SPECIFICATION 033000: CAST-IN-PLACE CONCRETE

PART 1.0 GENERAL

1.1 DESCRIPTION

The work specified in this specification consists of furnishing the equipment, labor, materials, and incidentals required for the construction of all Portland cement, cast-in-place concrete items.

1.2 REFERENCE DOCUMENTS

- American Association of State Highway and Transportation Officials (AASHTO).
- American Concrete Institute (ACI)
- American Society for Testing and Materials (ASTM)
- Federal Specifications (Fed Spec)
- Military Specifications (Mil Spec)
- Portland Cement Association (PCA)

1.3 SUBMITTALS

1.3.1 Samples: Membrane-forming curing compound - Two one-pint samples, each type.

1.3.2 Design Mixes

1.3.2.1 At least 30 days prior to start of placing concrete submit design mixes for each class and type of concrete, indicating that the concrete ingredients and proportions will result in a concrete mix meeting the requirements specified.

1.3.2.2 Include for each class and type of concrete as many mix designs as there are combinations of different ingredients, or type of ingredients, anticipated to cover the requirements of the contract work.

1.3.2.3 Compressive test cylinders for each design mix must be made at the Contractor's expense by an independent testing laboratory approved by the Engineer and tested in accordance with the ACI Code and "Method of Test for Compressive Strength of Molded Concrete Cylinders (ASTM C39)" three cylinders will be required for each design mix.

1.3.2.4 Furnish two copies of each report to the Engineer and one copy to local government building department, as required, and the structural engineer. Concrete mix design, which does not meet the Specifications, will be rejected.

1.3.2.5 Establish the mix designs and have them tested through the laboratory.

1.3.2.6 Submit cylinder test results for the various mix designs showing compressive strength at 2, 7, and 28 days.

1.3.3 Proposed Method of Temperature Control

1.3.4 Certificates

1.3.4.1 Ingredients

a) Submit with the delivered field mix the design laboratory test reports and mill or manufacturer's certificates attesting to the conformance of ingredients with these specifications. Use ingredients in the design mix, which are representative samples

of the materials to be used in the contract work.

b) In case the source, brand or characteristic properties of the ingredients need to be varied during the term of the contract, submit revised laboratory mix report, in conformance with the previous procedures.

1.3.4.2 A Certificate of Compliance must be submitted for the following items:

a) Water stops
b) Floor hardener
c) Chemical curing compounds
d) Admixtures
e) Non-shrink grout
f) Epoxy bonding compound
g) Reinforcing steel

1.3.5 Submit a copy of any design exception prior to installation. Design exceptions are issued by the Utility Design Section Manager. Any deviation from the specifications requires a design exception.

1.4 RELATED WORK

- Specification 032000, Concrete Reinforcement
- Specification 031000, Forms and Formwork
- Hillsborough County Standard Pump Station Drawings
- Specification 333003, Wastewater Pumping Stations

PART 2.0 PRODUCT

2.1 QUALITY ASSURANCE

2.1.1 Properties of Concrete

2.1.1.1 General Requirements

a) Design mixes to produce concrete of proper workability, durability, compressive strength, maximum density, and minimum shrinkage and permeability.
b) Design mixes to have a minimum water-cement ratio, the largest permissible maximum size specified coarse aggregate, and an optimum percentage of fine aggregate.
c) Use maximum size of coarse aggregate in accordance with ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

2.1.1.2 Durability: For durability purposes, use a water-cement ratio in accordance with either ACI 211.1, Tables 5.3.4 (a and b), as determined by the type of structure and exposure conditions, or 0.50 by weight whichever is the lesser.

2.1.1.3 Workability: Use approved chemical or air-entraining admixtures, or suitable combinations thereof in accordance with ASTM C260 to improve workability, as well as to reduce water and cement contents, and minimize shrinkage and permeability of concrete, provided that these admixtures do not adversely affect other required properties of concrete.

2.1.1.4 Strength

a) Design the mix for each class and type of concrete of a specified compressive strength based on the required overdesign factor according to ASTM C94, and assuming a coefficient of variation equal to 15. Unless otherwise shown, working

stress method of design will apply to structures.

b) For working stress method of design each class of concrete must be designed so that not more than 20 percent of the compressive strength tests will have values less than the specified compressive strength, and the average of six consecutive strength tests will be equal to or greater than the specified compressive strength.

2.1.2 Method of Proportioning

2.1.2.1 For proportioning mixes use methods as described in ACI 211.1.

2.1.2.2 Do not vary the proportions of the ingredients of the approved mixes without the written approval of the Structural Engineer.

