SECTION 5

PORTLAND CEMENT CONCRETE

5.1 GENERAL

This section of the specifications defines materials to be used in all Portland cement concrete work and requirements for mixing, placing, finishing, and curing.

5.2 MATERIALS

Materials used in Portland cement concrete and reinforcing of Portland cement concrete shall meet the following requirements:

A. Cement: Portland cement shall be low alkali Type II or Type III and shall comply with the Standard Specification for Portland cement, ASTM C-150.

B. Aggregates: Concrete aggregates shall comply with ASTM C-33 latest edition. Maximum aggregate size shall be one (1) inch.

C. Water: Water used in mixing concrete shall be clean and free from oil, acid, salt, injurious amounts of alkali, organic matter, or other deleterious substances.

D. Entraining Agent: An air-entraining agent shall be used in all concrete exposed to the weather. The agent shall conform to ASTM Designations C-175 and C-260.

E. Admixtures: No admixture will be permitted to be used in Portland cement concrete unless such use is specifically authorized by the City Engineer.

F. Fly Ash: May only be added to a mix design approved by the City Engineer according to UDOT specification. Fly ash mixtures will be considered for structural concrete only.

G. Reinforcing Steel: All bar material used for reinforcement of concrete shall be intermediate grade steel conforming to the requirements of ASTM Designation A-615 GR-60 and shall be deformed in accordance with ASTM Designation A-305. The reinforcing shall be clean and free from rust, scale, paint, grease or other foreign matter which might impair the bond.

H. Welded Wire Fabric: Welded wire fabric for concrete reinforcement shall conform to the requirements of ASTM A-185.

5.3 CONCRETE MIX

For the purpose of practical identification, concrete has been divided into three classes: Class A, B, and C as follows:

Class	Minimum Cement (sacks/c.y.)	Minimum 28-day Comp. Strength (psi)	Primary Use
A	6 1/2	4000	Reinforced structural concrete.
B	6	3500	Sidewalks, curbs and gutter, cross gutter, pavements, and unreinforced footings and foundations.
C	5	2500	Thrust blocks, anchors, and mass concrete.

Note: Above specifications refer to 94-pound sacks of Portland cement.

All concrete shall also comply with the following requirements:

A. Aggregates: The maximum size of the aggregate shall be not larger than one-fifth of the narrowest dimension between forms within which the concrete is to be cast, nor larger than three-fourths of the minimum clear spacing between reinforcing bars or between reinforcing bars and forms. For non-reinforced concrete slabs, the maximum size of aggregates shall not be larger than one-fourth the slab thickness.

B. Water: Sufficient water shall be added to the mix to produce concrete with minimum practicable slump.

Unless otherwise authorized by the Engineer, the nominal slump for all concrete shall be zero to three (0-3) inches with a maximum slump of four (4) inches. No concrete shall be placed with a slump in excess of five (5) inches.

The consistency of the concrete shall be determined in accordance with ASTM C-143.

The maximum permissible water-cement ratio (including free moisture on aggregates) shall be five (5) and five and three-fourths (5-3/4) gallons per bag of cement, respectively, for Class A and B air entrained concrete.

C. Air Entraining: Air content for air entrained concrete shall comply with the following:

Course Aggregate Size (in)	Air Content (%)
3/4 or 1	6 +/- 1
3/8 or 1/2	7 +/- 1

The air entraining agent shall be added to the mixing water by means of mechanical equipment capable of accurate measurement and control.

5.4 FORMS

Forms shall be substantially built and adequately braced so as to withstand the liquid weight of concrete. All linings, studding, walling, and bracing shall be such as to prevent bulging, spreading, or loss of true alignment while pouring and displacement of concrete while setting. Forms shall be of the exact height and dimensions to give the thickness and width of concrete as shown on the plans, or as mentioned in these specifications.

Metal forms shall be used for curb and gutter work except at curves. All edge forms for sidewalk pavements, curbs, and gutters shall be of sufficient rigidity and adequately braced to accurately maintain line and grade. Prior to concrete placement, all forms shall be lightly coated with oil to prevent concrete adhesion to form materials.

All sidewalks shall be a minimum of four (4) inches thick and four (4) feet wide throughout entire cross section edge to edge.

Forms for curved sections shall be so constructed and placed so that the finished surface of walls and edge of sidewalks, curbs, and gutters will not deviate appreciably from the arc of the curve.

