

DIVISION 3 - CONCRETE
SECTION 03020
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

03020 - 1.1 DESCRIPTION

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

03020 - 1.2 REFERENCE DOCUMENTS

- A. American Concrete Institute (ACI)
B. American Society for Testing and Materials (ASTM)
C. Portland Cement Association (PCA)
D. American Association of State Highway and Transportation Officials (AASHTO).

03020 - 1.3 QUALITY ASSURANCE

- A. Properties of Concrete:
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 Committee 613 Report, Recommended Practice for Selecting Proportions for Concrete.
 2. Durability:
For durability purposes, use a water-cement ratio in accordance with either ACI Committee Report 613, Table 4 as determined by the type of structure and exposure conditions, or 0.50 by weight whichever is the lesser.
 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.
 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 shall 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.
- B. Method of Proportioning:
1. For proportioning mixes use methods as described in ACI Report 613.
 2. Do not vary the proportions of the ingredients of the approved mixes without the written approval of the Structural Engineer.

03020 - 1.4 SUBMITTALS

- A. Samples:
1. Membrane-forming curing compound: Two one-pint samples, each type.
- B. Design Mixes:
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.
 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.
 3. Compressive test cylinders for each design mix shall 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.
 4. Furnish two (2) copies of each report to the Engineer and one copy to local government building department and structural engineer. Concrete mix design, which does not meet the Specifications, will be rejected.
 5. Establish the mix designs and have them tested through the laboratory.
 6. Submit cylinder test results for the various mix designs showing compressive strength at 2, 7, and 28 days.
- C. Proposed Method of Temperature Control
- D. Certificates:
1. Ingredients:
 - a. Submit with the mix 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 above procedures.

2. Certificate of Compliance:
 - a. Certificates of compliance shall be submitted for the following items:
 - (1.) Waterstops
 - (2.) Floor hardener
 - (3.) Chemical curing compounds
 - (4.) Admixtures
 - (5.) Non-shrink grout
 - (6.) Epoxy bonding compound
 - (7.) Reinforcing steel

03020 - 1.5 RELATED WORK

- A. Concrete Reinforcement, Section 03010.
- B. Forms and Formwork, Section 03030.

03020 - 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Aggregates:
 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. If aggregates show segregation or the different grades become mixed, rescreen before placing in the proportioning bins.
 3. Do not use aggregates from different sources or of different gradations alternatively. Mix only to obtain different gradations.
 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.
- B. Package Cement:
 1. Deliver to the project site in original sealed packages labeled with the weight, name of the manufacturer, brand, and type specified.
 2. Store packages in a watertight building.
 3. Do not use cement, which has been reclaimed by cleaning bags.
 4. Do not use cement, which has been damaged by exposure or over-stocking.
 5. Do not deliver packages varying more than three percent from the specified weight.
 6. Packaged cement will be subject to test at any time.
- C. Bulk Cement:
 1. Store bulk cement separately from other cement and protect from deterioration from exposure to moisture and intrusion of foreign matter.
 2. Provide facilities to maintain separation of cement meeting the requirements of these specifications from other cement.

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

PART 2 - PRODUCT

03020 - 2.1 MATERIALS

- A. Portland Cement: ASTM C150 Type I or II
- B. Admixtures:
 1. Approved brands: 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.
- C. Membrane Forming Curing Compound shall comply with provisions of ASTM C309, Type 1 (100 resin) with fugitive dye, and Type 2.
- D. Waterproof Curing Sheet shall comply with provisions of ASTM C171, type 1.1.1 and 1.1.2.
- E. Burlap Sheet shall comply with provisions of AASHTO M182, Class 3 and 4.
- F. Water requirements:
 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. The pH to be not less than 6.5 nor greater than 7.5.
 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.
- G. Concrete Aggregate shall comply with the provisions of ASTM C33, with the following additional requirements:
 1. Coarse aggregate:

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	0.5

use of excess cement.)

Coal and lignite particles	0.5
Friable particles	0.25
Material passing Number 200 sieve (<i>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</i>)	1.0
Thin or elongated pieces (<i>length greater than five times the smallest dimensions of a circumscribing rectangular prism.</i>)	N/A
Other local deleterious substances	1.0

- b. Percentage of wear not exceeding 45 when tested in accordance with ASTM C131 and C535.
 - c. 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.
 - d. Gradation in accordance with Table 2 of ASTM C33 and represented by a smooth gradation curve within the required limits.
2. Fine Aggregate:
- a. Washed natural sand or washed manufactured sand. Manufactured sand may be subject to special gradation requirements as directed by the Project Manager.
 - b. Gradation in accordance with ASTM C33 and represented by a smooth granulometric curve within required limits.
 - (1) 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.
 - c. 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.