2.2 MATERIALS

2.2.1 Portland cement: ASTM C150 Type I for pump station slabs, drives, and sidewalks, and Type II for wet wells and manholes.

2.2.2 Admixtures: Chlorides may be present in admixtures provided the total chloride in the proposed concrete mixture, including chloride ions contributed by the admixture or admixtures, aggregates and mixing water, is not in excess of 150 ppm.

2.2.3 Water requirements

2.2.3.1 Containing no impurities, suspended particles, algae, or dissolved natural salts in quantities that will cause:

a) Corrosion of reinforcing steel.
b) Volume change that will increase shrinkage cracking.
c) Efflorescence.
d) Excessive air entraining.

2.2.3.2 The pH to be not less than 6.5 or greater than 7.5.

2.2.3.3 When tested in accordance with AASHTO T26, standard mortar briquette tests to show no indication of unsoundness, change in time-of-setting not in excess of 30 minutes, or reduction in strength not more than ten percent.

2.2.4 Concrete Aggregate must comply with the provisions of ASTM C33, with the following additional requirements in the following table.

Deleterious Substance	Maximum Allowable Percent by Weight
Soft Particles (a higher percentage may be approved by the Engineer where concrete is not subject to abrasion, provided concrete strength is achieved without the use of excess cement.)	0.5
Coal and lignite particles	0.5
Friable particles	0.25
Material passing Number 200 sieve (for crushed aggregates if the material finer than the Number 200 sieve consists of dust of fracture essentially free from clay or shale, percentage may be increased to 1.5)	1.0
Thin or elongated pieces (length N/A greater than five times the smallest dimensions of a circumscribing rectangular prism.)	N/A
Other local deleterious substances	1.0

2.2.4.1 Percentage of wear not exceeding 45 when tested in accordance with ASTM C131 and C535.

2.2.4.2 Weighted percentage of loss not more than 15 percent by weight when subjected to five cycles of the magnesium sulfate soundness test in accordance with ASTM C88.

2.2.4.3 Gradation in accordance with Table 2 of ASTM C33 and represented by a smooth gradation curve within the required limits.

2.2.5 Fine Aggregate

2.2.5.1 Washed natural sand or washed manufactured sand. Manufactured sand may be subject to special gradation requirements as directed by the Project Manager.

2.2.5.2 Gradation in accordance with ASTM C33 and represented by a smooth granulometric curve within required limits. The minimum percentages of the material passing the Number 50 and Number 100 sieves may be reduced to five and zero respectively if the aggregate is to be used in concrete with three percent minimum air-entrainment, or concrete containing more than 5.5 bags of cement per cubic yard.

2.2.5.3 Weighted percentage of loss not more than 12 percent by weight when subjected to five cycles of the magnesium sulphate soundness test in accordance with ASTM C88.

Deleterious Substance	Maximum Allowable Percent by Weight
Friable particles	1.0
Coal and lignite	0.5
Material passing Number 200 sieve & Other deleterious substances (such as shale, alkali, mica, coated grains, soft and flaky particles)	5.0

2.2.5.4 Free from injurious amounts of organic impurities as determined by ASTM C40. Should material fail to pass test for organic impurities in sand for concrete, retest in accordance with ASTM C87. If the fine aggregate shows by the colorimetric test a darker color than that of the sample originally approved for work, stop using the aggregate until tests satisfactory to the Project Manager or Hillsborough County Inspector have been made to determine whether the change in color is indicative of an injurious amount of deleterious substances.

2.2.6 Water stops

2.2.6.1 Elastomer water stops must be made of flexible polyvinyl chloride, must be dense, homogeneous, free from porosity and other imperfections, and dumbbell in shape.

2.2.6.2 Materials must be resistant to chemical action with Portland cement, acids and alkalis, and not affected by fungi. They must show no effect when immersed for 10 days at room temperature in 10 percent solutions of sulfuric acid, hydrochloric acid, and sodium chloride, and a saturated lime solution. Resistance to fungi must be determined by ASTM G21.

2.2.6.3 Material must not be adversely affected when subjected to tests for low temperature brittleness (-35 degrees F), in accordance with ASTM D1329, and for water absorption (maximum 5 percent by weight).

2.2.6.4 Water stops not indicated otherwise must be six-inch by 3/8-inch.

2.2.7 Membrane Forming Curing Compound must comply with provisions of ASTM C309, Type 1 (100 resin) with fugitive dye, and Type 2.

