

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 Description

- A. Scope: Contractor shall furnish all labor, equipment, materials and services necessary for the manufacture, transportation and placement of all plain and reinforced concrete work, as shown on the Contract Drawings or as ordered by the Engineer, except for the work specifically included under other items.
- B. Related Work Specified Elsewhere:
 - 1. Section 02200, Earthwork.
 - 2. Section 03200, Reinforcing Steel.

1.2 Codes and Standards

- A. Concrete work shall conform to the latest applicable requirements of the following codes and standards, including all reference therein.
 - 1. New York State Uniform Fire Prevention and Building Code.
 - 2. Building Code Requirements for Reinforced Concrete ACI 318.
 - 3. Specifications for Structural Concrete for Buildings ACI 301.
 - 4. Recommended Practice for Concrete Formwork, ACI 347.
 - 5. Manual of practice for detailing reinforced concrete structures ACI 315.
 - 6. Sanitary structures, ACI 350.
- B. Any procedure, materials or operation specified by reference to the American Society for Testing and Materials (ASTM), the American Concrete Institute (ACI), Local Building Code or other reference, shall comply with the requirements of the current and most recent specifications or standards. In conflicts between listed standards and this specification, the more stringent requirements shall govern.
- C. Contractor is expected to obtain the most recent issue of all standards, recommendations, codes or specifications referred to within this specification.

1.3 Submittals

- A. In accordance with the procedures and requirements set forth in the General Conditions and Division I, Contractor shall submit the following:
 - 1. Shop Drawings.
 - 2. Certifications of compliance with specifications for all sources of each material.
 - 3. Name of the Cement Manufacturer.
 - 4. Manufacturer's data on all admixtures.
 - 5. Concrete mix design.
 - 6. Delivery Tickets: Furnish to Engineer copies of all delivery tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C 94, Section 16.
- B. Each submittal shall be identified by the Specification Section No.
- C. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed materi-

als compliance with the Contract Documents.

- D. Partial, incomplete or illegible submissions will be returned to the Contractor without review for resubmission.

1. Shop Drawings shall include but not be limited to:

- a. Complete reinforcing bar detailing drawings and schedules.
- b. Location plans for all construction joints. Contractor may elect to show this information on the reinforcement detailing drawings.

PART 2 - PRODUCTS

2.1 Cement

- A. All cement shall be made by a well-known and acceptable manufacturer. Unless otherwise permitted, the product of not more than one plant shall be used in the work. Cement shall be Type II Portland cement and shall conform to the requirements of ASTM Designation C 150. In special cases, when high early strength is desired, Type III Portland cement may be used with the approval of the Engineer. Lumpy, moist or partially set cement, or cement injured by age or exposure shall not be used. Certified copies of mill reports shall be submitted.
- B. Cement used in the work shall correspond to that upon which the selection of concrete proportions was based. Only one brand of Portland Cement shall be used in the work.

2.2 Aggregates

- A. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.
- B. Contractor shall submit to the Engineer for approval, a minimum of two (2) suppliers of aggregates he proposes to use.
- C. Contractor shall furnish confirmation to the Engineer that he can obtain 100% of the needed aggregates from one area prior to approval to pour concrete.
- D. Fine Aggregate: Fine aggregate shall conform to ASTM Designation C 33 and consist of natural sand, clean, sharp and free from loam, clay, lumps or other deleterious substances. Bank run (material as mined without further processing) will not be allowed.
- E. Coarse Aggregate (Typical): Coarse aggregate shall be crushed stone or gravel. It shall conform to the requirements of ASTM Designated C 33 and the latest revision thereof. It shall be clean, uncoated, processed aggregate free from loam, clay, lumps or other deleterious substances.

2.3 Water

- A. Water for use in concrete and mortar shall be from a potable domestic supply and free from injurious amounts of mineral and organic substance.

2.4 Admixtures

- A. Admixtures shall be used only when and as specified herein or approved by the Engineer, and shall conform to the Specifications of ASTM C 260 or C 494.
- B. Admixtures shall be in accordance with the following:
 - 1. Type-A, a water reducing admixture of the hydroxylated carboxylic acid or the hydroxylated polymer types, conforming to ASTM C 494.

