

1 **SECTION 32 13 13**
2 **CONCRETE PAVING**

3 **PART 1 - GENERAL**

4 **1.1 SUMMARY**

5 A. Section includes:

- 6 1. Finished pavement constructed of Portland cement concrete including
7 monolithically poured curb on the prepared subgrade or other base course.

8 B. Deviations from this City of Fort Worth Standard Specification

- 9 1. None.

10 C. Related Specification Sections include, but are not necessarily limited to:

- 11 1. Division 0 - Procurement and Contracting Requirements
12 2. Division 1 - General Requirements
13 3. Section 32 01 29 - Concrete Paving Repair
14 4. Section 32 13 73 - Concrete Paving Joint Sealants

15 **1.2 PRICE AND PAYMENT PROCEDURES**

16 A. Measurement

17 1. Measurement

- 18 a. Measurement for this Item shall be by the square yard of completed and
19 accepted Concrete Pavement in its final position as measured from back of curb
20 for various:

- 21 1) Classes
22 2) Thicknesses

23 2. Payment

- 24 a. The work performed and materials furnished in accordance with this Item will
25 be paid for at the unit price bid per square yard of Concrete Pavement.

26 3. The price bid shall include:

- 27 a. Shaping and fine grading the placement area
28 b. Furnishing and applying all water required
29 c. Furnishing, loading and unloading, storing, hauling and handling all concrete
30 ingredients including all freight and royalty involved
31 d. Mixing, placing, finishing and curing all concrete
32 e. Furnishing and installing all reinforcing steel
33 f. Furnishing all materials and placing longitudinal, warping, expansion, and
34 contraction joints, including all steel dowels, dowel caps and load transmission
35 units required, wire and devices for placing, holding and supporting the steel
36 bar, load transmission units, and joint filler material in the proper position; for
37 coating steel bars where required by the Drawings
38 g. Sealing joints
39 h. Monolithically poured curb
40 i. Cleanup

1 **1.3 REFERENCES**

2 A.Reference Standards

- 3 1. Reference standards cited in this specification refer to the current reference standard
4 published at the time of the latest revision date logged at the end of this
5 specification, unless a date is specifically cited.
- 6 2. ASTM International (ASTM):
7 a. A615/A615M, Deformed and Plain Billet-Steel Bars for Concrete
8 Reinforcement
9 b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the
10 Field
11 c. C33, Concrete Aggregates
12 d. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete
13 Specimens
14 e. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed
15 Beams of Concrete
16 f. C94/C94M, Standard Specifications for Ready-Mixed Concrete
17 g. C150, Portland Cement
18 h. C595, Portland-Limestone Cement
19 i. C156, Standard Test Method for Water Loss (from a mortar specimen) Through
20 Liquid Membrane-Forming Curing Compounds for Concrete
21 j. C172, Standard Practice for Sampling Freshly Mixed Concrete
22 k. C260, Air Entraining Admixtures for Concrete
23 l. C309, Liquid Membrane-Forming Compounds for Curing Concrete, Type 2
24 m. C494, Chemical Admixtures for Concrete, Types “A”, “D”, “F” and “G”
25 n. C618, Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral
26 Admixture in Concrete
27 o. C881, Standard Specification for Epoxy-Resin-Base Bonding Systems for
28 Concrete
29 p. C1064, Standard Test Method for Temperature of Freshly Mixed Hydraulic-
30 Cement Concrete
31 q. C1602, Standard Specification for Mixing Water Used in the Production of
32 Hydraulic Cement Concrete.
33 r. D698, Laboratory Compaction Characteristics of Soil Using Standard Effort
34 (12,400 ft-lbf/ft³)
- 35 3. American Concrete Institute (ACI):
36 a. ACI 305.1-14 Specification for Hot Weather Concreting
37 b. ACI 306.1-90, Standard Specification for Cold Weather Concreting
38 c. ACI 318, Building Code Requirements for Structural Concrete and Commentary

39 **1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]**

40 **1.5 SUBMITTALS [NOT USED]**

41 **1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS**

- 42 A. Mix Design: submit for approval. See Item 2.4.A.

1 **1.7 CLOSEOUT SUBMITTALS [NOT USED]**

2 **1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**

3 **1.9 QUALITY ASSURANCE [NOT USED]**

4 **1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]**

5 **1.11 FIELD CONDITIONS**

6 A.Weather Conditions

- 7 1. Place concrete when concrete temperature is between 40°F and 95°F when
8 measured in accordance with ASTM C1064 at point of placement.
- 9 2. Hot Weather Concreting
 - 10 a. Concrete paving operations shall be approved by the City project manager or
11 designee when the concrete temperature exceeds 95°F.
 - 12 b. Concrete shall not be placed when concrete temperature is above 100°F under
13 any circumstances.
- 14 3. Cold Weather Concreting
 - 15 a. No concrete shall be placed when ambient temp in shade and away from
16 artificial heat is below 40°F and falling. Concrete may be placed when ambient
17 temp is above 35°F and rising. Unless the City project manager or designee
18 approves paving to continue, suspend concreting operations if a descending air
19 temperature in the shade and away from artificial heat falls below 40°F. Do not
20 resume concreting operations until an ascending air temperature in the shade and
21 away from artificial heat reaches 35°F and rising. Contractor should take all the
22 precautions necessary to prevent freezing of concrete. Frozen concrete must be
23 removed and replaced.
 - 24 4. It is to be distinctly understood that the contractor is responsible for the quality and
25 strength of the concrete placed under any weather conditions.

26 B.Time: Place concrete after sunrise and no later than shall permit the finishing of the
27 pavement in natural light, or as directed by the City.

28 **1.12 WARRANTY [NOT USED]**

29 **PART 2 - PRODUCTS**

30 **2.1 OWNER-FURNISHED PRODUCTS [NOT USED]**

31 **2.2 MATERIALS**

32 A.Cementitious Material: ASTM C150, ASTM C595 Type IL Cement.

33 B.Aggregates: ASTM C33.

34 C.Water: ASTM C1602.

35 D.Admixtures: When admixtures are used, conform to the appropriate specification:

- 36 1. Air-Entraining Admixtures for Concrete: ASTM C260.
- 37 2. Chemical Admixtures for Concrete: ASTM C494, Types “A”, “D”, “F” and “G.”
- 38 3. Fly Ash

- a. Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete: ASTM C618.
- b. Fly ash may be substituted at one pound per pound of cement up to 25% of the specified cement content when such batch design is approved by the Engineer.