2.2.8 Waterproof Curing Sheet must comply with provisions of ASTM C171, type 1.1.1 and 1.1.2.

2.2.9 Burlap Sheet must comply with provisions of AASHTO M182, Class 3 and 4.

2.2.10 Materials for Curing Concrete

2.2.10.1 Vapor Barrier - Polyethylene Sheeting: Polyethylene sheeting must be natural color and must have a normal thickness of 0.006 inch (six mils) and be of the widest practicable widths. The loss of moisture when determined in accordance with ASTM C156 must not exceed 0.055 gram per square centimeter of surface. See Construction Drawings for locations.

2.2.10.2 Polyethylene-Coated Burlap: Polyethylene-coated burlap must be four mils thick white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap must weigh not less than nine ounces per square yard and must conform to Fed. Spec. CCC-C-467. The loss of moisture when determined in accordance with ASTM C156 must not exceed 0.055 gram per square centimeter of surface.

2.2.10.3 Liquid Membrane-Forming Compound: Liquid membrane-forming compound must conform to ASTM C309, white-pigmented Type 2, and be free of paraffin or petroleum.

2.2.10.4 Liquid Chemical Compound Curing

a) Liquid chemical compound curing must be accomplished by the application of a suitable sealer-hardener designed for sealing and hardening in addition to curing of the concrete, applied by the method and at the rate recommended by the manufacturer.
b) It must not reduce the adhesion of paint, waterproofing or other material to be applied to the concrete. The chemical compound must be free of petroleum resins or waxes.
c) The loss of moisture when determined in accordance with ASTM C156 must not exceed 0.055 gram per square centimeter of surface. The abrasion loss must not exceed 80 percent of that of the same concrete, untreated, when tested in accordance with ASTM C418 at age 28 days.
d) The adhesion to the treated concrete must be at least 90 percent of the adhesion to the same concrete, untreated. The test for adhesion will consist of forming mortar or concrete slabs, three moisture cured and three liquid chemical cured for each type of covering to be applied. After curing for 28 days, the slabs must be permitted to dry in air.
e) The covering must be adhered to the troweled face of the slabs with the adhesive to be used in the work. After the adhesion has set, cuts one inch apart and six to 10 inches long must be made through the adhered covering, forming strips to one end of which a calibrated spring type balance or other devise must be attached. The strips must be peeled off at a rate of two to 100 inches per minute. The pull required to peel the covering from the slabs must be the average of three specimens.

2.2.10.5 Chemical Floor Hardener: All concrete floor slabs, both interior and exterior, not having an additional applied finish, must have a liquid concrete hardener applied in accordance with the manufacturer's recommendations

2.2.11 Joint-Sealing Materials: Joint-sealing materials must conform to ASTM D1850.

2.2.12 Expansion Joint Filler: Expansion joint filler must be pre-formed type conforming to ASTM D1751.

2.2.13 Slots and Inserts for Masonry Anchors

2.2.13.1 Dovetail Anchor Slots: Dovetail anchor slots must be formed of zinc-coated sheet steel, U.S. 24 minimum gage, provided in concrete faced with or abutting masonry.

2.2.13.2 Inserts: Inserts must be formed of nine minimum gauge zinc-coated steel wire, engaged between a two-piece half-round wood core, and having loops for embedding in concrete.

2.2.14 Epoxy Bonding Compound: Epoxy bonding compound must conform to ASTM C881.

2.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

2.3.1 Aggregates

2.3.1.1 Transport and stockpile aggregates according to their sources and gradations. Handle in a manner, which will prevent segregation and loss of fines or contamination with earth or foreign materials.

2.3.1.2 If aggregates show segregation or the different grades become mixed, rescreen before placing in the proportioning bins.

2.3.1.3 Do not use aggregates from different sources or of different gradations alternatively. Mix only to obtain different gradations.

2.3.1.4 Do not transfer aggregates directly from trucks, railroad cars or barges to the proportioning bins when the moisture content is such that it will affect the accuracy of the proportioning of the concrete mixture. In such case, stockpile aggregate until the excess moisture drains off.

2.3.2 Package Cement

2.3.2.1 Deliver to the project site in original sealed packages labeled with the weight, name of the manufacturer, brand, and type specified.

2.3.2.2 Store packages in a watertight building.

2.3.2.3 Do not use cement, which has been reclaimed by cleaning bags.

2.3.2.4 Do not use cement, which has been damaged by exposure or over-stocking.

2.3.2.5 Do not deliver packages varying more than three percent from the specified weight.

2.3.2.6 Packaged cement will be subject to test at any time.

2.3.3 Bulk Cement

2.3.3.1 Store bulk cement separately from other cement and protect from deterioration from exposure to moisture and intrusion of foreign matter.

2.3.3.2 Provide facilities to maintain separation of cement meeting the requirements of these specifications from other cement.

2.3.3.3 Provide in cement manufacturer's plant, facilities for sampling of cement at the weighing hopper or in the feed line immediately before entering the hopper.