2. Type-D, a water reducing and retarding admixture conforming to ASTM C 494.
 3. Type-E, a water reducing and accelerating admixture conforming to ASTM C 494.
 4. Type-F, an air entraining admixture, "Darex AEA" as manufactured by W.R. Grace and Co., "Sika-AER" by Sika Chemical Corp., or equal conforming to ASTM C 260.
- C. Contractor shall submit manufacturer's descriptive details of admixtures for approval.

2.5 Tests of Material

- A. Engineer shall have the right to order the test of any material entering into concrete or reinforced concrete to determine its suitability for the purpose. Tests shall be made in accordance with the requirements of the ASTM. The complete record of such tests shall be available for inspection during the progress of the work.

2.6 Proportioning

- A. Concrete proportions, including water-cement ratio, shall be established on the basis of laboratory trial batches, with materials to be employed, in conformance with Chapter 4, ACI 318-83.
- B. Contractor shall develop and submit a series of at least three trial design mixes to the Owner for approval. A copy of the approved design mix shall be forwarded to the District at least one week before delivery of each class of concrete to the job site.
- C. Contractor shall engage an independent testing laboratory in accordance with ACI 211 to attain properties of strength, water-cement ratio, slump, and entrained air content specified. This work shall be paid for by the Contractor.
- D. Trial design mixes of each class of concrete required shall be made in accordance with ASTM C 39 by the testing laboratory. Four standard six inch compression cylinders two tested at seven and two at 28 days, shall be made in accordance with ASTM C 192 using the materials and proportions proposed for this project.
- E. Certification of aggregates shall be made a part of these tests and referenced on the reports which shall be issued at seven and 28 days. These tests shall be repeated, if necessary, because of changes in materials or unsatisfactory results.
- F. Quantity of ingredients to use per batch shall be governed by the size of the concrete mixer and the composition of the concrete, but shall not exceed the rated capacity specified for the mixer by the manufacturer of that equipment. Proportion of cement, aggregates, admixtures and water shall be such as to produce a mixture which will be watertight and work readily into the corners and angles of the forms and around reinforcement by methods of placing and consolidation employed on the work, but without permitting the materials to segregate or excessive free water to collect on the surface.
- G. Proportion of cement, aggregates, admixtures and water used in the concrete shall be based on tests of grading and moisture content of materials, slump of concrete mixture, strength of concrete and the following factors:
1. Minimum Cement Content, lbs. per cubic yard: 600.
 2. Maximum Water-Cement Ratio, by Weight: 0.45.
 3. Percent Air Content: 6 + 1 percent.

4. Slump Range: 3 to 4 inches.
 5. Compressive Strength, lbs. per sq. inch at 28 days - $F'c = 4000$ psi (typical).
 6. Compressive strength for concrete fill at 28 days shall be $F'c = 4000$ psi.
- H. All concrete, unless noted on the Contract Drawing shall be air entrained concrete.

2.7 Ready-Mixed Concrete

- A. Ready-mixed concrete production methods and facilities shall comply with Standard Specifications for Ready-Mixed Concrete, ASTM C 94. Batch deliveries shall not exceed the rated capacity specified for the mixer by the manufacturer of that equipment.
- B. Contractor shall submit affidavits from the ready-mixed concrete supplier certifying that the proposed mix to be supplied satisfies all the requirements under this item and those outlined under "Proportioning". Such affidavits shall be subject to the approval of the Engineer.

2.8 Embedded Items

- A. Items such as plates, angles, inserts, bolts and similar items not specified elsewhere shall be provided and installed under this Section unless specified otherwise. All embedded items shall be hot dip galvanized after fabrication (unless otherwise noted). All galvanized elements that will be embedded in or will come in contact with concrete and mortar will require a chromate coating. This coating should be accomplished in the galvanizing plant by either dipping the galvanized elements in a solution of sodium or potassium dichromate acidified with sulfuric acid or spraying this solution on the galvanized surfaces.
- B. All aluminum items in contact with concrete and mortar shall receive a bituminous coating such as Butumastic Super Service Black, by Kop-Coat, Inc., or equal.

2.9 Chemical Hardener

- A. Chemical hardener shall be Lapidolith by Sonneborn, Hornolith by W.R. Grace or equal fluosilicate base material. Hardener shall be applied to all concrete slabs except where adjacent concrete is to be placed against the slab.

2.10 Concrete Bonding Agent

- A. The concrete bonding agent shall be an epoxy-resin bonding type, two component, polyamide type, Sikadur Hi-Mod by Sika Chemical Corporation or equal.

