

CHAPTER 5

PORTLAND CEMENT CONCRETE

SECTION 5.01 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.

SECTION 5.02 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 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. Reinforcing Steel: All bar material used for reinforcement of concrete shall be intermediate grade steel conforming to the requirements of ASTM Designation A-615 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.
- G. Welded Wire Fabric: Welded wire fabric for concrete reinforcement shall conform to the requirements of ASTM A-185.

SECTION 5.03 CONCRETE MIX

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

<u>Class</u>	<u>Minimum Cement (94 lb. sacks/c.y.)</u>	<u>Recommended 7-day Comp. Strength (psi)</u>	<u>Minimum 28-day Comp. Strength (psi)</u>	<u>Primary Use</u>
A	6 ½	3000	4000	Reinforced structural concrete.
B	6 ½	3000	4000	Sidewalks, curbs and gutter, cross gutter, pavements, and unreinforced footings and foundations.
C	5	1875	2500	Thrust blocks, anchors, mass concrete
D	±1/2 (Submit Design)	N/A	50 - 150	Flowable fill (5-10 inch slump)

B. All concrete shall also comply with the following requirements:

1. 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 unreinforced concrete slabs the maximum size of aggregates shall not be larger than one-fourth the slab thickness.
2. Water: Sufficient water shall be added to the mix to produce concrete with minimum practicable slump.
 - a. Unless otherwise authorized by the City Engineer or City Inspector, the nominal slump for all concrete shall be 0-3 inches with a maximum slump of 4 inches. When adverse or difficult conditions affect the placement of the concrete, the City Engineer, or Inspector, may authorize a greater slump, provided both the water and cement are increased. Water shall be added at a ratio not to exceed 30 pounds per sack of added cement per cubic yard of concrete.
 - b. The consistency of the concrete shall be determined in accordance with ASTM C-143.

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

SECTION 5.04 FORMS

- A. 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.
- B. 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.
- C. Forms for curved sections shall be so constructed and placed that the finish surface of walls and edge of sidewalks, curbs, and gutters will not deviate appreciably from the arc of the curve.
- D. Exposed vertical and horizontal edges of the concrete in structures shall be chamfered by the placing of moldings in the forms.

SECTION 5.05 JOINTS

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

- A. Sidewalks shall have contraction joints at intervals equal to the width of sidewalk, but not exceeding 2 times the slab thickness in feet. For example, the maximum joint spacing for a 4 inch thick concrete slab would be 8 feet. Contraction joints shall be approximately 3/16 inches wide and be a minimum of 1/4 of the total slab thickness. Along curb, gutter, and sidewalk sections, 1/2 inch thick expansion joints (joint filler material) shall be placed the full depth of concrete plus 1 inch at every 50 foot increment, at major points of curvature,

at each side of structures, and as otherwise noted within the standard details. In addition, 1/2 inch expansion joints should be provided at locations where sidewalks adjoin curbs or existing sidewalks.

- B. Curb and Gutter shall have contraction joints placed at intervals not to exceed 10 feet. Contraction joints should be placed with the use of 1/8 inch thick steel division plates of the exact cross section of the curb and gutter.
- C. Concrete Removal/Replacement
 - 1. Curb, gutter & sidewalk: When short (shorter than 8 feet long) sections of curb, gutter or sidewalk must be removed & replaced, the entire section (from joint to joint) shall be removed. When surrounded by existing concrete sections, each concrete section to be removed shall be sawcut to the full depth of concrete once on one side of the section and twice on the opposite side (two sawcuts within 4-6 inches of each other) to ensure that the remaining concrete sections are not damaged during concrete removal. When replacing longer sections of curb, gutter, or sidewalk (longer than 8 feet long) the minimum section length replaced (or remaining) shall be 4 feet. 1/2 inch joint filler material shall be required at each side of concrete sections that are replaced.
 - 2. Sidewalk construction through drive approaches: In the event that sidewalks are installed prior to the installation of drive approaches, and they are not constructed to meet the drive approach standards referenced within the Standard Details, all non-compliant sidewalk sections shall be removed and replaced as part of the drive approach construction.
- D. Expansion Material - Material for 1/2 inch expansion joints shall be as defined in AASHTO M-33, and shall be installed with its top approximately 1/4 inch below the concrete surface.

SECTION 5.06 REINFORCING STEEL PLACEMENT

- A. 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.
- B. 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.

- C. Splices of bars shall be made only where shown on the approved plans or as approved by the City Engineer or City Inspector. 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.
- D. Welding of reinforcing steel will not be permitted unless specifically authorized by the City Engineer or City Inspector.