2.3.3.4 Do not use different brands of cement, or the same brand of cement from different sources without approval.

PART 3.0 EXECUTION

3.1 FIELD QUALITY CONTROL

3.1.1 Air Entrainment: Determine the air content of concrete in accordance with the recommendations of ASTM C231.

3.1.2 Testing of Concrete

3.1.2.1 Compression test cylinders for all concrete pours must be made at the Contractor's expense by an independent testing laboratory approved by the Project Manager or Hillsborough County Inspector and tested in accordance with the ACI Code and "Method of Test for Compressive Strength of Molded Concrete Cylinders (ASTM C39)" three cylinders will be required for the first 5 cubic yards and four for each 50 cubic yards thereafter for each day's pour.

3.1.2.2 Furnish two copies of each report to the Project Manager or Hillsborough County Inspector and one copy to local government building department, if required, and structural engineer. Concrete, which does not meet the Specifications, will be required to be removed and replaced at the Contractor's expense or may be subjected to a load test, also at Contractor's expense.

3.1.2.3 For each work shift, when concrete is delivered, at least one set of specimens will be made. A set of test specimens will consist of at least four standard cylinders from a batch. At least one specimen of the set will be tested for two-day, seven-day, and 28-day compressive strength. The tests for two-day compressive strength, approximately 25 percent of the 28-day compressive strength, will be used to aid in the determination of form, false-work and centering removal. The tests for seven-day compressive strength, approximately 60 percent of the 28-day compressive strength, will be likewise used.

3.1.2.4 Slump tests, yield tests, and air content tests will be performed by the laboratory with no less frequently than that of casting strength specimen sets; however, the Project Manager or Hillsborough County Inspector reserves the right to have the concrete tested as often as they deem necessary.

3.1.2.5 Submit a delivery ticket from the concrete supplier to the Project Manager or Hillsborough County Inspector before unloading at the site for each batch delivered to the site setting forth the following information:

a) Name of supplier
b) Name of batching plant and location
c) Ticket Serial number
d) Date
e) Truck number
f) Specific job designation (contract number and location)
g) The volume of concrete (cubic yards)
h) Specific class and type of concrete (in conformance with the specification requirement)
i) Time loaded
j) Type and brand of cement
k) Weight of cement
l) Maximum size of aggregates
m) Weight of coarse and fine aggregates, respectively

n) Maximum amount of water to be added and amount of water added at the site, if any
o) Kind and amount of admixtures

3.1.2.6 Concrete Strengths

a) Determine compressive strengths from standard test specimens taken by the laboratory according to ASTM C31 and ASTM C172, and cured and tested in accordance with ASTM C39. Core drilling and testing will be in accordance with ASTM C94.
b) Compute and evaluate in accordance with ASTM C94.

3.1.2.7 Air content: Determine in accordance with ASTM C231.

3.1.2.8 Cement factor: Determine in accordance with ASTM C138.

3.1.2.9 Modulus of elasticity: Determine the modulus of elasticity and Poisson's Ratio in accordance with ASTM C469 as directed by the Structural Engineer.

3.1.2.10 Slump: Determine in accordance with ASTM C143.

3.1.2.11 Unit Weight: Determine the unit weight in accordance with ASTM C138 as directed by the Structural Engineer.

3.1.3 Design Mix

3.1.3.1 Specified 28 days compressive strength of concrete must be as follows:

a) f'c = 4000 psi for all structurally reinforced concrete work (ex: wet wells, manholes, pump station slabs, and pump station drives).
b) f'c = 3000 psi concrete for exterior work and all flatwork underfoot, such as sidewalks, residential driveways, steps, or ramps.

Mag. Agg Size	Air Content (% by Vol.)
1/2"	7% + or - 2%
3/4"	6% + or - 2%
1"	5% + or - 1-1/2%
1-1/2"	4-1/2% + or - 1-1/2%

Concrete exposed to weather must have a maximum of 5-1/2 gallons of water per sack of cement and a minimum of 6-1/4 sacks of cement per cubic yard.

c) f'c = 3000 psi concrete for mud mats, limited site voids, soil boring voids, and for under foundations where excavated to excessive depth.
d) f'c = 3000 psi concrete for grout with maximum size coarse aggregate not exceeding 3/8 inch.