2.11 Curing Compounds

- A. The compound shall conform to the Federal Spec TT-C0800A, clear, 30% solids content minimum. Where curing and hardening compound is permitted for all interior slabs, use "Eucosil" by the Euclid Chemical Company or "Curetox" by Toch Brothers or equal.

2.12 Grout

- A. Mix A - Nonshrink Grout: The nonshrink, nonstaining grout, shall be "Euco N-S" by the Euclid Chemical Company, or "Masterflow 713" by Master Builders, or equal.
- B. Mix B - Nonshrink, Epoxy Grout: The nonshrink, epoxy

grout shall be Euco High Strength Grout by the Euclid Chemical Company, or Sikadur Hi-Mod Grout by Sika Chemical Company, or equal.

- C. Mix C - Plain Grout: Plain mix grout shall consist of 1 part of Portland cement to two parts sand by weight.

2.13 Finish and Repair Compounds

- A. Finish and repair compounds shall be Poly-Patch by Euclid Chemical Co., Sikatop by Sika Chemical Co. or equal.

PART 3 - EXECUTION

3.1 Compression Test Cylinders

- A. The Contractor will perform, control and pay for all tests specified herein. All testing shall be performed in accordance with procedures specified herein. Contractor shall be required to furnish labor to the Engineer for assisting in preparing test cylinders for testing. Contractor shall give the Engineer a minimum of 24 hours notice prior to concrete placement after all other requirements of these specifications have been met.
- B. Strength tests shall conform to ASTM C 172 for sampling, ASTM C 31 for making and curing test cylinders and ASTM C 39 for testing. Three test cylinders of concrete for each 50 cubic yards or fraction thereof. Where placement does not require 50 yards, three test cylinders shall be made for whatever has been placed. One specimen shall be broken at 7 days and the remainder at 28 days.
- C. Slump and air content tests shall conform to ASTM C 143 for slump and ASTM C 231 (pressure method for air content). Each test shall be made whenever strength specimens are made and as often as necessary for control and acceptance purposes and as required by the Engineer.
- D. Additional specimens shall be made when the Contractor desires approval of form removal earlier than set forth under "Removal of Forms" later in this section. Requests for testing of additional specimens shall require approval of the Engineer.

3.2 Consistency

- A. Consistency of the concrete shall be checked by the Engineer by standard slump cone tests. Maximum slump shall be 4 inches. Contractor shall make any necessary adjustments in the mix as the Engineer may direct and shall upon written order suspend all pouring operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for any delays, material or labor costs due to such eventualities.
- B. The approved consistency of the concrete mix shall at all times be as stiff or dry as is practicable, considering the particular type of work being done and the necessity of obtaining a dense, impervious, watertight concrete. Thin or wet mixes as a substitute for proper placing facilities or adequate placing labor will not be permitted, nor will the appearance of free water in the forms.

3.3 Mixing Conditions

- A. Concrete shall be mixed only in such quantities as required for immediate use. No concrete shall be mixed while the air temperature is below 40 degrees F, without permission of the Engineer. If permission is granted for mixing concrete under such conditions, the work shall be in accordance with ACI 306, "Recommended Practice for Winter Concreting"

and the aggregates or water, or both if required, shall be heated and temperature of the concrete, when placed, shall not be less than 70 degrees F, nor more than 100 degrees F.

B. Hot Weather Placing:

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
 2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 80 degrees F when the temperature is rising and below 85°F when the temperature is falling. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated in the total amount of mixing water.
 3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 4. Wet forms thoroughly before placing concrete.
 5. Do not place concrete at a temperature so as to cause difficulty from loss of slump, flash set, or cold joints.
 6. Do not use set-control admixtures unless approved by the Engineer in mix designs.
 7. Obtain Engineer's approval of other methods and materials proposed for use.
- C. Retempering of concrete by adding water or other materials will not be permitted.

3.4 Formwork

- A. Forms for concrete shall be constructed of wood, plywood, steel or other approved material. Type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No false work or forms shall be used which are not clean and suitable. Deformed, broken or defective false work and forms shall be removed from the work.
- B. Forms for concrete shall be true to line and grade, and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. Forms shall be smooth and free from surface irregularities. Reuse of forms subject to approval by the Engineer at time of installation. Wire ties will not be permitted where the concrete surface will be exposed to either water or weathering. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls and slabs. Bevels shall be 3/4 inch unless otherwise noted.
- C. Inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a chemical type release agent, and shall be applied lightly by spray to avoid retardation. Contractor shall submit manufacturer to Engineer for his approval. Forms for concrete surfaces that are to be waterproofed shall be wetted prior to concreting.