- | d. | Deleterious Substances | Maximum Percentage
by Weight |
|----|--|---------------------------------|
| | Friable particles | 1.0 |
| | Coal and Lignite | 0.5 |
| | Material passing
No. 200 sieve & Other
deleterious substances
<i>(such as shale, alkali,
mica, coated grains,
soft and flaky particles)</i> | 5.0 |
- e. 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 have been made to determine whether the change in color is indicative of an injurious amount of deleterious substances.

H. Waterstops:

1. Elastomer Waterstops:

- a. Elastomer waterstops shall be made of natural or synthetic rubber or polyvinyl chloride, shall be dense, homogeneous, free from porosity and other imperfections, and symmetrical in shape. Materials shall be resistant to chemical action with portland cement, acids and alkalies, and not affected by fungi. They shall show no effect when immersed for 10 days at room temperature in 10 percent solutions of sulphuric acid, hydrochloric acid, and sodium chloride, and a saturated lime solution. Resistance to fungi shall be determined by ASTM G 21. Material shall not be adversely affected when subjected to tests for low temperature brittleness (-35 degrees F), in accordance with ASTM D 1329, and for water absorption (maximum 5 percent by weight). Waterstops not indicated otherwise shall be 6-inches by 3/8-inch.

I. Materials for Curing Concrete:

1. Polyethylene Sheeting:

- a. Polyethylene sheeting shall be natural color and shall have a normal thickness of 0.004 inch. The loss of moisture when determined in accordance with ASTM C 156 shall not exceed 0.055 gram per square centimeter of surface.

2. Polyethylene-Coated Burlap:

- a. Polyethylene-coated burlap shall be 4 mils thick white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard and shall conform to Fed. Spec. CCC-C-467. The loss of moisture when determined in accordance with ASTM C 156 shall not exceed 0.055 gram per square centimeter of surface.
3. Liquid Membrane-Forming Compound:
 - a. Liquid membrane-forming compound shall conform to ASTM C 309, white-pigmented Type 2, and be free of paraffin or petroleum.
4. Liquid Chemical Compound Curing:
 - a. Liquid chemical compound curing shall 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. It shall not reduce the adhesion of paint, waterproofing or other material to be applied to the concrete. The chemical compound shall be free of petroleum resins or waxes. The loss of moisture when determined in accordance with ASTM C 156 shall not exceed 0.055 gram per square centimeter of surface. The abrasion loss shall not exceed 80 percent of that of the same concrete, untreated, when tested in accordance with ASTM C 418 at age 28 days. The adhesion to the treated concrete shall 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 shall be permitted to dry in air. The covering shall 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 6 to 10 inches long shall be made through the adhered covering, forming strips to one end of which a calibrated spring type balance or other device shall be attached. The strips shall be peeled off at a rate of 2 to 100 inches per minute. The pull required to peel the covering from the slabs shall be the average of three specimens.
- J. Chemical Floor Hardener:
 1. Chemical Floor Hardener: All concrete floor slabs, both interior and exterior, not having an additional applied finish, shall have a liquid concrete hardener applied in accordance with the manufacturer's recommendations. Acceptable hardeners are:

a.	Sonneborn	Lapidolith
b.	Chem-Masters	Sciolith
c.	W.R. Meadows	Pena-lith
d.	Protex	Lithoplate
- K. Joint-Sealing Materials:
 1. Joint-sealing materials shall conform to ASTM D 1850.

- L. Expansion Joint Filler:
 - 1. Expansion joint filler shall be preformed type conforming to ASTM D 1751.
- M. Slots and Inserts for Masonry Anchors:
 - 1. Dovetail Anchor Slots:
 - a. Dovetail anchor slots shall be formed of zinc-coated sheet steel, U.S. 24 minimum gage, provided in concrete faced with or abutting masonry.
 - 2. Inserts:
 - b. Inserts shall be formed of 9 minimum gauge zinc-coated steel wire, engaged between a two-piece half-round wood core, and having loops for embedding in concrete.
- N. Epoxy Bonding Compound:
 - 1. Epoxy bonding compound shall conform to ASTM C881.
- O. Vapor Barrier:
 - 1. Vapor barrier shall be polyethylene sheet .006 inch (6 mil) thickness of widest practicable widths. See Construction Drawings for locations.