3.1.3.2 Mix Proportioning: Mix proportioning for wastewater treatment structures (wet wells and manholes) must produce watertight concrete resistant to naturally occurring or commonly used chemicals, with a 28-day compressive strength of 4000 psi in accordance with Method 1 (ACI 301) and the following:

a) Maintain a minimum water to cement ratio consistent with the point of placement.
b) Provide the following minimum cementitious content:

ASTM C33 Coarse Aggregate No	Lbs. per cu yd
467	517
57 or 67	564

c) Provide air entrainment as follows:
5% + 1% - coarse aggregate no. 467
6% + 1% - coarse aggregate no. 57 or 67

3.1.4 Classes of Concrete

3.1.4.1 Classes of concrete are designated by numerals corresponding to their specified 28-day compressive strengths in pounds per square inch as determined by ASTM C94.

3.1.4.2 When class is not indicated use 4,000 psi concrete.

3.1.4.3 Each class of concrete may comprise one or more mixes determined by the maximum size of aggregate, cement factor and types of admixtures used.

3.1.5 Minimum Cement Factor: Observe the minimum cement factor for the various classes of concrete as follows:

Classes of Concrete (in psi)	Minimum Cement Factor (Bags per cu yd of Concrete)
5,000	6.5
3,500 - 4,000	6.25
3,000 - 3,400	5.75

3.2 MATERIAL PREPARATION

3.2.1 Concrete Production

3.2.1.1 Ready Mix Concrete: Ready-mixed concrete must be batched, mixed and transported in accordance with ASTM C94. Plant equipment and facilities must conform to "Certification of Ready Mixed Concrete Production Facilities of the National Ready Mixed Concrete Association."

3.2.1.2 On-site Batching: Concrete produced by on-site volumetric batching and continuous mixing must be batched and mixed in accordance with and must conform to all requirements of ASTM C685.

3.2.2 Admixtures

3.2.2.1 Air entraining admixture: Use for concrete exposed to weathering or in contact with rock or moist soil.

3.2.2.2 Chemical admixtures

a) Use water reducing admixtures in concrete areas below grade in contact with rock, earth, or fill.

b) Employ admixtures without interfering with the specified air content dosage of air-entrained concrete.

c) Except as specified, use water reducing, set retarding or set accelerating admixtures only with Project Manager's approval.

d) If the introduction of certain admixtures to improve concrete strength is permitted by the Engineer, do not reduce the cement content below the minimum amounts specified.

3.2.2.3 Use calcium chloride only as specifically authorized in writing by the Project Manager. Do not use calcium chloride in pre-stressed concrete, underground structures, reinforced concrete, or in concrete used to encase or in contact with structural steel or cast iron.

3.2.3 Consistency: Slump must not exceed two inches above design mix slump as approved by the Engineer and must be kept at a practical minimum for the point of placement.

3.2.4 Construction Joints

3.2.4.1 Joints not shown on the Construction Drawings must be made and located so as to not impair the strength of the structure and must be subject to approval of the Engineer. In general, construction joints must be placed such that no vertical pour may exceed 10 to 15 feet and no horizontal pour may exceed 20 to 30 feet. Horizontal joints in walls and columns must be at the underside of floors, slabs, beams, or girders and at the top of footings of grade slabs. Joints must be perpendicular to the main reinforcement.

3.2.4.2 Reinforcement in Construction Joints: All reinforcing steel and welded wire fabric must be continued across joints. Keys and inclined dowels must be provided as indicated. Longitudinal keys at least 1-1/2 inches deep must be provided in all joints in walls and between walls and slabs or footings.

3.2.4.3 Preparation of Surface: The surface of the concrete at all joints must be thoroughly cleaned and all laitance removed.

3.2.4.4 Bonding: When a bonded construction joint is required, bond must be obtained by one of the following methods.

a) The use of a bonding compound for concrete, conforming to Mil. Spec. MIL-B-19235.
b) The use of suitable chemical retardant which delays but does not prevent setting of the surface mortar. Retarded mortar must be removed within 24 hours after placing to produce a clean exposed aggregate bonding surface.
c) By roughening the surface of the concrete in proper manner which will expose the aggregate uniformly and damaged concrete at the surface.

3.2.5 Expansion Joints, Cleavage Joints, Water stops and Embedded Items

3.2.5.1 Expansion Joints and Cleavage Joints:

a) Expansion joints must be provided in any structure having a dimension of 120 feet in any principal direction. Desirable maximum spacing is 50 to 60 feet.
b) Reinforcement must stop two inches from the face of an expansion joint.
c) Expansion joints and cleavage joints must not be less than 1/2-inch wide except as indicated otherwise.
d) Expansion joints (not exposed to weather) must be filled completely with preformed joint material conforming to ASTM D1751. Expansion joints exposed to weather, cleavage joints between vertical masonry surfaces, and floor slabs laid on earth must be filled to a depth of one-inch from the surface or face of the concrete width deep space above the preformed material conforming to ASTM D1751. The one-inch deep space above the preformed material must be cleaned after the concrete has been cured, and when dry, filled flushed with joint sealing material. Reinforcement or other embedded metal items bonded to the concrete, except dowels in floors bonded on only one side of joint, must not be permitted to extend continuously through any expansion joint.