E. Steel Reinforcement: ASTM A615.

F. Steel Wire Reinforcement: Not used for concrete pavement.

G. Dowels and Tie Bars

- 1. Dowel and tie bars: ASTM A615.
- 2. Dowel Caps
 - a. Provide and install dowel caps with enough range of movement to allow complete closure of the expansion joint.
 - b. Caps for dowel bars shall be of the length shown on the Drawings and shall have an internal diameter sufficient to permit the cap to freely slip over the bar.
 - c. In no case shall the internal diameter exceed the bar diameter by more 1/8 inch, and one end of the cap shall be tightly closed.
- 3. Epoxy for Dowel and Tie Bars: ASTM C881.
 - a. See following table for approved producers of epoxies and adhesives

| Pre-Qualified Producers of Epoxies and Adhesives | |
|--|---------------------------|
| Product Name | Producer |
| Concresive 1420 | BASF |
| HTE-50 | Hilti |
| T 308 + | Powers Fasteners |
| P E 1000+ | Powers Fasteners |
| C-6 | Ramset-Redhead |
| Epcon G-5 | Ramset-Redhead |
| Pro-Poxy-300 Fast Tube | Unitex |
| Shep-Poxy TxIII | CMC Construction Services |
| Ultrabond 1300 Tubes | Adhesives Technology |
| Ultrabone 2300 N.S. A-22-2300 Slow Set | Adhesives Technology |
| Dynapoxy EP-430 | Pecora Corp. |
| EDOT | Simpson Strong Tie |
| ET22 | Simpson Strong Tie |
| SET 22 | Simpson Strong Tie |
| SpecPoxy 3000FS | SpecChem |

- b. Epoxy Use, Storage and Handling
 - 1) Package components in airtight containers and protect from light and moisture.

- 1 2) Include detailed instructions for the application of the material and all
- 2 safety information and warnings regarding contact with the components.
- 3 3) Epoxy label requirements
- 4 a) Resin or hardener components
- 5 b) Brand name
- 6 c) Name of manufacturer
- 7 d) Lot or batch number
- 8 e) Temperature range for storage
- 9 f) Date of manufacture
- 10 g) Expiration date
- 11 h) Quantity contained
- 12 4) Store epoxy and adhesive components at temperatures recommended by the
- 13 manufacturer.
- 14 5) Do not use damaged or previously opened containers and any material that
- 15 shows evidence of crystallization, lumps skinning, extreme thickening, or
- 16 settling of pigments that cannot be readily dispersed with normal agitation.
- 17 6) Follow sound environmental practices when disposing of epoxy and
- 18 adhesive wastes.
- 19 7) Dispose of all empty containers separately.
- 20 8) Dispose of epoxy by completely emptying and mixing the epoxy before
- 21 disposal

22 H.Reinforcement Bar Chairs

- 23 1. Reinforcement bar chairs or supports shall be of adequate strength to support the
- 24 reinforcement bars and shall not bend or break under the weight of the
- 25 reinforcement bars or Contractor's personnel walking on the reinforcing bars.
- 26 2. Bar chairs may be made of metal (free of rust), precast mortar or concrete blocks or
- 27 plastic.
- 28 3. For approval of plastic chairs, representative samples of the plastic shall show no
- 29 visible indications of deterioration after immersion in a 5-percent solution of
- 30 sodium hydroxide for 120-hours.
- 31 4. Bar chairs may be rejected for failure to meet any of the requirements of this
- 32 specification.

33 I. Joint Filler

- 34 1. Joint filler is the material placed in concrete pavement and concrete structures to
- 35 allow for the expansion and contraction of the concrete.
- 36 2. Wood Boards: Used as joint filler for concrete paving.
- 37 a. Boards for expansion joint filler shall be of the required size, shape and type
- 38 indicated on the Drawings or required in the specifications.
- 39 1) Boards shall be of selected stock of redwood or cypress. The boards shall
- 40 be sound heartwood and shall be free from sapwood, knots, clustered
- 41 birdseyes, checks and splits.
- 42 2) Joint filler, boards, shall be smooth, flat and straight throughout, and shall
- 43 be sufficiently rigid to permit ease of installation.
- 44 3) Boards shall be furnished in lengths equal to the width between
- 45 longitudinal joints, and may be furnished in strips or scored sheet of the
- 46 required shape.

3. Dimensions. The thickness of the expansion joint filler shall be shown on the Drawings; the width shall be not less than that shown on the Drawings, providing for the top seal space.
4. Rejection. Expansion joint filler may be rejected for failure to meet any of the requirements of this specification.

J. Joint Sealants. Provide Joint Sealants in accordance with Section 32 13 73.

K. Curing Materials

1. Membrane-Forming Compounds.
 - a. Conform to the requirements of ASTM C309, Type 2, white pigmented compound and be of such nature that it shall not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete.
 - b. The compound shall produce a firm, continuous uniform moisture-impermeable film free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete.
 - c. It shall, when applied to the damp concrete surface at the specified rate of coverage, dry to touch in 1 hour and dry through in not more than 4 hours under normal conditions suitable for concrete operations.
 - d. It shall adhere in a tenacious film without running off or appreciably sagging.
 - e. It shall not disintegrate, check, peel or crack during the required curing period.
 - f. The compound shall not peel or pick up under traffic and shall disappear from the surface of the concrete by gradual disintegration.
 - g. The compound shall be delivered to the job site in the manufacturer's original containers only, which shall be clearly labeled with the manufacturer's name, the trade name of the material and a batch number or symbol with which test samples may be correlated.
 - h. When tested in accordance with ASTM C156 Standard Test Method for Water Loss (from a mortar specimen) Through Liquid Membrane-Forming Curing Compounds for Concrete, the liquid membrane-forming compound shall restrict the loss of water present in the test specimen at the time of application of the curing compound to not more than 0.01-oz.-per-2 inches of surface.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL

A. Mix Design

1. Concrete Mix Design and Control
 - a. The City has a pre-approved list of concrete mix designs. The pre-approved list can be found on the City website under Project Resources Folder. These mix designs meet the requirements of applicable City specifications and the Contractor may use mix designs from the list without the need for review and approval. The contractor shall notify the City in writing which mix in the pre-approved list the contractor uses for a project.
 - b. For a mix design not included in the pre-approved list, the Contractor shall submit a design of the concrete mix it proposes to use and a full description of the source of supply of each material component at least 10 calendar days prior to the start of concrete paving operations.
 - c. The design of the concrete mix shall produce a quality concrete complying with these specifications and shall include the following information:

- 1) Design Requirements and Design Summary
- 2) Material source
- 3) Dry weight of cement/cubic yard and type
- 4) Dry weight of fly ash/cubic yard and type, if used
- 5) Saturated surface dry weight of fine and coarse aggregates/cubic yard
- 6) Design water/cubic yard
- 7) Quantities, type, and name of admixtures with manufacturer's data sheets
- 8) Current strength tests or strength tests in accordance with ACI 318
- 9) Current Sieve Analysis and -200 Decantation of fine and coarse aggregates and date of tests
- 10)
- 11) Fineness modulus of fine aggregate
- 12) Specific Gravity and Absorption Values of fine and coarse aggregates
- 13) L.A. Abrasion of coarse aggregates
- 14) d. Once mix design approved by City, maintain intent of mix design and maximum water to cement ratio.
- 15)
- 16) e. No concrete may be placed on the job site until the mix design has been approved by the City.
- 17)
- 18) 2. Quality of Concrete
- 19) a. Consistency
- 20) 1) In general, the consistency of concrete mixtures shall be such that:
- 21) a) Mortar shall cling to the coarse aggregate
- 22) b) Aggregate shall not segregate in concrete when it is transported to the place of deposit
- 23) c) Concrete, when dropped directly from the discharge chute of the mixer, shall flatten out at the center of the pile, but the edges of the pile shall stand and not flow
- 24) d) Concrete and mortar shall show no free water when removed from the mixer
- 25) e) Concrete shall slide and not flow into place when transported in metal chutes at an angle of 30 degrees with the horizontal
- 26) f) Surface of the finished concrete shall be free from a surface film or laitance
- 27)
- 28) 2) When field conditions are such that additional moisture is needed for the final concrete surface finishing operation, the required water shall be applied to the surface by hand sprayer only and be held to a minimum amount.
- 29) 3) The concrete shall be workable, cohesive, possess satisfactory finishing qualities and be of the stiffest consistency that can be placed and vibrated into a homogeneous mass.
- 30)
- 31) 4) Excessive bleeding shall be avoided.
- 32)
- 33) 5) If the strength or consistency required for the class of concrete being produced is not secured with the minimum cement specified or without exceeding the maximum water/cement ratio, the Contractor may use, or the City may require, an approved cement dispersing agent (water reducer); or the Contractor shall furnish additional aggregates, or aggregates with different characteristics, or the Contractor may use additional cement in order to produce the required results.
- 34)
- 35) 6) The additional cement may be permitted as a temporary measure, until aggregates are changed and designs checked with the different aggregates or cement dispersing agent.
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- 1 7) The Contractor is solely responsible for the quality of the concrete
- 2 produced.
- 3 8) The City reserves the right to independently verify the quality of the
- 4 concrete through inspection of the batch plant, testing of the various
- 5 materials used in the concrete and by casting and testing concrete cylinders
- 6 or beams on the concrete actually incorporated in the pavement.
- 7 b. Standard Class
- 8 1) Unless otherwise shown on the Drawings or detailed specifications, the
- 9 standard class for pavement and related concrete for streets and alleys is
- 10 shown in the following table:
- 11

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Standard Classes of Pavement and Related Concrete

| Class of Concrete ¹ | Minimum Cementitious (Lb. /CY) | 28 Day Min. Compressive Strength ² (Psi) | Max. w/cm Ratio | Course Aggregate Maximum Size (Inch) | General Usage (Informational Only) |
|--------------------------------|--------------------------------|---|-----------------|--------------------------------------|---|
| A | 470 | 3,000 | 0.58 | 1-1/2 | Sidewalks and ADA ramps, driveways, curb & gutter, median pavement |
| CIP | 470 | 3,000 | 0.50 | 1-1/2 | Inlets, manholes, junction boxes, encasement, blocking, collars, light pole foundations |
| C | 517 | 3,600 | 0.45 | 1-1/2 | Headwalls, wingwalls, culverts, drilled shafts |
| P | 517 | 3,600 | 0.45 | 1-1/2 | Machine placed Paving |
| H | 564 | 4,500 | 0.45 | 1-1/2 | Hand Placed Paving |
| HES | 564 | 4,500 | 0.45 | 1-1/2 | HES Paving |
| S | 564 | 4,000 | 0.45 | 1-1/2 | Bridge slabs, top slabs of direct traffic culverts, approach slabs |

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1. All exposed horizontal concrete shall have a minimum of 3% entrained-air.
2. Minimum Compressive Strength Required.
 - a) Concrete Sidewalks and Curb & Gutter: Class A
 - b) Cast-In-Place Concrete Structures: Class CIP and Class C
 - c) Machine-Laid concrete: Class P
 - d) Hand-Laid concrete: Class H
 - e) Structural Concrete: Class S
 - f) High Early Strength Concrete: Class HES
 - (1) When shown on the Drawings or allowed, provide Class HES concrete for very early opening of pavements area or leave outs to traffic.
 - (2) Design class HES to meet the requirements of class specified for concrete pavement and a minimum compressive strength of 2,600 psi in 24 hours, unless other early strength and time requirements are shown on the Drawings allowed.

c. Slump

- 1) Slump requirements for pavement and related concrete shall be as specified in the following table:

Concrete Pavement and Related Concrete Slump Requirements Add classes of concrete

| Concrete Use | Recommended Design and Placement Slump, | Acceptable Placement Slump, (Inch) |
|--------------|---|------------------------------------|
| | | |

| | (Inch) | |
|--|-------------------------------|---|
| Slip-Form/Form-Riding Paving | 1-1/2 | 1 – 3 |
| Hand Formed Paving | 4 | 3 – 5 |
| Headwalls, wingwalls, culverts, inlets, manholes, junction boxes, encasement, blocking, collars, light pole foundations, slabs, sidewalk, curb and gutter, concrete valley gutter and other miscellaneous concrete | 4 | 3 – 5 |
| Drilled shafts | 6 ¹ / ₂ | 5 ¹ / ₂ – 7 ¹ / ₂ |

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- 2) No concrete shall be permitted with slump in excess of the maximums shown.
- 3) Any concrete mix failing to meet the above consistency requirements, although meeting the slump requirements, shall be considered unsatisfactory, and the mix shall be changed to correct such unsatisfactory conditions.