3.5 Form Accessories

- A. Form accessories shall be of a commercially manufactured type. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete after ends, or end fas-

teners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to wastewater or enclosed surfaces above the wastewater, and not less than 1 inch from the formed face of all other concrete. Form ties in walls designed to retain liquids shall be provided with a water seal at midthickness of the wall. Form ties shall be commercially manufactured steel rods capable of withstanding applied pressures. Wire ties are not acceptable.

3.6 Placing Concrete

- A. Before any major concrete pour is started, Contractor shall prepare and submit to the Engineer for approval a schedule of his proposed operations. Approval of the schedule by the Engineer shall not relieve the Contractor of his responsibility for producing concrete work of the highest quality.
- B. No foundation, slab or pavement concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the Engineer. Contractor shall coordinate work with the requirements of Section 02200. Earthwork. No concrete shall be placed until all reinforcing steel, anchor bolts, pipes, conduits, sleeves and other work required to be built into concrete have been inspected and approved by the Engineer. All concrete shall be placed during the daylight hours except with the consent of the Engineer; the placing of concrete in any portion of the work shall not be started unless it can be completed in daylight. If special permission is obtained to carry on work during the night, an adequate floodlight system must be provided.
- C. Concrete shall be placed in forms as soon as practicable after mixing, and in no case shall concrete be used which does not reach its final position in the forms within 1-1/2 hours after truck mixed concrete leaves the plant as evidenced by the delivery ticket given to the concrete inspector.
- D. The method and manner of placing concrete shall be such as to avoid the possibility of segregation of the concrete materials or the displacement of the reinforcement. When troughs or chutes are used in placing concrete, their angle of inclination shall not exceed 1 vertical to 2 horizontal with respect to the horizontal. When pipes are used, they shall be kept full of concrete and have their lower ends buried in fresh concrete; such pipes shall be used in the same manner as a tremie. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete. open troughs or chutes shall be metal or metal-lined, and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.
- E. Dropping the concrete a distance of more than four (4) feet or depositing a large quantity at any point, running or working it along the forms will not be permitted.
- F. Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.
- G. All concrete shall be deposited in approximately horizontal layers not deeper than 18-inches. Each part of the form shall be filled by placing the concrete as near to its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the inserts, piping and reinforcing bars without disturbing them.

- H. All concrete shall be consolidated by continuous working with suitable tools and also by the use of approved mechanical vibrating devices (10,000 vibrations per minute minimum). All formed faces shall be well-spaced and the mortar flushed to the surface.
- I. Mechanical vibrators shall be an approved type transmitting vibrations directly to the concrete with sufficient intensity to cause flow and settlement. Their operation shall be carefully controlled to give sufficient duration to accomplish thorough compacting without overagitation which will cause segregation of the materials. Every effort shall be made to ensure that all concrete work is solid, compact, watertight, and smooth to prevent the formation of laitance.
- J. The various pours shall be planned and executed to ensure that once started the placing of concrete in a pour shall be continuous and in a manner to prevent any initial set from starting in any concrete before fresh concrete is placed against it.
- K. After the concrete has acquired its initial set, care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars.
- L. Bonding for Next Concrete Pour: Roughen surfaces of set concrete at all joints, except where bonding is obtained by use of a concrete bonding agent. Clean surfaces of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner to expose bonded aggregate uniformly and to not leave laitance, loose particles of aggregate, or damaged concrete at the surface.
- M. Bonding of fresh concrete to fully-cured hardened concrete or existing concrete shall be accomplished by using an epoxy-resin bonding agent.