3.2.5.2 Water stops

a) All horizontal and vertical construction and expansion joints providing for fluid containment in a wet space as well as joints located in exterior walls below grade must have placed in the joint a water stop to develop effective water tightness. Wet space must include tanks, channels, chambers, etc. used to store, convey or contain

fluids or solids containing fluids.

b) The material, design, and location of water stops in construction joints and expansion joints must be as indicated or as specified herein. Each piece of premolded water stop must be maximum practicable length in order that the number of end joints will be held to a minimum. Joints at intersections and at ends of pieces must be made in the manner most appropriate to the material being used. Joints must develop effective water tightness fully equal to that of the continuous water stop material and must permanently develop not less than 50 percent of the mechanical strength of the parent section and must permanently retain its flexibility.

3.2.5.3 Other Embedded Items

a) All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support must be placed prior to concreting.

b) All sub-contractors, whose work is related to the concrete or must be supported by it, must be given ample notice and opportunity to introduce or furnish embedded items before the concrete is placed.

c) All ferrous metal sleeves, insets, anchors, and other embedded ferrous items exposed to the weather or where rust would impair the appearance or finish of the structure must be galvanized.

3.2.5.4 Placing Embedded Items

a) Expansion joint material, water stops, and embedded items must be positioned accurately and supported against displacement.

b) Voids in sleeves, inserts, and anchor slots must be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

c) Aluminum must not be embedded in concrete except where aluminum is protected from direct contact with the concrete.

3.2.5.5 Reinforcing Bars: Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items, but not so as to impair design strengths of the members. If bars are moved more than one bar diameter, the resulting arrangement of bars must be subject to the approval of the Project Engineer.

3.3 CONVEYING

3.3.1 General Requirements

3.3.1.1 Convey concrete from the point of delivery with a continuous flow of concrete to the point of placement without segregation.

3.3.1.2 Provide an arrangement at the discharge end of a conveyor to prevent segregation. “Free fall” from point of discharge to final placement location must not exceed five feet horizontally or five feet vertically.

3.3.2 Chutes and Troughs

3.3.2.1 Use only ferrous metal or approved plastic or rubber lined chutes and open troughs. Where steep slopes are required, discharge the concrete into a hopper. Keep chutes or open troughs clean of hardened concrete by thoroughly flushing with water after each use.

3.3.2.2 Discharge the water used for cleaning outside the lines of the structure.

3.3.3 Adjustable Length Pipes (Elephant Trunks)

3.3.3.1 Use flexible pipes only of ferrous metal, rubber or plastic, six-inch minimum diameter

and use in a manner that will not cause segregation of the concrete.

3.3.3.2 Locate chutes or flexible pipes so that concrete is delivered in a continuous flow to points not more than five feet horizontally and five feet vertically from its final location.

3.3.3.3 Thoroughly clean flexible pipes or elephant trunks after each use.

3.3.4 Buggies: Construct runaways on which buggies will operate such that they will not come in contact with or be supported by the reinforcing steel of the structure.

3.3.5 Pumping Equipment

3.3.5.1 Use pumping equipment, designed to handle the types, classes and volumes of concrete to be conveyed without segregation.

3.3.5.2 Operate the pump equipment so that a continuous stream of concrete without air pockets is conveyed. Position the discharge end of the line as near the final position of the concrete as possible (not to exceed the distances specified in section 3.3.1.2).

3.4 PREPARATION FOR PLACEMENT

3.4.1 Do not place concrete until all formwork, steel reinforcement, installation of embedded parts, preparations for finishing unformed areas, scaffolding, lighting, power and methods and procedures for placing concrete have been approved. Refer to Specification 032000 for installation of concrete reinforcement and Specification 031000 for formwork requirements. All surfaces of forms and embedded materials must be cleaned of dried mortar or grout from previous pours. Poorly consolidated concrete at construction joints and all loose material must be removed. Surfaces of concrete and embedded materials must be cleaned of laitance, or oil and other bond destroying agents.

3.4.2 Surfaces against which concrete is to be placed must be clean and free of running water, mud, loose material, oil, debris, frost and ice. Rock surfaces must be free of semidetached and unsound fragments. Absorptive base surfaces must be moistened thoroughly or otherwise treated so that moisture will not be drawn from freshly placed concrete.

3.4.3 Coat faces of removable concrete forms with form oil approved by the Project Manager or Hillsborough County Inspector.