7 **PART 3 - EXECUTION**

8 **3.1 INSTALLERS [NOT USED]**

9 **3.2 EXAMINATION [NOT USED]**

10 **3.3 PREPARATION [NOT USED]**

11 **3.4 INSTALLATION**

12 **A. Equipment**

- 13 1. All equipment necessary for the construction of this item shall be on the project.
- 14 2. The equipment shall include spreading devices (augers), internal vibration, tamping, and surface floating necessary to finish the freshly placed concrete in such a manner as to provide a dense and homogeneous pavement.
- 15 3. Machine-Laid Concrete Pavement
- 16 a. Fixed-Form Paver. Fixed-form paving equipment shall be provided with forms that are uniformly supported on a sufficiently firm subbase to prevent sagging under the weight of machine.
- 17 b. Slip-Form Paver
- 18 1) Slip-form paving equipment shall be provided with traveling side forms of sufficient dimensions, shape and strength so as to support the concrete laterally for a sufficient length of time during placement.
- 19 2) City may reject use of Slip-Form Paver if paver requires over-digging and impacts trees, mailboxes or other improvements.
- 20 4. Hand-Laid Concrete Pavement
- 21 a. Machines that do not incorporate these features, such as roller screeds or vibrating screeds, shall be considered tools to be used in hand-laid concrete construction, as slumps, spreading methods, vibration, and other procedures are more common to hand methods than to machine methods.
- 22 5. City may reject equipment and stop operation if equipment does not meet requirements.

34 **B. Concrete Mixing and Delivery**

- 1 1. Transit Batching: shall not be used – onsite mixing not permitted
- 2 2. Ready Mixed Concrete
- 3 a. The concrete shall be produced in an approved method conforming to the
- 4 requirements of this specification and ASTM C94/C94M.
- 5 b. City shall have access to ready mix plant to obtain material samples.
- 6 c. When ready-mix concrete is used, sample concrete per ASTM C172 Alternate
- 7 Procedure 2:
- 8 1) As the mixer is being emptied, individual samples shall be taken after the
- 9 discharge of approximately 10 percent and 90 percent of the load.
- 10 2) The method of sampling shall provide that the samples are representative of
- 11 widely separated portions, but not from the very ends of the batch.
- 12 d. The mixing of each batch, after all materials are in the drum, shall continue until
- 13 it produces a thoroughly mixed concrete of uniform mass as determined by
- 14 established mixer performance ratings and inspection, or appropriate uniformity
- 15 tests as described in ASTM C94.
- 16 e. The entire contents of the drum shall be discharged before any materials are
- 17 placed therein for the succeeding batch.
- 18 f. Retempering or remixing shall not be permitted.
- 19 3. Delivery
- 20 a. Deliver concrete at an interval not exceeding 30 minutes or as determined by
- 21 City to prevent cold joint.
- 22 4. Delivery Tickets
- 23 a. For all operations, the manufacturer of the concrete shall, before unloading,
- 24 furnish to the purchaser with each batch of concrete at the site a delivery ticket
- 25 on which is printed, stamped, or written, the following information to determine
- 26 that the concrete was proportioned in accordance with the approved mix design:
- 27 1) Name of concrete supplier
- 28 2) Serial number of ticket
- 29 3) Date
- 30 4) Truck number
- 31 5) Name of purchaser
- 32 6) Specific designation of job (name and location)
- 33 7) Specific class, design identification and designation of the concrete in
- 34 conformance with that employed in job specifications
- 35 8) Amount of concrete in cubic yards
- 36 9) Time loaded or of first mixing of cement and aggregates
- 37 10) Water added by receiver of concrete
- 38 11) Type and amount of admixtures

39 C. Subgrade

- 40 1. When manipulation or treatment of subgrade is required on the Drawings, the work
- 41 shall be performed in proper sequence with the preparation of the subgrade for
- 42 pavement.
- 43 2. The roadbed shall be excavated and shaped in conformity with the typical sections
- 44 and to the lines and grades shown on the Drawings or established by the City.
- 45 3. All holes, ruts and depressions shall be filled and compacted with suitable material
- 46 and, if required, the subgrade shall be thoroughly wetted and reshaped.
- 47 4. Irregularities of more than 1/2 inch., as shown by straightedge or template, shall be
- 48 corrected.

5. The subgrade shall be uniformly compacted to at least 95 percent of the maximum density as determined by ASTM D698.
6. Moisture content shall be within minus 2 percent to plus 4 percent of optimum.
7. The prepared subgrade shall be wetted down sufficiently in advance of placing the pavement to ensure its being in a firm and moist condition.
8. Sufficient subgrade shall be prepared in advance to ensure satisfactory prosecution of the work.
9. The Contractor shall notify the City at least 24 hours in advance of its intention to place concrete pavement.
10. After the specified moisture and density are achieved, the Contractor shall maintain the subgrade moisture and density in accordance with this Section.
11. In the event that rain or other conditions may have adversely affected the condition of the subgrade or base, additional tests may be required as directed by the City.