3.7 Protection and Curing

- A. Careful attention shall be given to the proper curing and protection of all concrete in the structures. The Work shall be protected from the elements, flowing water and from defacement of any nature during construction operations.
- B. After placing and finishing of concrete, concrete shall be cured and protected in accordance with Chapter 12 ACI 301, and as stated below.
 - 1. Curing Methods:
 - a. Perform curing of concrete by moist curing, or by moisture retaining cover curing. Use curing compound only in cold weather and only when approved by the Engineer and as herein specified.
 - b. Slabs to receive chemical resistant heavy duty concrete topping or ceramic tile shall not be cured with liquid curing compound, but shall be moisture cured.
 - c. For curing, use water that is free of impurities which could etch or discolor exposed, natural concrete surfaces.
 - 2. Provide moisture curing by any of the following methods:
 - a. Keeping the surface of the concrete continuously wet by covering with water.
 - b. Continuous water-fog spray.
 - c. Covering the concrete surface with the specified absorptive cover, thoroughly saturating the cover with water, and keeping the absorptive cover continuously wet with sprinklets or porous hoses. Place absorptive cover so as to provide coverage of the concrete surfaces and edges, with a 4-inch lap over adjacent

absorptive covers.

3. Provide moisture-retaining cover curing as follows:
 - a. Cover the concrete surfaces with the specified moisture-retaining cover for curing concrete, placed in the widest practical width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.
4. Provide liquid curing compound as follows:
 - a. Apply the specified curing and sealing compound to all slabs with carpet, with resilient tile or left exposed. Apply the specified curing and hardening compound to all other interior slabs and tank bases and slabs that are to receive grout topping. Slabs to receive terrazzo floors, chemical resistant heavy duty concrete topping or ceramic tile shall not be cured with liquid curing compound, but shall be moisture cured. Compounds shall be applied immediately after final finishing in a continuous operation by power spray equipment in accordance with the manufacturer's directions. Recoat areas which are subjected to heavy rainfall within 3 hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period. For concrete surfaces which will be in contact with potable water, the manufacturer shall certify that the curing compound used is nontoxic.
- C. Curing Formed Surfaces: Cure formed concrete surfaces, including the undersides of girders, beams, supported slabs and other similar surfaces by moist curing with the forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- D. Curing Unformed Surfaces:
 1. Initially cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by applying the specified curing compound.
 2. Final cure unformed surfaces, unless otherwise specified, by any of the methods specified above, as applicable.
- E. Temperature of Concrete During Curing:
 1. When the atmospheric temperature is 40 degrees F and below, maintain the concrete temperature between 50 degrees F and 70 degrees F continuously throughout the curing period. When necessary, make arrangement before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protection complying with the requirements of ACI 306.
 2. When the atmospheric temperature is 80°F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protection complying with the requirements of ACI 305, unless otherwise specified.
 3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5 degrees F in any one hour and 50 degrees F in any 24-hour period.

Removal of Forms and Supports:					
Temperature (Degrees F)					
	Over 95°F	70°F - 95°F	60°F - 70°F	50°F 60°F	Below 50°F
a. Walls	5 days	1 day	2 days	3 days	Do not remove forms until site-cured test
b. Columns	7 days	2 days	3 days	4 days	cylinder develops
c. Beam Soffits	10 days	4 days	5 days	6 days	50% of 28-day strength.
d. Slabs	10 days	5 days	6 days	7 days	5 inches thick or less
e. Slabs over 5 inches thick	12 days	6 days	8 days		

- F. Protection from Mechanical Injury: During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.
- G. When the concrete is placed in air temperatures of 40 degrees or lower the concrete shall be heated as described under Item 3.3 Mixing Conditions.
- H. The concrete shall be protected during transit, and before and after placing, as directed by the Engineer, to retain all heat possible in the concrete mix.
- I. After the concrete has been placed, it shall be enclosed and protected so as to maintain the temperature of the concrete at not less than 50 degrees F until 70 percent of the designated strength has been attained, as indicated by cylinder tests.
- J. Finished surfaces and wall edges located where travel and further construction work is necessary shall be suitably protected from damage by temporary guards or covers as directed by the Engineer.

3.8 Removal of Forms and Shoring

- A. Forms shall not be disturbed until the concrete has adequately hardened. Shoring shall not be removed until the supported member has acquired sufficient strength to support its weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Removal of forms shall be accomplished in such a manner and sequence as will prevent injury to the concrete.
- B. Provisions of ACI 301, Sections 4.5, 4.6 and 4.7 apply. Subject to the District's requirements and upon approval, forms may be removed at the following minimum times unless high-early strength is specified. Shoring may be required at the option of the Engineer beyond these periods.
- C. When high-early strength concrete is specified, a schedule for removal of forms will be developed in the field from the age/strength relationships established for the materials and proportions used by tests in accordance with ACI-301, Section 3.8.
- D. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods.