3.4.4 Slabs installed on grade must have the surface graded and compacted prior to setting the forms and reinforcing.

3.5 PLACEMENT

3.5.1 General Requirements

3.5.1.1 Place concrete continuously and as soon as possible after mixing. Do not use vibrators for shifting the mass of fresh concrete.

3.5.1.2 Place concrete in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. Cover each layer of concrete with fresh concrete within 45 minutes.

3.5.1.3 Do not place concrete which has attained its initial set or concrete which has contained its mix water for more than 90 minutes.

3.5.1.4 Notify the Project Manager or the Hillsborough County Inspector at least 24 hours in advance of the start of concrete placing.

3.5.1.5 Placing will not be permitted when, in the opinion of the Project Manager or the Hillsborough County Inspector the sun, heat, wind or limitations of facilities furnished prevent proper finishing and curing.

3.5.1.6 Control concrete temperature at time of placement:
a) To be not less than 45° F
b) To be not more than 90 ° F

3.5.1.7 Unless approved by the Project Manager or the Hillsborough County Inspector, do not start concreting when descending natural air temperature falls lower than 40 ° F.

3.5.1.8 Start placement of structural concrete on/or next to a construction joint with a three-inch thick layer of over-sanded mix with 3/4-inch maximum aggregate, an extra sack of cement per cubic yard, and a five-inch slump.

3.5.1.9 Deposit concrete as nearly as practicable directly in its final position so that the lateral movement will not result in segregation of the coarse aggregate, mortar, or water from the concrete mass. Do not use methods and equipment in depositing concrete in forms which result in clusters or groups of coarse aggregate being separated from the concrete mass. When concrete is placed through a drop chute, use one or more vibrators where concrete is falling to prevent stacking and separation.

3.5.1.10 Place formed concrete, in continuous, approximate horizontal layers, the depth of which generally must not exceed 24 inches. Lesser depths may be required where necessary to ensure that each new layer can be made monolithic with the previous layer.

3.5.2 Compaction

3.5.2.1 Consolidate all concrete by vibration to the maximum practicable density, so that it is free from pockets of coarse aggregate and entrapped air, and filled tightly against, all formed surfaces and embedded materials. In consolidating each layer of concrete operate the vibrator at regular and frequent intervals, and in a near vertical position. Allow the vibrating head to penetrate and re-vibrate concrete in the upper zone of the underlying layers.

3.5.2.2 Re-vibrate the top layer of each placement systematically at the latest time the concrete can be made plastic by means of vibration. Do not place layers of concrete until the layers previously placed have been vibrated thoroughly as specified.

3.5.2.3 Consolidate concrete by electric or pneumatic drive vibrators of sufficient power and capacity to consolidate the concrete effectively and quickly. Operate concrete vibrators at speeds of at least 7,000 rpm when immersed in the concrete. Have standby vibrators in good condition readily available if needed during concrete placement. Use equipment capable of obtaining results and operating reliably and effectively with a concrete mix that is not excessively over-sanded or high in slump and may occasionally be of lower slump than intended.

3.5.3 Finishing: Surface finishes must comply with ACI 301 Section 5.3.3, Finishing formed surfaces, or 5.3.4, Finishing unformed surfaces. The standard finish for exterior slab on grade unformed surfaces must be a broom finish.

3.6 CURING AND PROTECTING

3.6.1 General Requirements

3.6.1.1 Protect freshly placed concrete from excessive hot or cold temperatures. Maintain concrete surfaces without drying for the period of time necessary for the hydration of the

cement and the proper hardening of the concrete.

3.6.1.2 Cure newly placed concrete for a cumulative period of seven days at an air temperature in excess of 55° F.

3.6.1.3 During the curing period keep steel and wood forms set. If forms are removed during curing use one of the following methods of curing immediately and continue for the remainder of the curing period.

3.6.2 Moisture Curing and Protection (Use any one of the methods specified in the following)

3.6.2.1 Apply continuous sprinkling over the entire surface with a nozzle or nozzles. During the first 24 hours use a system that atomizes the water providing a mist and not a spray. Do not apply moisture under pressure directly upon the concrete and avoid flowing or washing on the surfaces while susceptible to erosion.

3.6.2.2 Cover the entire surface of the concrete with double thickness burlap sheet, laid directly on the concrete and kept wet at all times. Maintain in good condition.

3.6.2.3 Sprinkle, as previously specified, for at least 18 hours and then immediately cover the concrete surface with waterproof curing sheets, free from holes or tears. Hold in position in such manner that the entire surface of the concrete being cured is fully covered at all times.

