal to the adjustment from the Table multiplied by 2).

B) Pay Adjustments for Bridge Decks and Approach Slabs

For those sections corrected or ground in a manner approved by the City Engineer pay adjustments for smoothness of bridge decks will be based on the profile indices determined after corrective actions. Pay for a bridge deck or approach slab extent that is corrected or ground for any reason will be limited to a maximum of full pay, including extents whose profile indices would otherwise justify incentive pay.

For projects with multiple bridges, the bridges will be evaluated independently. Corrective action on any bridge will not affect the pay adjustment on any other bridge.

The smoothness pay adjustments will be determined for each extent in accordance with Table 330:3.

TABLE 330:3 SMOOTHNESS PAY ADJUSTMENTS Bridge Decks and Approach Slabs	
CLASS I	
Profile Index (in/mi)	**Adjustment ($ / Extent) [1,3]**
6 or less	7,500
6.1 through 24	10,500 - 500*x*
24.1 through 36	55,500 - 2,375*x*
More than 36	Unacceptable [2]
CLASS II	
10 or less	7,500
10.1 through 24	12,850 - 535*x*
24.1 through 40	45,010 - 1,875*x*
More than 40	Unacceptable [2]

Where "*x*" is the profile index (in/mi.)

[1] These adjustments for the bridge decks and approach slabs are independent of thickness of the bridge deck.

[2] Failure to correct to maximum acceptable profile index will result in zero payment for the affected extents.

APPENDIX A

SMOOTHNESS SPECIFICATION INFORMATION SHEET

FOR

PROJECT NUMBER, JP NO. 00000(04), COUNTY

Equipment -
The profilograph / profilometer is to be ***provided*** by the *(select one)*:

☐ CITY ☐ CONTRACTOR

The profilograph / profilometer is to be ***operated*** by the *(select one)*:

☐ CITY ☐ CONTRACTOR

Roadway -

☐ - The requirements specified in this special provision ***will*** govern the smoothness requirements for the paving on this project.

☐ - The requirements specified in this special provision ***will not*** govern the smoothness requirements for the paving on this project.

Bridge -

☐ - The requirements specified in this special provision ***will*** govern the smoothness requirements for the following bridges according to each bridge's classification:

Bridge Number	**Class I or II [1]**
☐- All Bridges	

- Class I bridge decks are those that do not present significant special problems due to geometry.

- Class II bridge decks are those that do present significant special problems due to geometry. Geometric features include but are not limited to skews, variable widths, variations in super elevation, sharp horizontal curves, or multiple profiles. The classification specified herein is final and will be used as a basis for payment.

- The requirements specified in this special provision **will not** govern the smoothness requirements for this project.

SECTION 340--ASPHALT SAFETY EDGE

340.01 DESCRIPTION

The asphalt safety edge is a beveled pavement edge to help lessen the severity of roadway departures. When a driver drifts off the paved surface, the safety edge provides greater ease for re-entering the roadway, and reduces the risk of over steering and loss of control of the vehicle.

Safety edge is required on asphalt concrete highway construction (permanent or temporary), on all routes, for all design speeds and types of traffic, when the following conditions exists:

- the roadway is an open section (no curb),
- the increase in pavement thickness is 2" or greater, and
- the paved shoulder width is 4 feet or less.

With the City Engineer's approval, the safety edge may be constructed when the paved shoulder width is greater than 4 feet.

340.02 MATERIALS

Construct the safety edge using the same material used to construct the adjoining pavement or shoulder.

340.03 EQUIPMENT

Equip the paver to ensure a 30 ± 5 degree wedge along the outside edge(s) of the roadway (measured from the horizontal plane) is in place after final compaction of the final surface course. Use an approved mechanical device that will:

- Apply compactive effort to the asphalt mixture to eliminate objectionable voids as the mixture passes through the wedge device, and
- Produce a wedge with a uniform texture, shape, and density while automatically adjusting to varying heights encountered along the roadway shoulder.

340.04 CONSTRUCTION METHODS

When paving operations result in a drop off of greater than 2 inches at the outside edge(s), or as approved by the City Engineer, attach a device to the paver screed to confine material at the end gate and extrude the asphalt material in a wedge shape having an angle between 30 ± 5 degrees. Ensure the wedge is compacted sufficiently as to eliminate objectionable voids. Maintain contact between the device and road shoulder surface; and allow automatic transition to cross roads, driveways, and obstructions. Use the device to constrain the asphalt head, reducing the area and increasing the density of the extruded profile.

The City Engineer may allow short sections of handwork when necessary for transitions at driveways, intersections, interchanges, and bridges.

Do not construct the safety edge at longitudinal joints in the pavement section.

Safety edge shape can be constructed on each lift of asphalt, or on the full specified depth on the final lift.

340.05 TESTING — VACANT

340.06 METHOD OF MEASUREMENT

Asphalt safety edge will not be measured for payment.