3.9 Record of Placings and Form Removal

- A. An accurate record shall be maintained of the dates of con-

crete placings and the exact location thereof and the dates of removal of forms. These records shall be available for inspection at all times on the job, and two copies shall be furnished to the Engineer upon completion of the concrete work.

3.10 Quality of Concrete Work

- A. Make all concrete solid, compact and smooth, and free of laitance, cracks and cold joints.
- B. All concrete for liquid retaining structures, and all concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
- C. Cut out and properly replace to the extent ordered by the Engineer, or repair to the satisfaction of the Engineer, surfaces which contain cracks or voids, are unduly rough, or are in any way defective. Thin patches or plastering will not be acceptable.
- D. All leaks through concrete, and cracks, holes or other defective concrete shall be repaired and made watertight by the Contractor.
- E. Repair, removal, and replacement of defective concrete as ordered by the Engineer shall be at no additional cost to the District.
- F. Tolerances and criteria delineated in ACI 301 shall be strictly adhered to.

3.11 Admixtures

- A. When directed or approved by the Engineer, an admixture shall be added to the concrete to control the rate of hardening and workability. Admixture shall be of the retardant type under high temperatures and the accelerating type under low temperatures. The admixture shall be added to the mix at the batch plant and the proportions shall be in strict accordance with the manufacturer's recommendations.
- B. Concrete retardant shall be used to expose aggregate and to provide the concrete with rough bonding surfaces at all horizontal construction joints. Apply retardant on forms or spray on unformed horizontal construction joints in strict accordance with manufacturer's directions. Remove all unset mortar by wire brushing or with a water jet within the time limit specified by the manufacturer. In lieu of the above method of exposing aggregate, a water blast or sand blast method may be used for vertical and horizontal surfaces. The Contractor must satisfactorily demonstrate, on sample Panels, that the proposed method can achieve an etch of 1/8-inch, minimum.
- C. Use air entraining admixture in all concrete, except interior slabs subject to abrasion, unless otherwise shown or specified. Add air entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the prescribed limits.

3.12 Construction Joints

- A. Construction joints shall be located as shown on the Contract Drawings where structural integrity is affected. Otherwise, Contractor shall submit description of the joint and its location to Engineer for approval.
 - 1. Additional construction joints shall be located as follows:
 - a. In walls locate joints at a spacing of approximately 40 feet.
 - b. All corners shall be part of a continuous pour, and

should a construction joint be required, the joint shall not be located closer than 12 feet from a corner.

- c. In foundation slabs and slabs on grade locate joints at a spacing of 40 feet maximum. Place concrete in a checkerboard pattern.
 - d. In mats and structural slabs and beams, locate joints in compliance with ACI 301, Chapter 6 and recommendations of ACI 350, at a spacing of 40 feet maximum.
 - e. Provide other additional construction joints as required to satisfactorily complete all Work.
- B. In general, joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and the top of footings or floor slabs, unless otherwise indicated on the Contract Drawing. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
 - C. All reinforcing steel and welded wire fabric shall be continued across joints. Keys and inclined dowels shall be provided as shown on the Contract Drawings or as directed by the Engineer. Longitudinal keys at least 1-1/2 inches deep shall be provided in all joints in walls and between walls and slabs or footings, except as specifically noted otherwise on the Contract Drawings.
 - D. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air or light sand blasting. On horizontal joints where concrete is to be placed on hardened concrete, a slush coat of mortar 1/2 inch to 1 inch thick with slump less than 6 inches, made of the same materials as the concrete, but without the coarse aggregate, shall be worked well into the irregularities of the hard surface just ahead of the concrete pour.

3.13 Slabs on Ground

- A. The subgrade for slabs on ground shall be well drained and of adequate and uniform load bearing nature. The in-place density of the subgrade soils shall be at least the minimum required in the specifications. The bottom of an undrained granular base course shall not be lower than the adjacent finished grade.
- B. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing it shall be raised and maintained above 50 degrees F long enough to remove all frost from the subgrade.
- C. The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no free water standing on the subgrade nor any muddy or soft spots when the concrete is placed.
- D. Provide control joints in slabs-on-grade at locations indicated on the drawings. Control joints may be construction joints or sawed joints (cut 1/4 of the slab depth). For floors receiving floor coverings, joints may be made by insertion of fiberboard strips (1/4 of the slab depth) into the unset concrete. Wire mesh or reinforcement shall be interrupted 2 inches clear each side of sawed or impressed control joints.
- E. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Slabs to be finished as specified

in Item 3.14 hereinafter.