At the option of the Contractor, a slip form curb and gutter machine may be used in place of forms, provided that the finished results are satisfactory and approved by the City Engineer. A continuous deposit of concrete shall be maintained so as to minimize stopping of the machine. Special care shall be exercised to compact that portion of the subgrade supporting the machine.

Exposed vertical and horizontal edges of the concrete in structures shall be chamfered by the placing of moldings in the forms.

5.5 JOINTS

Joints shall be provided for sidewalk and curb and gutter as follows:

A. Sidewalks shall have contraction joints at intervals of ten (10) feet (maximum), which joints shall be approximately 3/16-inch wide and be approximately 25% of the total slab thickness. In addition, one-half (½) inch expansion joints shall be provided at 50-foot intervals and at locations where sidewalks adjoin curbs or existing sidewalks, driveways, or aprons.

Where curbs and curb and gutter are placed by slipform methods, the contraction joints every ten (10) feet may be provided by cutting into the fresh concrete to a minimum depth of 1-1/2 inches to create a plane of weakness. The edges of such joints shall be rounded to provide a neat workmanlike appearance. Four (4) inch expansion joints will be required at adjacent pavement, sidewalk, radius points, or structures or as set forth in the standard drawings. The expansion joints shall be the full cross-sectional thickness of the concrete being placed every 50 feet minimum. See Standard Drawing No. 207-208.

B. Curb and Gutter shall be cut into lengths of ten (10) feet by the use of 1/8-inch steel division plates of the exact cross section of the curb and gutter. Also, one-half (½) inch expansion joints shall be provided at curb and gutter radii where the curb and gutter abuts a solid object and at intervals not to exceed 50 feet unless otherwise specified by the City Engineer.

Where curbs and curb and gutter are placed by slipform methods, the contraction joints every ten (10) feet may be provided by cutting into the fresh concrete to a minimum depth of 1-1/2 inches to create a plane of weakness. The edges of such joints shall be rounded to provide a neat workmanlike appearance. Four (4) inch expansion joints will be required at adjacent pavement, sidewalk, radius points, or structures or as set forth in the standard drawings. The expansion joints shall be the full cross-sectional thickness of the concrete being placed every 100 feet minimum. See Standard Drawing No. 206.

Material for one-half (1/2) inch expansion joints shall be as defined in AASHTO M—33, and shall be installed with its top approximately flush with the concrete surface.

5.6 REINFORCING STEEL PLACEMENT

Reinforcing steel shall be clean and free from rust, scale, paint, grease, or other foreign matter which might impair the bond to concrete.

Reinforcing bars shall be held accurately placed as shown on the approved plans and shall be securely held in position in accordance with Concrete Reinforcing Steel Institute

"Recommended Practice for Placing Reinforcing Bars," and by using concrete or metal chairs, spacers, metal hangers, supporting wires, and other approved devices of sufficient strength to resist crushing under full load. No steel shall extend from or be visible on any finished surface and shall have a minimum of two (2) inches of concrete cover. Bars shall be grade 60.

Placing bars on layers of fresh concrete as the work progresses and adjusting bars during the placing of concrete will not be permitted. No concrete shall be deposited until the placing of the reinforcing steel has been inspected and approved.

Splices of bars shall be made only where shown on the approved plans or as approved by the City Engineer. Where bars are spliced, they shall be lapped at least 30 diameters.

Splicing shall be accomplished by placing the bars in contact with each other and wiring them together.

Welding of reinforcing steel will not be permitted unless specifically authorized by the City Engineer.

5.7 PREPARATIONS

Before batching and placing concrete, all equipment for mixing and transporting the concrete shall be cleaned, all debris and ice shall be removed from the places to be occupied by the concrete, forms shall be thoroughly wetted (except in freezing weather) or oiled, and masonry filler units that will be in contact with concrete shall be well drenched (except in freezing weather), and the reinforcement shall be thoroughly cleaned of ice or other coatings. Water shall be removed from spaces to receive concrete and kept below subgrade until the concrete has set.

Before placing concrete on earth surfaces, the surfaces shall be free from frost, ice, mud, and water. When the subgrade surface is dry soil or pervious material, it shall be sprayed with water immediately before placing of concrete or shall be covered with waterproof sheathing paper or a plastic membrane. No concrete shall be placed until the surfaces have been inspected and approved by the City Engineer or City Inspector.