340.07 BASIS OF PAYMENT

Include the cost of constructing the asphalt safety edge in the price bid for the asphalt concrete paving pay item(s) included in the contract.

SECTION 341--ASPHALT CRACK REPAIR

341.01 DESCRIPTION

This section covers sawing, cleaning, and sealing joints in existing asphalt concrete pavement.

341.02 MATERIALS

Provide materials in accordance with the following criteria:

A) ¾" Wide or Less

The asphalt crack seal material must be Crafco Polyflex Type 2 – Part No. 34518, RP FLEX 2 or approved equal.

B) Greater than ¾" to Less than 2" Wide

Asphalt cracks greater than 3/4" to less than 2" wide in pavement surfaces requires Type S6 Hot Mix Asphalt in accordance with Section 908.04.

C) 2" Wide and Greater

Transverse asphalt cracks 2" wide or wider will require the following:

- Class "C" Concrete (2400 PSI strength within 3 days) in accordance with 901.01.
- Geo-Composite Fabric Membrane (Bid Item 822-01) in accordance with the Special Technical Provisions.

341.03 EQUIPMENT

A) Concrete Saw

Provide concrete saws capable of sawing asphalt concrete to the dimensions described herein. Handheld saws are allowed when used in a manner that accomplishes that crack preparation and widening in an acceptable manner.

B) Air Compressor

Provide air compressors capable of delivering compressed air with a pressure of at least 90 psi [620 kPa]. Ensure the compressors include traps to remove free water and oil from the compressed air.

C) Provide self-propelled steel wheel compactors.

341.04 CONSTRUCTION METHODS

The City Engineer will mark the asphalt cracks to be repaired and identify the crack width and crack repair strategy required.

A) ¾" Wide or Less

The asphalt crack seal material must be installed in accordance with the manufacturer's recommendations. The asphalt crack seal material must be placed first when also using Type S6 Hot Mix Asphalt Crack Repair to fill cracks between ¾" and 2".

Varying crack widths to be sealed by the contractor as follows:

- Cracks between 0" and ¾" are sealed only with asphalt crack seal material Crafco Polyflex Type 2 – Part No. 34518, RP FLEX 2 or approved equal.
- Cracks greater than ¾" to less than 2" are filled only with Type S6 Hot Mix Asphalt.
- When narrow cracks (0" to ¾") intersect wider cracks (3/4" to 2"), the Crafco sealant must be installed first.

Whenever a leveling course is used, 0" to ¾" cracks must be cleaned but not sealed by the contractor. Cleaning consists of 90 psi compressed air, brushing or vacuum techniques to remove debris. Include cost of cleaning in other items of work.

B) Greater than ¾" to Less than 2" Wide

Asphalt cracks greater than 3/4" to less than 2" wide in pavement surfaces to be overlaid with Hot Mix Asphalt must be cleaned by the contractor by blowing out the cracks using a 90-psi air compressor and in a manner acceptable to the City Engineer. Fill cleaned cracks by hand with Type S6 Hot Mix Asphalt prior to resurfacing. Said asphalt must be placed about 3/8" to 1/2" above the existing pavement surface to allow for compaction. A small steel wheel roller shall be used to compact the asphalt.

C) 2" Wide and Greater

Transverse asphalt cracks 2" wide or wider must be repaired by contractor by removing the asphalt and cleaning the crack. The trench width must be a minimum of 6" and the trench depth must be a minimum of 6" or the depth of the asphalt pavement, whichever is greater. The trench walls must be vertical. The trench must be filled with Class "C" Concrete (2400 PSI strength within 3 days) concrete up to the existing pavement surface. The bottom of the trench must be firm and unyielding before concrete placement. A two-foot-wide strip of "Geo-Composite Fabric Membrane" (Bid Item 822-01) must be centered and placed on the trench. The "Geo-Composite Fabric Membrane" must be installed per the Special Technical Provisions. The fabric will not be paid for separately and will be included in the cost of the *Asphalt Crack Repair* item.

341.05 TESTING — VACANT

341.06 METHOD OF MEASUREMENT

The City Engineer will measure the length and width classification of asphalt crack repaired that has been successfully completed in accordance with this specification. Transitions between width classifications will be measured at the greater width classification for payment.

Any Geo-Composite Fabric Membrane or Class "C" Concrete required will not be measured and paid for separately.

341.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) ASPHALT CRACK REPAIR (3/4" WIDE OR LESS)	Linear Foot [Meter]
(B) ASPHALT CRACK REPAIR (GREATER THAN 3/4" TO LESS THAN 2" WIDE)	Linear Foot [Meter]
(C) ASPHALT CRACK REPAIR. (2" WIDE AND GREATER)	Linear Foot [Meter]

The per linear foot payment for *Asphalt Crack Repair* shall be full compensation for furnishing all materials (including asphalt crack seal material, fabric and Class "C" Concrete), labor, equipment, tools and incidentals, and for performing the work in accordance with this specification.