3.14 Concrete Finish

- A. Unless otherwise called for or shown on the Contract Drawings all exposed edges shall have a 3/4 inch chamfer.
- B. Concrete surfaces that are not exposed in the completed work will require no special finish other than such pointing up as is necessary to leave them smooth and impervious. All openings left by the removal of form ties shall be pointed up carefully with mortar. All concrete surfaces that are exposed in the completed work to the atmosphere or to water shall be finished as specified herein. Immediately after removal of forms, finishes as hereinafter specified will be applied.
1. Formed vertical Faces:
- All exposed vertical faces of formed concrete shall be prepared for the specified finish as follows. Remove all forms in such manner as to prevent damage to the concrete and at the proper time for the required finish.
 - Point up all areas, remove any projections and fins, repair all honeycomb as permitted and approved by the Engineer, and fill in all tie holes. Mortar used for filling and repairs shall be of the proper consistency and of the same color as the adjacent concrete. Any pointing up and repair not consistent with these specifications or approved by the Engineer shall be redone at no extra cost to the District.
 - A grout finish shall be used on all exposed exterior and interior vertical and formed faces of concrete, unless otherwise noted or specified.
 - The grout finish on walls shall be carried at least 12 inches below finished grade or to the floor slab in case of interior wall faces.
 - After the pointing has been sufficiently set to permit it, the grout finish shall be applied in the following manner: The concrete surface shall be thoroughly moistened (but not soaked and no free water shall be standing) and the entire surface painted with a sand-cement wash. The wash shall be composed of one (1) part of Portland cement, of which portion approximately thirty-three (33) percent shall be White Portland cement, and one (1) to one and one-half (1-1/2) parts fine clean sand passing a No. 30 sieve. The grout shall be of such consistency that it will not run when applied to vertical surfaces, and so that it will fill all voids in the surface of the concrete. The sand-cement wash shall be applied with a brush and thoroughly worked into the concrete at a rate that will completely fill all voids in the surface of the concrete and provide a firm even texture uniform in color. After the wash has started to harden slightly, but before it has taken its initial set, any excess material shall be removed with a straight edge, and in about an hour, the surface shall be rubbed with a rough cloth or pad to remove the excess wash entirely from the surface and leave the voids filled. The wash shall be applied without a break in application (time lapse sufficient to allow wash to set up) in any wall, beam or column face except at corners, edges or other offsets. Prior to final approval of the work, any surface which has been disfigured by drippings or other causes shall be thoroughly cleaned, using a weak solution of muriatic acid, if necessary, and grout finish application repeated as required. The entire grout finish operation shall be accomplished

using a single brand of Portland cement and a single source of sand throughout the Project.

2. Unformed Horizontal Surfaces:

- All bottoms of tanks or liquid retaining structures, shall receive a hard, smooth steel trowel finish. Dusting with sand or cement will not be permitted.
- All exterior horizontal concrete surfaces shall be screeded and then worked to a true, smooth surface with wood floats and proper edging or jointing tools.
- All interior concrete floors and slabs shall receive a swirl finish.
- Provide smooth form finish for all interior and exterior exposed beams and undersides of slabs.
- Floors shall have the aggregate well worked down from the surface and be given a hard, smooth steel trowel finish. After the hard, smooth finish is obtained, the finisher shall make an additional pass over the surface to obtain a nonskid finish, commonly known as a "swirl finish" which is smoother than "sidewalk finish" but is not of a glass like smoothness.
- Dusting with sand or cement will not be permitted.
- Paint, silicone damp-proofing or other coatings or substances shall not be applied to surfaces or adjoining joint surfaces until sealants have been installed and are nominally cured.
- Ferrous Metal Joint Surfaces: Clean to bare, non-oxidized metal by sandblasting or the approved process.
- Nonferrous Metal Joint Surfaces: Remove lacquer or other temporary protective coatings and clean with toluol, xylol, xylene, MEK, or other cleaner recommended by sealant manufacturer.
- Concrete and Masonry Joint Surfaces: Etch bonding surfaces with a 5 percent solution of muriatic acid, rinse thoroughly with water, and dry.