5.8 CONCRETE MIXING

The concrete shall be mixed until there is a uniform distribution of the materials. Sufficient water shall be used in mixing concrete to produce a mixture which will flatten and quake when deposited in place, but not enough to cause it to flow. Sufficient water shall be used in concrete in which reinforcement is to be imbedded, to produce a mixture which will flow sluggishly when worked and which, at the same time, can be conveyed from the mixer to the forms without separation of the coarse aggregate from the mortar. In no case shall the quantity of water used be sufficient to cause the collection of a surplus in the forms.

Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set forth in ASTM C-94. Concrete shall be delivered and deposited in its final position within 60 minutes if the air temperature is above 80°F or within 90 minutes if the air temperature is below 80°F after adding the cement and water to the mixture. Washing out of mixer trucks shall not be permitted within City rights-of-way, and shall be permitted only in approved locations.

5.9 DEPOSITING

Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. The concrete placing shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the corners of forms and reinforcing bars. No concrete that has partially hardened or been contaminated by foreign material shall be deposited in the work, nor shall retempered concrete be used.

All concrete in structures shall be vibrator compacted during the operation of placing and shall be thoroughly worked around reinforcement and embedded fixtures and into the corners of the forms.

5.10 PLACING CONCRETE IN COLD WEATHER

No concrete shall be poured where the air temperature is lower than 40 degrees Fahrenheit unless adequate means are provided to heat the aggregates and water and protect the work. When concrete is poured below a temperature of 40 degrees Fahrenheit, the ingredients of the concrete shall be heated so that the temperature of the mixture shall not be less than 50 degrees or more than 100 degrees Fahrenheit. Cement shall not be added while the temperature of the mixed aggregates and the water is greater than 100 degrees Fahrenheit. **Calcium chloride will not be permitted**. Concrete shall be maintained at a 40 degree Fahrenheit temperature for three days (minimum) subsequent to pouring. No concrete shall be put into place until the ground forming the subgrade has been fully thawed out. When there is likelihood of freezing during the curing period, the concrete shall be protected by means of an insulation covering to prevent freezing of the concrete for a period of not less than seven days after placing.

Equipment for protecting concrete from freezing shall be available at the job site prior to placing concrete. Particular care shall be exercised to protect edges and exposed corners from freezing. In the event heating is employed, care shall be taken to insure that no part of the concrete becomes dried out or is heated to temperatures above 90 degrees Fahrenheit. The housing, covering, or other protection used shall remain in place and intact at least 24 hours after the artificial heating is discontinued.

5.11 FINISHING

All concrete work shall be carefully performed and shall produce a quality visual appearance as is common to the industry.

After the concrete for slabs has been brought to the established grade and screened, it shall be worked with a magnesium float and then given a light broom finish. In no case shall dry cement or a mixture of dry cement and sand be sprinkled on the surface to absorb moisture or hasten hardening. Surface edges of all slabs shall be rounded to a radius of one-half (½) inch.

After concrete has been poured in curb and gutter forms, it shall be puddled and spaded so as to insure a thorough mixture, eliminate air pockets, and create uniform and smooth sides. Before the concrete has thoroughly set, and while the concrete is still green, the forms shall be removed and the front and top sides shall be finished with a float or steel trowel to make a uniform finished surface. Wherever corners are to be rounded, special steel trowels shall be used while the concrete is workable and the corners constructed to the dimensions specified.

The top and face of the curb and also the top of the apron on combined curb and gutter must be finished true to line and grade and without any irregularities of surface noticeable to the eye. The gutter shall not hold water to a depth of more than one-fourth (1/4) of an inch, nor shall any portion of the surface or face of the curb or gutter depart more than one-fourth (1/4) of an inch from a straight edge ten (10) feet in length, placed on the curb parallel to the center line of the street nor shall any part of the exposed surface present a wavy appearance.

5.12 CURING AND PROTECTION

As soon as the concrete has hardened sufficiently to prevent damage, the finished surface shall be protected for curing one of the following ways:

A. Ponding of water on the surface or continuous sprinkling.

B. Application of absorptive mats such as three (3) inches of cured hay, clean straw, or fabric kept continuously wet.

C. Application of two (2) inches of moist earth or sand uniformly distributed on the surface and kept saturated by spraying with water.

D. Application of light colored waterproof plastic materials, conforming to "Specifications for Waterproof Sheet Materials for Curing Concrete" ASTM C-171, placed and maintained in contact with the surface of the concrete.

E. Application of a curing compound, conforming to "Specifications for Liquid Membrane - Forming Compounds for Curing Concrete" ASTM C-309. The compound shall be light in color and shall be applied in accordance with the manufacturer's recommendations immediately after any water sheen, which may develop after finishing has disappeared from the concrete surface.