D.Placing and Removing Forms

1. Placing Forms
 - a. Forms for machine-laid concrete
 - 1) The side forms shall be metal, of approved cross section and bracing, of a height no less than the prescribed edge thickness of the concrete section, and a minimum of 10 feet in length for each individual form.
 - 2) Forms shall be of ample strength and staked with adequate number of pins capable of resisting the pressure of concrete placed against them and the thrust and the vibration of the construction equipment operating upon them without appreciable springing, settling or deflection.
 - 3) The forms shall be free from warps, bends or kinks and shall show no variation from the true plane for face or top.
 - 4) Forms shall be jointed neatly and tightly and set with exactness to the established grade and alignment.
 - 5) Forms shall be set to line and grade at least 200 feet, where practicable, in advance of the paving operations.
 - 6) In no case shall the base width be less than 8 inches for a form 8 inches or more in height.
 - 7) Forms must be in firm contact with the subgrade throughout their length and base width.
 - 8) If the subgrade becomes unstable, forms shall be reset, using heavy stakes or other additional supports may be necessary to provide the required stability.
 - b. Forms for hand-laid concrete
 - 1) Forms shall extend the full depth of concrete and be a minimum of 1-1/2 inches in thickness or equivalent when wooden forms are used, or be of a gauge that shall provide equivalent rigidity and strength when metal forms are used.
 - 2) For curves with a radius of less than 250 feet, acceptable flexible metal or wood forms shall be used.
 - 3) All forms showing a deviation of 1/8 inch in 10 feet from a straight line shall be rejected.
2. Settling. When forms settle over 1/8 inch under finishing operations, paving operations shall be stopped the forms reset to line and grade and the pavement then brought to the required section and thickness.

3. Cleaning. Forms shall be thoroughly cleaned after each use.
4. Removal.
 - a. Forms shall remain in place until the concrete has taken its final set.
 - b. Avoid damage to the edge of the pavement when removing forms.
 - c. Repair damage resulting from form removal and honeycombed areas with a mortar mix within 24 hours after form removal unless otherwise approved.
 - d. Clean joint face and repair honeycombed or damaged areas within 24 hours after a bulkhead for a transverse construction joint has been removed unless otherwise approved.
 - e. When forms are removed before 72 hours after concrete placement, promptly apply membrane curing compound to the edge of the concrete pavement.

E. Placing Reinforcing Steel, Tie, and Dowel Bars

1. General
 - a. When reinforcing steel tie bars, dowels, etc., are required they shall be placed as shown on the Drawings.
 - b. All reinforcing steel shall be clean, free from rust in the form of loose or objectionable scale, and of the type, size and dimensions shown on the Drawings.
 - c. Reinforcing bars shall be securely wired together at the alternate intersections and all splices and shall be securely wired at each intersection dowel and load-transmission unit intersected.
 - d. All bars shall be installed in their required position as shown on the Drawings.
 - e. The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and, where permitted, such storage shall be limited to quantities and distribution that shall not induce excessive stresses.
2. Splices
 - a. Provide standard reinforcement splices by lapping and tying ends.
 - b. Comply with ACI 318 for minimum lap of spliced bars where not specified on the Drawings.
3. Installation of Reinforcing Steel
 - a. All reinforcing bars and bar mats shall be installed in the slab at the required depth below the finished surface and supported by and securely attached to bar chairs installed on prescribed longitudinal and transverse centers as shown by sectional and detailed drawings on the Drawings.
 - b. Chairs Assembly. The chair assembly shall be similar and equal to that shown on the Drawings and shall be approved by the City prior to extensive fabrication.
 - c. After the reinforcing steel is securely installed above the subgrade as specified in Drawings and as herein prescribed, no loading shall be imposed upon the bar mats or individual bars before or during the placing or finishing of the concrete.
4. Installation of Dowel Bars
 - a. Install through the predrilled joint filler and rigidly support in true horizontal and vertical positions by an assembly of bar chairs and dowel baskets.
 - b. Dowel Baskets
 - 1) The dowels shall be held in position exactly parallel to surface and centerline of the slab, by a dowel basket that is left in the pavement.
 - 2) The dowel basket shall hold each dowel in exactly the correct position so firmly that the dowel's position cannot be altered by concreting operations.
 - c. Dowel Caps

- 1) Install cap to allow the bar to move not less than 1-1/4 inch in either direction. Grease bar before adding cap to prevent bonding with the concrete.
5. Tie Bar and Dowel Placement
 - a. Place at mid-depth of the pavement slab, parallel to the surface.
 - b. Place as shown on the Drawings.
6. Epoxy for Tie and Dowel Bar Installation
 - 1) Epoxy bars as shown on the Drawings.
 - 2) Use only drilling operations that do not damage the surrounding structures.
 - 3) Blow out drilled holes with compressed air.
 - 4) Completely fill the drilled hole with approved epoxy before inserting the tie bar into the hole.
 - 5) Install epoxy grout and bar at least 6 inches embedded into concrete.

F. Joints

1. Joints shall be placed where shown on the Drawings or where directed by the City.
2. The plane of all joints shall make a right angle with the surface of the pavement.
3. No joints shall have an error in alignment of more than 1/2 inch at any point.
4. Joint Dimensions
 - a. The width of the joint shall be shown on the Drawings, creating the joint sealant reservoir.
 - b. The depth of the joint shall be shown on the Drawings.
 - c. Dimensions of the sealant reservoir shall be in accordance with manufacturer's recommendations.
 - d. After curing, the joint sealant shall be 1/8 inch to 1/4 inch below the pavement surface at the center of the joint.
5. Transverse Expansion Joints
 - a. Expansion joints shall be installed perpendicularly to the surface and to the centerline of the pavement at the locations shown on the Drawings, or as approved by the City. Expansion joints shall continue to the farthest outside edge of paving and adjacent slabs, and should extend through monolithic or attached curbs so that there is no restriction to the movement of the joint at any point.
 - b. Joints shall be of the design width, and spacing shown on the Drawings, or as approved by the City.
 - c. Dowel bars, shall be of the size and type shown on the Drawings, or as approved by the City, and shall be installed at the specified spacing.
 - d. Support dowel bars with dowel baskets.
 - e. Dowels shall not restrict the free opening and closing of the expansion joint and shall not make planes of weaknesses in the pavement.
 - f. Greased Dowels for Expansion Joints.
 - 1) Coat dowels with a thin film of grease or other approved de-bonding material.
 - 2) Provide dowel caps on the lubricated end of each dowel bar.
 - g. Proximity to Existing Structures. When the pavement is adjacent to or around existing structures, expansions joints shall be constructed in accordance with the details shown on the Drawings.
6. Transverse Contraction Joints
 - a. Contraction or dummy joints shall be installed at the locations and at the intervals shown on the Drawings.