3.6.2.4 Do not damage burlap or waterproof sheet or concrete surfaces.

3.6.3 Membrane-Forming Curing Compound

3.6.3.1 Use a curing compound when the application of moisture is impracticable or the compounds will not jeopardize the appearance of the concrete. Except as otherwise specified, use Type 1 compound, uniformly applied over the surface at the thickness recommended by the manufacturer. Thoroughly mix compound and apply within one hour after mixing.

3.6.3.2 Where the surfaces are subjected to sunlight, apply Type 2 White compound.

3.6.3.3 Do not apply wax-resin type curing compounds to a surface where bond is required for additional concrete or where a bonded surface coating such as paint, tile, damp proofing, waterproofing, or roofing is to be applied.

3.6.3.4 Warm the curing compound if required for satisfactory application in accordance with the manufacturer's recommendations. If the film of the compound is damaged before the expiration of the curing period, repair immediately with additional compound.

3.6.3.5 Give surfaces the required surface finish prior to the application of the curing compound. Do not use curing compound on construction joints.

3.6.3.6 Apply curing compound in two coats, apply the first coat immediately after stripping of forms and acceptance of the concrete finish.

3.6.3.7 If the surface is dry, thoroughly wet the concrete with water and apply the curing compound just as the surface film of water disappears. Apply the second coat after the first coat has set.

3.6.3.8 Protect the coating against damage for a period of at least 10 days after application. Apply an additional coating to any coatings which get damaged.

3.7 WEATHER PROTECTION

3.7.1 Concrete must not be placed during rain or freezing weather unless approved measures are taken to prevent damage to concrete.

3.7.2 Concrete placed during periods of high winds, low humidity, high temperatures, and other conditions causing rapid drying must be initially cured with a fine fog spray of water applied immediately after finishing and maintained until final curing operations are started.

3.7.3 Under hot weather conditions, steps must be taken to reduce concrete temperature and water evaporation by proper attention to ingredients, production methods, handling, placing, protection, and curing.

3.7.4 Subject to approval, applicable preventive measures must be taken for placing concrete during hot and cold weather in conformance with ACI Reports 305R and 306R, latest revision, respectively entitled, "Hot Weather Concreting", and "Cold Weather Concreting".

3.8 DEFECTIVE CONCRETE

3.8.1 Concrete will be considered defective if it is structurally unsound, not watertight, improperly finished, or not within the tolerances specified herein.

3.8.2 Concrete will be considered defective if the concrete cylinder tests fail to meet the specified strength requirements at any location of the work. In such cases, take drilled cores at locations specified by the Project Manager or Hillsborough County Inspector. Core specimens will be tested by the laboratory in accordance with the requirements of ACI 301. If cored specimens do not indicate compliance with the compressive strength requirements, replace the defective portion of the structure.

3.8.3 Windsor probe tests conducted in conformance with ASTM, C803 may be conducted by the laboratory if approved by the Project Manager or Hillsborough County Inspector in lieu of taking and testing core specimens.

3.8.4 The Project Manager or Hillsborough County Inspector, at their discretion, will require replacement of the defective portion of the structure in accordance with the provision of ACI 201, Chapter 7. All strengthening or correction of defective concrete will be at no additional cost to the County.

3.9 DAMAGED WORK

3.9.1 Before final acceptance of the work, damage to surfaces, corners of concrete and concrete finish, whether such damage must have resulted from the action of the elements or damage from any cause whatsoever, must be neatly repaired, as approved by Project Manager or Hillsborough County Inspector at no additional cost to the County.

3.9.2 At damaged places where surface repairs are permitted, the concrete must be chipped out and a concrete patch installed. The patch must have a minimum thickness of two-inches, must be dense and watertight to meet specification requirements, and must have a smooth exposed surface matching the neat line of adjacent concrete.

3.10 TOLERANCE FOR CONCRETE CONSTRUCTION

3.10.1 Permissible surface irregularities are defined as "finishes," and are to be distinguished from tolerances as described herein.

3.10.2 Allowable tolerances are:

	Tolerance
Departure from established alignment	1/2 inch
Departure from established grade	1/2 inch
Variation from the plumb in the lines and surfaces of columns, piers, and walls in any 10 feet OR for exposed corner columns, control-joint grooves and other exposed to view lines in any 20 ft.	1/4 inch
Variation from plumb over the entire height, or length	1/2 inch
Variation in the level or from grades specified in slabs and beams	1/4 inch over 10 ft. ½ inch over 20 ft. or greater
Backfilled, in 10 feet	3/4 inch
Variation in cross-sectional dimensions of columns and beams, and in thickness of slabs and walls	Minus: 1/4 inch Plus: 1/2 inch
Variation in sizes and locations of slab and wall openings.	1/2 inch