The freshly finished surface shall be protected from hot sun and drying winds until it can be sprinkled or covered as above specified. The concrete surface must not be damaged or pitted by rain. The Contractor shall provide and use, when necessary, sufficient tarpaulins to completely cover all sections that have been placed within the preceding twelve (12) hours.

The Contractor shall erect and maintain suitable barriers to protect the finished surface. Any section damaged from traffic or other causes occurring prior to its official acceptance shall be repaired or replaced by the Contractor at his own expense in a manner satisfactory to the City Engineer.

Defective concrete conditions or surfaces shall be removed, replaced or repaired as directed by the City Engineer or Public Works Department.

No paving shall take place against concrete curb and gutter until the curb and gutter has cured for at least seven (7) days.

5.13 REMOVAL OF FORMS

The periods of time for form removal set fourth herein are permissive only and subject to the Contractor assuming all risks that may be involved. The time periods are minimum with no allowance therein for external loads. At times of low temperature, or other adverse conditions, the City Engineer may require the forms to be kept in place for longer periods of time.

The time periods are predicated on the use of concrete to which no admixtures have been added for the purpose of obtaining a high early strength, and upon the use of the same type of cement throughout the structure. If Type III cement is used, the minimum time periods for stripping forms will be established by the City Engineer in accordance with the materials, methods to be used, and the stresses to which the structure may be subjected.

A. Forms for concrete members subject to bending stresses, where the member relies upon forms for vertical support, may be removed seven (7) days after concrete is placed, providing concrete has developed sufficient strength.

B. Top slab forms other than that specified in (A), 48 hours.

C. Outside forms and inside wall forms which do not support the top slab forms, 16 hours.

D. Forms for open channel walls, 16 hours.

E. Arch sections in open cut, 12 hours.

5.14 CONCRETE DELIVERY TICKETS

The following information shall be furnished for each load of ready-mix concrete delivered to the site:

1. Number of cubic yards.

2. The exact amount of cement (this can be indicated either by weight or quantity).

3. The amount of sand (this can be indicated by weight or quantity).

4. The amount of gravel (this can be indicated either by weight or quantity).

5. The amount of mixing water, including moisture in aggregates (this can be indicated either by weight or quantity).

6. If water is added at job site, note amount.

7. Amount of slump in inches.

8. Type of cement.

9. Amount of air entrainment (if any) when delivered at job site.

10. Do aggregates meet ASTM specified - yes or no. Indicate maximum size of aggregate.

11. Amount and brand (or ASTM) of admixture other than air entraining agent (if any).

12. These tickets shall be given to the inspector; and if he is not on the job, the superintendent or foreman shall obtain these tickets and see that they are mailed to the Public Works Department. The foreman shall note location of concrete on job.

If any of the concrete delivered to the job site does not meet these specifications, as indicated on the delivery ticket, or tested by the City Inspector, the entire truck load may be rejected.

5.15 STRENGTH TESTS

The average strength of the concrete shall be verified based on the "strength test" in which the average strength of three standard cylinders is determined. The cylinder strength shall be determined at 28 days. One strength test shall be made for the first 15 yards of concrete poured and for each additional 50 yards of concrete placed in any one day at the option of the City Public Works Department or Engineer.

When the average of the strength test shall show a strength below that required, the concrete may be subject to rejection. The Contractor may elect to have made an alternate strength test on three core samples obtained in accordance with AASHTO designation T-24. The City Engineer or his representative will determine the location, in the particular pour in question, where the cores will be taken. They shall be tested as soon as practicable under his supervision. In-place concrete may be cored for testing at the option of the City Public Works Department or Engineer. All costs for securing the testing will be paid by the contractor, developer, or ready-mix supplier.

5.16 CURB AND GUTTER

The minimum slope on any curb and gutter or cross gutter shall be 0.5%. For maximum slope see section 2.2 J (pg. 2-4). The untreated base course beneath curb and gutter and sidewalk shall extend six (6) inches beyond the edge of the concrete to help prevent erosion beneath the slab.

Curb and Gutter installed over utility laterals shall be stamped with 3 inch tall letters, ¼ inch deep and shall be marked as follows:

UTILITY	MARK	PAINT COLOR
Culinary Water	W	Blue
Pressurized Irrigation	PI	Purple
Sewer	S	Green
Utility Conduit	UT	Red
Property Line	See Standard Drawing No. 215	None