PART 3 - EXECUTION

03020 – 3.1 FIELD QUALITY CONTROL

- A. Air Entrainment:
 - 1. Determine the air content of concrete in accordance with the recommendations of ASTM C231.
- B. Testing of Concrete:
 - 1. General requirements:
 - a. Compression test cylinders for all concrete pours shall be made at the Contractor's expense by an independent testing laboratory approved by the Project Manager 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.
 - b. Furnish two (2) copies of each report to the Project Manager 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.
 - c. 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 2-day, 7-day, and 28-day compressive strength. The tests for 2-day compressive strength, approximately 25 percent of the 28-day compressive strength, will be used to aid in the determination of form, falsework and centering removal. The tests for 7-day compressive strength, approximately 60 percent of the 28-day compressive strength,

- will be likewise used.
- d. 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 reserves the right to have the concrete tested as often as he deems necessary.
 - e. Submit a delivery ticket from the concrete supplier to the Project Manager before unloading at the site for each batch delivered to the site setting forth the following information:
 - (1) Name of supplier
 - (2) Name of batching plant and location
 - (3) Serial number of ticket
 - (4) Date
 - (5) Truck number
 - (6) Specific job designation (contract number and location)
 - (7) The volume of concrete (cubic yards)
 - (8) Specific class and type of concrete (in conformance with the specification requirement)
 - (9) Time loaded
 - (10) Type and brand of cement
 - (11) Weight of cement
 - (12) Maximum size of aggregates
 - (13) Weights of coarse and fine aggregates, respectively
 - (14) Maximum amount of water to be added and amount of water added at the site, if any
 - (15) Kind and amount of admixtures
2. 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. Air content:
 - a. Determine in accordance with ASTM C231.
 4. Cement factor:
 - a. Determine in accordance with ASTM C138.
 5. Modulus of elasticity:
 - a. Determine the modulus of elasticity and Poisson's Ratio in accordance with ASTM C469 as directed by the Structural Engineer.
 6. Slump:
 - a. Determine in accordance with ASTM C143.
 7. Unit Weight:
 - a. Determine the unit weight in accordance with ASTM C138 as directed by the Structural Engineer.

C. Design Mix:

1. Specified 28 days compressive strength of concrete shall be as follows:
 - a. $f'_c = 4000$ psi for all structurally reinforced concrete work.
 - b. $f'_c = 3000$ psi concrete for exterior work and all flatwork underfoot, such as walks, steps, ramps, drives, and porch floors: Also use for pipe thrust blocking and masonry cell fill.

<u>Mag. Agg. Size</u>	<u>Air Content (% by Vol.)</u>
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 shall have a maximum of 5-1/2 gal. 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.

2. Mix Proportioning:

- a. Mix proportioning for waste water treatment structures shall 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:

- (1) Maintain a minimum water to cement ratio consistent with the point of placement.
- (2) Provide the following minimum cement content:
ASTM C33 Coarse Aggregate No. & Lbs. per cu yd

467	517
57 or 67	564

- (3) Provide air entrainment as follows:

5 + 1% - coarse aggregate no. 467
6 + 1% - coarse aggregate no. 57 or 67

D. Classes of Concrete:

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.
2. When class is not indicated use 3,000 psi concrete.
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.

E. Minimum Cement Factor:

1. 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
Less than 3,000	4.5

03020 - 3.02 MATERIAL PREPARATION

A. Concrete Production:

1. Ready Mix Concrete:
 - a. Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C94. Plant equipment and facilities shall conform to "Certification of Ready Mixed Concrete Production Facilities of the National Ready Mixed Concrete Association."
2. On-site Batching:
 - a. Concrete produced by on-site volumetric batching and continuous mixing shall be batched and mixed in accordance with and shall conform to all requirements of ASTM C685.

B. Admixtures:

1. Air entraining admixture:
 - a. Use for concrete exposed to weathering or in contact with rock or moist soil.
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. Use calcium chloride only as specifically authorized in writing by the Project Manager. Do not use calcium chloride in prestressed concrete, underground structures, reinforced concrete, or in concrete used to encase or in contact with structural steel or cast iron.

C. Consistency:

1. Slump shall not exceed 2-inches above design mix slump as approved by the Engineer, and shall be kept at a practical minimum for the point of placement.