3.15 Cutting and Patching

- A. Where concrete areas are to be patched, the perimeter of the area is to be saw cut, and all deteriorate concrete is to be removed to a minimum depth of at least 3/4" behind the exposed reinforcing. The perimeter of the saw cut area shall be under cut all around. Any exposed reinforcing shall be spliced by flap welding where more than 25% of the cross sectional area of the rebar is lost. The exposed concrete and reinforcing shall then be sandblasted. The concrete surface now exposed shall be moistened and exposed reinforcing shall be cured with an anticorrosion, cementitious coating, (Sikatop 108 or approved equal). The saw cut area shall be filled to match the level of the existing surface with repair mortar (Sikatop 122 or approved equal) and cured with a membrane covering.

3.16 Concrete Stair Finish

- Apply nonslip broom finish to all concrete platforms, steps and ramps and elsewhere as directed by the Engineer.
- Immediately after troweling finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fiber bristle broom unless otherwise directed. Coordinate the required final finish with the Engineer before application.

3.17 Equipment Foundations

A. All equipment pads and foundations not otherwise noted on the drawings or in this specification shall be formed, reinforced and poured to the dimensions shown. All exposed surfaces except those surfaces subsequently required to receive grout and support equipment bases shall, unless otherwise noted elsewhere in the project specification, be finished as detailed in ACI 301, Chapter 10, to a "smooth form finish". Exterior angles shall be chamfered. Contractor shall build in all anchor bolts, sleeves and other built-in fittings as required for the equipment. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with indentions in the surface of 1/2" and irregular.

3.18 Concrete Receiving Chemical Hardener

A. After 28 days, minimum, concrete cure, apply chemical hardener in 3 applications to a minimum total coverage of the undiluted chemical of 100 sq. ft. per gallon and in accordance with manufacturer's recommendations as reviewed.

3.19 Grout

A. Applications:

1. Mix A - Nonshrink Grout Mix A - Nonshrink Grout shall be used for the setting of structural items such as base plates for columns and beams, equipment and other machinery. All grout shall be mixed and placed in strict accordance with the directions of the manufacturer.
2. Mix B - Nonshrink, Epoxy Grout Mix B - Nonshrink, Epoxy Grout shall be used for sloping floors (prior to installing Heavy Duty Floor Toppings), the setting of handrail Posts, expansion joint covers, and around new opening for doors, ducts, piping, and plain opening in existing walls or where indicated on the Contract Drawing. All grout shall be mixed and placed in strict accordance with the directions of the manufacturer.
3. Mix C - Plain Grout Mix C - Plain Grout shall be used at other locations and when ordered by the Engineer. For beds thicker than 1-1/2-inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2

parts of coarse aggregate having a top size of 3/8 inch should be added to Mix A and 50 pounds of 1/4 inch to 3/8 inch pea gravel may be added to each 100 pound bag of Mix B. The minimum amount of water required to produce a flowable grout that will completely fill the space to be grouted shall be used. Sands graded within the following limits should be used: 1) Passing No. 8 sieve - 95 to 100 percent. 2) Passing No. 16 sieve - 65 to 90 percent. 3) Passing No. 50 sieve - 10 to 30 percent. 4) Passing No. 100 sieve - 3 to 10 percent.

B. Preparation:

1. The underside of the base plate for columns and beams, equipment and other machinery shall be cleaned of all dirt, grease and oil-like films.
2. The pertinent concrete surfaces shall likewise be cleaned of all similar contamination and debris, chipping or roughening the surface if any laitance or poor concrete is in evidence. Special care shall be taken with the grout in hot or cold weather to insure proper setting and gain of strength. Aggravating conditions of placement are to be alleviated to an extent that the temperature of the grout up until time of set will be about the range of 60 degrees to 80 degrees F. Ice or hot water may be used and shields from the sun and hot winds shall be provided when required. Following cleaning, the concrete shall be water saturated for a period of six (6) hours, the excess water then removed from the surface and nonabsorbent edge forms erected.

C. Grouting: Grout shall be placed quickly and continuously, shall completely fill the space to be grouted and be thoroughly compacted and free of air pockets. The grout may be poured in place, pressure grouted by gravity, or pumped. The use of pneumatic pressure or dry-packed grouting requires approval of the Engineer. Whenever Practical, grout shall be poured from one side only and thence flow across to the open side to avoid air entrapment.

D. Finishing: If an expanding grouting aid is used, the recommendations of the manufacturer on finishing of exposed edges shall be strictly followed. All visible wedges shall be removed 48 or more hours after the grout has been placed.