- 1 b. Joints shall be of the design width, and spacing shown on the Drawings, or as
- 2 approved by the City.
- 3 c. Dowel bars, shall be of the size and type shown on the Drawings, or as
- 4 approved by the City, and shall be installed at the specified spacing.
- 5 d. Saw joints in a single cut to the width and depth the plans show. Begin sawing
- 6 as soon as the concrete hardens sufficiently to prevent excessive raveling along
- 7 the saw cut and finish before conditions induce uncontrolled cracking.
- 8 e. The joints shall be constructed by sawing to a 1/4 - inch width and to a depth of
- 9 1/4 of the actual pavement thickness, or deeper if so indicated on the Drawings.
- 10 f. Complete sawing as soon as possible in hot weather conditions and within a
- 11 maximum of 24 hours after saw cutting begins under cool weather conditions.
- 12 g. If sharp edge joints are being obtained, the sawing process shall be sped up to
- 13 the point where some raveling is observed.
- 14 h. Damage by blade action to the slab surface and to the concrete immediately
- 15 adjacent to the joint shall be minimized.
- 16 i. Any portion of the curing membrane which has been disturbed by sawing
- 17 operations shall be restored by spraying the areas with additional curing
- 18 compound.
- 19 7. Transverse Construction Joints
- 20 a. Construction joints formed at the close of each day's work or when the placing
- 21 of concrete has been interrupted for 30-minutes or longer shall be constructed
- 22 by use of metal or wooden bulkheads cut true to the section of the finished
- 23 pavement and cleaned.
- 24 b. Wooden bulkheads shall be constructed using material of a thickness not less
- 25 than nominal 2" lumber.
- 26 c. Longitudinal bars shall be held securely in place in a plane perpendicular to the
- 27 surface and at right angles to the centerline of the pavement.
- 28 d. Edges shall be rounded to 1/4-inch radius.
- 29 e. Any surplus concrete on the subgrade shall be removed upon the resumption of
- 30 the work.
- 31 8. Longitudinal Construction Joints
- 32 a. Longitudinal construction joints shall be of the type shown on the Drawings.
- 33 9. Joint Filler
- 34 a. Joint filler shall be as specified in 2.2.1 of the size and shape shown on the
- 35 Drawings.
- 36 b. Redwood Board joints shall be used for all pavement joints except for
- 37 expansion joints that are coincident with a butt joint against existing
- 38 pavements.
- 39 c. Boards with less than 25-percent of moisture at the time of installation shall be
- 40 thoroughly wetted on the job.
- 41 d. Green lumber of much higher moisture content is desirable and acceptable.
- 42 e. The joint filler shall be appropriately drilled to admit the dowel bars when
- 43 required.
- 44 f. The bottom edge of the filler shall extend to or slightly below the bottom of the
- 45 slab. The top edge shall be held not less than 1/2 inch below the finished
- 46 surface of the pavement in order to allow the finishing operations to be
- 47 continuous.

- g. The joint filler may be composed of more than one length of board in the length of joint, but no board of a length less than 6 foot may be used unless otherwise shown on the Drawings.
 - h. After the removal of the side forms, the ends of the joints at the edges of the slab shall be carefully opened for the entire depth of the slab.
10. Joint Sealing. Routine pavement joints shall be filled consistent with paving details and as specified in Section 32 13 73. Materials shall generally be handled and applied according to the manufacturer’s recommendations as specified in Section 32 13 73.

G.Placing Concrete

- 1. Unless otherwise specified in the Drawings, the finished pavement shall be constructed monolithically and constructed by machined laid method unless impractical. The City will make determination of what is practical. The maximum length of concrete lane that can be placed by hand pouring is 50 linear feet.
- 2. The concrete shall be rapidly deposited on the subgrade in successive batches and shall be distributed to the required depth and for the entire width of the pavement by approved methods.
- 3. Any concrete not placed as herein prescribed within the time limits in the following table will be rejected. Time begins when the water is added to the mixer.

Temperature – Time Requirements

| Concrete Temperature (at point of placement) | Max Time – minutes (no retarding agent) | Max Time – minutes (with retarding agent) ¹ |
|---|--|---|
| Non-Agitated Concrete | | |
| All temperatures | 45 | 45 |
| Agitated Concrete | | |
| Above 90°F | 45 | 75 |
| Above 75°F thru 90°F | 60 | 90 |
| 75°F and Below | 60 | 120 |

¹ Normal dosage of retarder.

- 4. Rakes shall not be used in handling concrete.
- 5. At the end of the day, or in case of unavoidable interruption or delay of more than 30 minutes or longer to prevent cold joints, a transverse construction joint shall be placed in accordance with 3.4.F.7 of this Section.
- 6. Honeycombing
 - a. Special care shall be taken in placing and vibrating the concrete against the forms and at all joints and assemblies so as to prevent honeycombing Concrete shall be uniformly consolidated throughout its width and depth, free from honey combed areas, and has a consistent void-free closed surface.
 - b. Excessive voids and honeycombing in the edge of the pavement, revealed by the removal of the side forms, may be cause for rejection of the section of slab in which the defect occurs.

1 H.Finishing

2 1. Machine

3 a. Tolerance Limits

- 4 1) While the concrete is still workable, it shall be tested for irregularities with
5 a 10-foot straightedge placed parallel to the centerline of the pavement so as
6 to bridge depressions and to touch all high spots.
7 2) Ordinates measured from the face of the straightedge to the surface of the
8 pavement shall at no place exceed 1/16 inch-per-foot from the nearest point of
9 contact.
10 3) In no case shall the maximum ordinate to a 10-foot straightedge be greater
11 than 1/8 inch.
12 4) Any surface not within the tolerance limits shall be reworked and
13 refinished.

14 b. Edging

- 15 1) The edges of slabs and all joints requiring edging shall be carefully tooled
16 with an edger of the radius required by the Drawings at the time the concrete
17 begins to take its "set" and becomes non-workable.
18 2) All such work shall be left smooth and true to lines.