D. Construction Joints:

1. Joints not shown on the Construction Drawings shall be made and located so as to not impair the strength of the structure and shall 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 shall be at the underside of floors, slabs, beams, or girders and at the top of footings of grade slabs. Joints shall be perpendicular to the main reinforcement.
 - a. Reinforcement in Construction Joints:
All reinforcing steel and welded wire fabric shall be continued across joints. Keys and inclined dowels shall be provided as indicated. Longitudinal keys at least 1-1/2 inches deep shall be provided in all joints in walls and between walls and slabs or footings.
 - b. Preparation of Surface:
The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed.
 - c. Bonding:
When a bonded construction joint is required, bond shall be obtained by one of the following methods.
2. The use of a bonding compound for concrete, conforming to Mil. Spec. MIL-B-19235.
3. The use of suitable chemical retardant which delays but does not prevent setting of the surface mortar. Retarded mortar shall be removed within 24 hours after placing to produce a clean exposed aggregate bonding surface.
4. By roughening the surface of the concrete in proper manner which will expose the aggregate uniformly and damaged concrete at the surface.

E. Expansion Joints, Cleavage Joints, Waterstops and Embedded Items:

1. Expansion Joints and Cleavage Joints:
 - a. Expansion joints shall be provided in any structure having a dimension of 120 feet in any principal direction. Desirable maximum spacing is 50 to 60 feet. Reinforcement shall stop 2 inches from the face of an expansion joint. Expansion joints and cleavage joints shall not be less than 1/2-inch wide except as indicated otherwise. Expansion joints not exposed to weather shall be filled completely with preformed joint material conforming to ASTM D 1751. Expansion joints exposed to weather and cleavage joints between vertical masonry surfaces and floor slabs laid on earth shall 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 D 1751. The one-inch deep space above the preformed material shall 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, shall not be permitted to extend continuously

through any expansion joint.

2. Waterstops:
 - 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 shall have placed in the joint a waterstop to develop effective watertightness. Wet space shall include tanks, channels, chambers, etc. used to store, convey or contain fluids or solids containing fluids.
 - b. The material, design, and location of waterstops in construction joints and expansion joints shall be as indicated or as specified herein. Each piece of premolded waterstop shall 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 shall be made in the manner most appropriate to the material being used. Joints shall develop effective watertightness fully equal to that of the continuous waterstop material and shall permanently develop not less than 50 percent of the mechanical strength of the parent section and shall permanently retain its flexibility.
3. Other Embedded Items:
 - a. All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support be placed prior to concreting. All sub-contractors, whose work is related to the concrete or must be supported by it, shall be given ample notice and opportunity to introduce or furnish embedded items before the concrete is placed. 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 shall be galvanized.
4. Placing Embedded Items:
 - a. Expansion joint material, waterstops, and embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids. Aluminum shall not be embedded in concrete except where aluminum is protected from direct contact with the concrete.
5. Reinforcing Bars:
 - a. 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 shall be subject to the approval of the Project Engineer.

03020 - 3.3 CONVEYING

- A. General Requirements:
 1. Convey concrete from the point of delivery with a continuous flow of concrete to

the point of placement without segregation.

2. Provide an arrangement at the discharge end of a conveyor to prevent segregation.
- B. Chutes and Troughs:
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.
 2. Discharge the water used for cleaning outside the lines of the structure.
- C. Adjustable Length Pipes (Elephant Trunks):
1. Use flexible pipes only of ferrous metal, rubber or plastic, six-inches minimum diameter and use in a manner that will not cause segregation of the concrete.
 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. Thoroughly clean flexible pipes or elephant trunks after each use.
- D. Buggies:
1. 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.
- E. Pumping Equipment:
1. Use pumping equipment, designed to handle the types, classes and volumes of concrete to be conveyed without segregation.
 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.

03020 - 3.4 PREPARATION FOR PLACEMENT

- A. 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. All surfaces of forms and embedded materials shall be cleaned of dried mortar or grout from previous pours. Poorly consolidated concrete at construction joints and all loose material shall be removed. Surfaces of concrete and embedded materials shall be cleaned of laitance, or oil and other bond destroying agents.
- B. Surfaces against which concrete is to be placed shall be clean and free of running water, mud, loose material, oil, debris, frost and ice. Rock surfaces shall be free of semidetached and unsound fragments. Absorptive foundation surfaces shall be moistened thoroughly or otherwise treated so that moisture will not be drawn from freshly placed concrete.
- C. Coat faces of removable concrete forms with form oil approved by the Project Manager.

03020 - 3.5 PLACEMENT**A. General Requirements:**

1. Place concrete continuously and as soon as possible after mixing. Do not use vibrators for shifting the mass of fresh concrete.
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. Do not place concrete which has attained its initial set or concrete which has contained its mix water for more than 90 minutes.
4. Notify the Project Manager at least 24 hours in advance of the start of concrete placing.
5. Placing will not be permitted when, in the opinion of the Project Manager, the sun, heat, wind or limitations of facilities furnished prevent proper finishing and curing.
6. Control concrete temperature at time of placement:
 - a. To be not less than 45° F
 - b. To be not more than 90° F
7. Unless approved by the Project Manager, do not start concreting when descending natural air temperature falls lower than 40° F.
8. Start placement of structural concrete on/or next to a construction joint with a 3-inch thick layer of oversanded mix with 3/4-inch maximum aggregate, an extra sack of cement per cubic yard, and a five-inch slump.
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 dropchute, use one or more vibrators where concrete is falling to prevent stacking and separation.
10. Place formed concrete, in continuous, approximate horizontal layers, the depth of which generally shall 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.