SECTION 5.07 PREPARATIONS

- A. 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.
- B. When 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 Inspector or City Engineer.

SECTION 5.08 CONCRETE MIXING

- A. 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.
- B. Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set forth in ASTM C-95. Concrete shall be delivered and deposited in its final position within 60 minutes after adding the cement and water to the mixture. Washing out of mixer trucks shall not be permitted within city rights-of-way.

SECTION 5.09 LAYOUT

- A. Curb and gutter shall be laid-out to be within 1-inch horizontally and ¼ -inch vertically from true line at all locations.

- B. Sidewalk cross slope for new construction is 2-percent. Replacement sidewalk cross slope is 4-percent maximum, 1-percent minimum.

SECTION 5.10 DEPOSITING

- A. 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.
- B. 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.
- C. After placement of concrete appurtenances, Contractor shall remove and discard all remaining concrete and construction materials outside of the approved construction section.

SECTION 5.11 PLACING CONCRETE IN COLD WEATHER

- A. No concrete shall be poured where the air temperature is lower than 35 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 35 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. 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 7 days after placing.
- B. 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.

SECTION 5.12 FINISHING

- A. 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 1/2 inches.

- B. 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.
- C. 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, of uniform width, free from humps, sags, and without any irregularities or wavy surface appearances noticeable to the eye. The gutter shall not hold water to a depth of more than one eighth (1/8) of an inch, nor shall any portion of the top face (or surface) of the curb or gutter depart more than one eighth (1/8) of an inch (except at grade changes or curves) from a straight edge ten (10) feet in length, placed on the curb parallel to the center line of the street.
- D. The cross section of curb, gutter and sidewalk placed shall match construction plan details. Any deviation (rotation, cross-section, slope, etc.) from the approved construction details may require removal of said curb, gutter and sidewalk as determined by the City Engineer or City Inspector.

SECTION 5.13 CURING AND PROTECTION

- A. As soon as the concrete has hardened sufficiently to prevent damage all concrete placed as part of curb, gutter, sidewalk, driveway approaches, collars, etc. shall be sealed with a curing compound or be sprinkled with water and kept wet for at least three (3) days. When a chemical curing agent is used, it must be applied in accordance with the manufacturer's specifications or as follows:
 - 1. Keep surfaces moist until the curing compound is applied.
 - 2. Complete all surface finishing before applying compound.
 - 3. Warm chilled compound that is too viscous to a maximum of 90 degrees F.
 - 4. Apply curing compound immediately after finishing operations are completed, or as otherwise recommended by curing compound manufacturer.
 - 5. Spray the entire surface of the concrete with a membrane curing compound at a uniform rate of 100 ft² /gallon, or as otherwise recommended by curing compound manufacturer.
 - 6. Immediately re-spray any portion damaged before the ten-day curing expires.
- B. The freshly finished surface shall be protected from hot sun and drying winds until it can be sealed or sprinkled 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.

- C. 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 or City Inspector.

SECTION 5.14 REMOVAL OF FORMS

- A. 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 or City Inspector may require the forms to be kept in place for longer periods of time.
- B. 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 or City Inspector in accordance with the materials, methods to be used, and the stresses to which the structure may be subjected. Forms may generally be removed as follows:
 - 1. Forms for concrete members subject to bending stresses, where the member relies upon forms for vertical support, may be removed seven days after concrete is placed, providing concrete has developed sufficient strength.
 - 2. Top slab forms other than that specified in (A) - 48 hours.
 - 3. Outside forms and inside wall forms which do not support the top slab forms - 16 hours.
 - 4. Forms for open channel walls - 16 hours.
 - 5. Arch sections in open cut - 12 hours.

SECTION 5.15 CONCRETE DELIVERY TICKETS

- A. 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. Temperature of concrete.
 13. These tickets shall be given to the inspector; and if he or she is not on the job, the superintendent or foreman shall obtain these tickets and see that they are delivered to the Public Works Department. The foreman shall note location of concrete on job.
- B. 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.

SECTION 5.16 CONCRETE TESTING

- A. 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 owner/developer/City may elect to collect and test additional 7 day cylinder strength tests to allow for early utilization of the concrete surface or to provide an early warning of potential concrete mix design problems. However, the cylinder strength approved by the City shall be determined at 28 days. Twenty eight day cylinder strength test results shall be provided to City inspection staff within 5 working days of the 28th day. 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.
- B. When submitted strength test results 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 City Inspector 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. All costs for securing the testing will be paid by the contractor.
- C. One (1) slump test and one (1) air 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.