19 2. Hand

- 20 a. Hand finishing permitted only in intersections and areas inaccessible to a
21 finishing machine.
22 b. When the hand method of striking off and consolidating is permitted, the
23 concrete, as soon as placed, shall be approximately leveled and then struck off
24 with screed bar to such elevation above grade that, when consolidated and
25 finished, the surface of the pavement shall be at the grade elevation shown on
26 the Drawings.
27
28 c. The straightedge and joint finishing shall be as prescribed herein.

29 I. Curing

- 30 1. The curing of concrete pavement shall be thorough and continuous throughout the
31 entire curing period.
32 2. Failure to provide proper curing as herein prescribed shall be considered as
33 sufficient cause for immediate suspension of the paving operations.
34 3. The curing method as herein specified does not preclude the use of any of the other
35 commonly used methods of curing, and the City may approve another method of
36 curing if so requested by the Contractor.
37 4. If any selected method of curing does not afford the desired results, the City shall
38 have the right to order that another method of curing be instituted.
39 5. After removal of the side forms, the sides of the slab shall receive a like coating
40 before earth is banked against them.
41 6. The solution shall be applied, under pressure with a spray nozzle, in such a manner
42 as to cover the entire surfaces thoroughly and completely with a uniform film.
43 7. The rate of application shall be such as to ensure complete coverage and shall not
44 exceed 20-square-yards-per-gallon of curing compound.
45 8. When thoroughly dry, it shall provide a continuous and flexible membrane, free
46 from cracks or pinholes, and shall not disintegrate, check, peel or crack during the
47 curing period.

- 1 9. If for any reason the seal is broken during the curing period, it shall be immediately
2 repaired with additional sealing solution.
- 3 10. When tested in accordance with ASTM C156 Standard Test Method for Water Loss
4 (from a mortar specimen) Through Liquid Membrane-Forming Curing Compounds
5 for Concrete, the curing compound shall provide a film which shall have retained
6 within the test specimen a percentage of the moisture present in the specimen when
7 the curing compound was applied according to the following.
- 8 11. Contractor shall maintain and properly repair damage to curing materials on
9 exposed surfaces of concrete pavement continuously for a least 72 hours.

10 J. Monolithic Curbs

- 11 1. Concrete for monolithic curb shall be the same as for the pavement and shall be
12 placed within 20 minutes of the placement of the slab concrete.
- 13 2. After the concrete has been struck off and sufficiently set, the exposed surfaces
14 shall be thoroughly worked to achieve an acceptable surface finish.
- 15 3. The exposed edges shall be rounded by the use of an edging tool to the radius
16 indicated on the Drawings.
- 17 4. All exposed surfaces of curb shall be brushed to a smooth and uniform surface.

18 K. Pavement Leaveouts

- 19 1. Pavement leaveouts as necessary to maintain and provide for local traffic shall be
20 provided at location indicated on the Drawings or as directed by the City.
- 21 2. The extent and location of each leaveout required and a suitable crossover
22 connection to provide for traffic movements shall be determined in the field by the
23 City.

24 3.5 REPAIR

25 A. Repair of concrete pavement concrete shall be consistent with the Drawings and as
26 specified in Section 32 01 29.

27 3.6 RE-INSTALLATION [NOT USED]

28 3.7 SITE QUALITY CONTROL

29 A. Concrete Placement

- 30 1. Place concrete using a fully automated paving machine. Hand paving is only
31 permitted in areas such as intersections where use of paving machine is not
32 practical.
 - 33 a. All concrete pavement not placed by hand shall be placed using a fully
34 automated paving machine as approved by the City.
 - 35 b. Screeds are considered hand placement paving method.

36 B. Testing of Materials

- 37 1. Samples of all materials for testing shall be provided by the contractor at no
38 expense to the City, unless otherwise specified in the special provisions or in the
39 Drawings.
- 40 2. In the event the initial sampling and testing does not comply with the specifications,
41 **all subsequent testing of the material in order to determine if the material is**
42 **acceptable shall be at the Contractor's expense at the same rate charged by the**
43 **commercial laboratories.**

- 1 3. All testing shall be in accordance with applicable ASTM Standards and concrete
2 testing technician must be ACI certified or equivalent.

3 C.Pavement Thickness Test

- 4 1. Pavement thickness test shall be performed by a commercial testing laboratory
5 approved by the City every 100 feet or fraction thereof in accordance with TxDOT
6 Designation: Tex-423-A, unless otherwise shown on the plans. Test locations shall
7 be at the discretion of the City.
8 2. In the event a deficiency in the thickness of pavement is revealed during normal
9 testing operations, core samples shall be taken at the contractor's expense to verify
10 deficiency of more than 0.2 in. from plan thickness and to isolate the deficient area.
11 3. Where the average thickness of pavement in the area found to be deficient in
12 thickness by more than 0.20 inch, but not more than 0.50-inch, payment shall be
13 made at an adjusted price as specified in the following table.
14

| Deficiency in Thickness Determined by Cores | Proportional Part Of Contract Price |
|--|--|
| Inches | Allowed |
| 0.00 – 0.20 | 100 percent |
| 0.21 – 0.30 | 80 percent |
| 0.31 – 0.40 | 70 percent |
| 0.41 – 0.50 | 60 percent |

- 15 4. Any area of pavement found deficient in thickness by more than 0.50 inch but not
16 more than 0.75 inch or 1/10 of the thickness specified on the Drawings, whichever
17 is greater, shall be evaluated by the City.
18 5. If, in the judgment of the City the area of such deficiency should not be removed
19 and replaced, there shall be no payment for the area retained.
20 6. If, in the judgment of the City, the area of such deficiency warrants removal, the
21 area shall be removed and replaced, at the Contractor's entire expense, with
22 concrete of the thickness shown on the Drawings.
23 7. Any area of pavement found deficient in thickness by more than 0.75 inch or more
24 than 1/10 of the plan thickness, whichever is greater, shall be removed and replaced
25 with concrete of the thickness shown on the Drawings at the Contractor's sole
26 expense.
27 8. No additional payment over the contract unit price shall be made for any pavement
28 of a thickness exceeding that required by the Drawings.
29

30 D.Pavement Strength Test

- 31 1. During the progress of the work the commercial testing laboratory casts test
32 cylinders for conforming to ASTM C31, to maintain a check on the compressive
33 strengths of the concrete being placed.