B. Compaction:

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 revibrate concrete in the upper zone of the underlying layers.
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. 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 oversanded or high in slump and may occasionally be of lower slump than intended.

03020 - 3.6 CURING AND PROTECTING

A. General Requirements:

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

B. Normal Curing And Protection:

(Use any one of the methods specified below:)

1. Use ponding on horizontal surfaces providing the surface is submerged at all time for the required curing period.
2. Apply continuous sprinkling with nozzle or nozzles which, during the first 24 hours, atomizes the follow of water providing a mist and not a spray. Do not apply the moisture under pressure directly upon the concrete and avoid flowing or washing on the surfaces while susceptible to erosion.
3. 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.
4. Sprinkle, as specified above, for at least 18 hours and then immediately cover the concrete surface with water proof 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.
5. Do not damage burlap or waterproof sheet or concrete surfaces.

C. Membrane-Forming Curing Compound:

1. Use a curing compound when authorized for circumstances where the application of moisture is impracticable and where such 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.

2. Where the surfaces are subjected to sunlight, apply Type 2 White compound.
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, dampproofing, waterproofing, or roofing is to be applied.
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.
5. Give surfaces the required surface finish prior to the application of the curing compound. Do not use curing compound on construction joints.
6. Apply curing compound in two coats, apply the first coat immediately after stripping of forms and acceptance of the concrete finish.
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.
8. Protect the coating against damage for a period of at least 10 days after application. Apply an additional coating to coatings which are damaged.

03020 - 3.7 WEATHER PROTECTION

- A. Concrete shall not be placed during rain or freezing weather unless approved measures are taken to prevent damage to concrete. Concrete placed during periods of high winds, low humidity, high temperatures, and other conditions causing rapid drying shall be initially cured with a fine fog spray of water applied immediately after finishing and maintained until final curing operations are started. Under hot weather conditions, steps shall be taken to reduce concrete temperature and water evaporation by proper attention to ingredients, production methods, handling, placing, protection, and curing. Subject to approval, applicable preventive measures shall be taken for placing concrete during hot and cold weather in conformance with ACI Reports 305 R-77 and 306R, dated May 1978, respectively entitled, "Hot Weather Concreting", and "Cold Weather Concreting".

03020 - 3.8 DEFECTIVE CONCRETE

- A. Concrete will be considered defective if it is structurally unsound, not watertight, improperly finished, or not within the tolerances specified herein.
 1. 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. 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.
 2. Windsor probe tests conducted in conformance with ASTM, C-803 may be conducted by the laboratory if approved by the Project Manager in lieu of taking and testing core specimens.

- 3. The Project Manager, at his 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.

03020 - 3.9 DAMAGED WORK

- A. Before final acceptance of the work, damage to surfaces, corners of concrete and concrete finish, whether such damage shall have resulted from the action of the elements or damage from any cause whatsoever, shall be neatly repaired, as approved by Project Manager at no additional cost to the County.
- B. At damaged places where surface repairs are permitted, the concrete shall be chipped out and a concrete patch installed. The patch shall have a minimum thickness of two-inches, shall be dense and watertight to meet specification requirements, and shall have a smooth exposed surface matching the neat line of adjacent concrete.

03020 - 3.10 TOLERANCE FOR CONCRETE CONSTRUCTION

- A. Permissible surface irregularities are defined as "finishes," and are to be distinguished from tolerances as described herein.
- B. Allowable tolerances are:
 - 1. Structures:
 - Departure from established alignment 1 inch
 - Departure from established grade 1 inch
 - Variation from the plumb in the lines and surfaces of columns, piers, and walls exposed, in 10 ft..... 1/2 inch
 - Backfilled, in 10 ft. 1 inch
 - Variation in the level or from grades specified in slabs and beams exposed, in 10 ft..... 1/2 inch
 - Backfilled, in 10 ft. 1 inch
 - Variation in cross-sectional dimensions of columns, piers, slabs, walls and beams minus. 1/4 inch
 - plus..... 1/2 inch
 - Variation in sizes and locations of slab and wall openings. 1/2 inch

END OF SECTION