2. Test cylinders shall be taken from a representative portion of concrete being placed for every 150-cubic yards of concrete pavement placed, but in no case shall fewer than 1 set of cylinders be taken per day of placement. After the cylinders have been cast, they shall remain on the job site and then transported, moist cured, and tested in accordance with ASTM C31 and ASTM C39.
3. In each set, one of the cylinders shall be tested at 7 days (3 days for HES concrete), two cylinders shall be tested at 28 days (three cylinders for 4" by 8" cylinders), and the remaining cylinder shall be retained for testing at 56 days, if necessary. Concrete must attain its design strength within 56 days. The 4" by 8" cylinders are acceptable only when the nominal maximum aggregate size of the mix is less than 1-1/4 inch.
4. If the average 28-day test results indicate deficient strength, the Contractor may, at its option and expense, core the pavement in question and have the cores tested by an approved laboratory in accordance with ASTM C42 and ACI 318 protocol. The average of all cores must meet 100 percent of the minimum specified strength, with no individual core resulting in less than 90 percent of design strength, in order to override the results of the cylinder tests.
5. In the event cylinders and/or cores do not meet minimum specified strength, additional cores may be taken to identify the limits of deficient concrete pavement at the expense of the Contractor.
6. Cylinders and/or cores must meet minimum specified strength. Pavement not meeting the minimum specified strength shall be subject to the money penalties or removal and placement at the Contractor's expense as shown in the following table.

| Percent Deficient | Percent of Contract Price Allowed |
|--|--|
| Greater Than 0 percent - Not More Than 10 percent | 90-percent |
| Greater Than 10 percent - Not More Than 15 percent | 80-percent |
| Greater Than 15 percent | 0-percent or removed and replaced at the entire cost and expense of Contractor as directed by City |

7. Deficiency shall be determined on a panel by panel basis.
8. The amount of penalty shall be deducted from payment due to Contractor
9. No additional payment over the contract unit price shall be made for any pavement with a strength exceeding that required by the Drawings and/or specifications.

E. Cracked Concrete Acceptance Policy

1. If cracks exist in concrete pavement upon completion of the project, the Project Inspector shall decide as to the need for action to address the cracking as to its cause and recommended remedial work.
2. If the recommended remedial work is routing and sealing of the cracks to protect the subgrade, the Inspector shall make the determination as to whether to rout and seal the cracks at the time of final inspection and acceptance or at any time prior to the end of the project maintenance period. The Contractor shall perform the routing and sealing work as directed by the Project Inspector, at no cost to the City, regardless of the cause of the cracking.
3. If remedial work beyond routing and sealing is determined to be necessary, the Inspector and the Contractor shall meet to determine the cause of the cracking.

- 1 a. If agreement is reached that the cracking is due to deficient materials or
2 workmanship, the Contractor shall perform the remedial work at no cost to the
3 City. Remedial work in this case shall be limited to removing and replacing the
4 deficient work with new material and workmanship that meets the requirements
5 of the contract.
- 6 b. If the Inspector and the Contractor agree that the cause of the cracking is not
7 deficient materials or workmanship, the City may request the Contractor to
8 provide an estimate of the cost of the necessary remedial work and/or additional
9 work to address the cause of the cracking, and the Contractor will perform that
10 work at the agreed-upon price if the City elects to do so.
- 11 4. If the Inspector and the Contractor cannot agree on the cause of the cracking, the
12 City may hire an independent geotechnical engineer, acceptable to the Contractor,
13 to perform testing and analysis to determine the cause of the cracking. The
14 contractor shall pay 50 percent of the costs of the independent testing. Contractor
15 shall provide one half of the estimated costs of the independent testing to be held by
16 the City.
- 17 5. If the independent geotechnical engineer determines that the primary cause of the
18 cracking is the Contractor's deficient material or workmanship, the remedial work
19 will be performed at the Contractor's entire expense and the Contractor will also
20 reimburse the City for the City's portion of cost of the geotechnical investigation.
21 Remedial work in this case shall be limited to removing and replacing the deficient
22 work with new material and workmanship that meets the requirements of the
23 contract.
- 24 6. If the geotechnical engineer determines that the primary cause of the cracking is not
25 the Contractor's deficient material or workmanship, the City will return the held
26 funds to the Contractor. The Contractor, on request, will provide the City an
27 estimate of the costs of the necessary remedial work and/or additional work and
28 will perform the work at the agreed-upon price as directed by the City.

29 **3.8 SYSTEM STARTUP [NOT USED]**

30 **3.9 ADJUSTING [NOT USED]**

31 **3.10 CLEANING [NOT USED]**

- 32 A.No concrete washout, mix, slurry, cuts, mud or solids etc., may enter the storm water
33 system including curb lines. Equipment washout allowed only in areas shown on
34 drawings and test materials or slag must be removed from site prior to final acceptance.

35 **3.11 CLOSEOUT ACTIVITIES [NOT USED]**

36 **3.12 PROTECTION [NOT USED]**

37 **3.13 MAINTENANCE [NOT USED]**

38 **3.14 ATTACHMENTS [NOT USED]**

39

END OF SECTION

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| Revision Log | | |
|--------------|--------------------------------|---|
| DATE | NAME | SUMMARY OF CHANGE |
| 12/20/2012 | | 1.2.A – Modified items to be included in price bid |
| 05/21/2014 | Doug Rademaker | 2.2.D – Modified to clarify acceptable fly ash substitution in concrete paving |
| 03/19/2021 | Zelalem Arega/Doug Black | 1.11.A – modified to clarify concrete placement temperature restrictions 2.4.A, B, D – to clarify concrete quality control process and requirements 3.7. C & D - to modify and clarify the pavement strength test and change in pavement thickness measurement methodology 3.7.E – Modified to clarify cracked concrete acceptance policy |
| 3/11/2022 | Zelalem Arega | 1.3.A.h, 2.2 – Added ASTM C595, Type IL cement |
| 6/10/2022 | M Owen | 3.4 G. 1. – Clarified language re: machine laid vs. hand poured |