CITY OF FORT WAYNE MASTER UPDATED: 03/12/2018

SECTION 03 00 05

CONCRETE

NTS: This specification section includes information for projects with minor, uncomplicated concrete work, particularly for small, general-use construction, such as cast in place structures, that are not water retaining structures. Note that this section is referenced by other specification sections that are typically used for linear utility projects. For example Section 33 49 13 Storm Drainage Manholes references this section for the concrete requirements of manhole flow channels and inverts. Include this section in the project manual as applicable, edit and delete items based on project specific requirements.

For larger concrete projects, specifier may choose to separate concrete, reinforcement, formwork, and accessories into separate, more detailed specifications.

1. GENERAL
	1. DESCRIPTION
		1. Scope:
			1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete, forming, reinforcing, and related materials.
			2. The Work includes:
				1. Providing concrete consisting of Portland cement, fine and coarse aggregates, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured.
				2. Fabricating and placing reinforcing, including ties and supports.
				3. Design, erection, and removal of formwork.
				4. Building into the concrete all sleeves, frames, anchorage devices, inserts, and other items required to be embedded in concrete.
				5. Providing openings in concrete as required to accommodate Work under this and other Sections.
		2. Coordination:
			1. Review installation procedures under other Sections and coordinate installation of items to be installed in the concrete Work.

NTS: Edit the applications for Class “A” and Class “B” to suit project. Delete or add additional concrete classifications if required.

* + 1. Classifications of Concrete:
			1. Class “A” concrete includes the following:
				1. Sidewalks
				2. Curbs
				3. Gutters
				4. Drives
				5. Steel-reinforced structures
				6. All other concrete unless otherwise shown or indicated.
			2. Class “B” concrete shall be placed without forms or with simple forms, with little or no reinforcing and includes the following:
				1. Concrete fill.
				2. Duct banks.
				3. Unreinforced encasements.
				4. Thrust blocks.
	1. MEASUREMENT AND PAYMENT

NTS: Retain one version of the two below for concrete payment and delete the other. One section is for unit price payments and the other section “A” for lump sum payments.

Unit Price - Adjust paragraph below for additional work item numbers as needed.

* + 1. Concrete: (Unit Price)
			1. Work Item Number and Title

 **03 00 05- A Concrete**

* + - 1. Payment for concrete is to be on a unit price basis as noted in the Bid Schedule.
			2. The payment quantity shall be per cubic yard of concrete placed. This includes, but is not limited to formwork, reinforcing, concrete, finishing and testing.

 A. Concrete: (Lump Sum )

1. Work Item Number and Title

 **03 00 05- A Concrete**

2. Payment for Concrete Work shall be a lump sum price.

3. The lump sum price shall constitute full compensation for providing all labor, materials, and equipment, both temporary and permanent, and all other cost associated with the installation of concrete. This includes, but is not limited to formwork, reinforcing, concrete, finishing and testing.

* 1. REFERENCES

NTS: Retain applicable standards and add others as required.

* + 1. Standards referenced in this Section are listed below:
			1. American Concrete Institute.
				1. ACI 214R, Evaluation of Strength Test Results of Concrete.
				2. ACI 224R, Control of Cracking in Concrete Structures.
				3. ACI 301, Specifications for Structural Concrete.
				4. ACI 304R, Guide for Measuring, Mixing, Transport­ing and Placing Concrete.
				5. ACI 305R, Hot Weather Concreting.
				6. ACI 306R, Cold Weather Concreting.
				7. ACI 309R, Guide for Consolidation of Concrete.
				8. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
				9. ACI 347, Guide to Formwork for Concrete.
				10. ACI SP-66, ACI Detailing Manual.
			2. ASTM International.
				1. ASTM A185/A185M, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
				2. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
				3. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
				4. ASTM C33/C33M, Specification for Concrete Aggregates.
				5. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
				6. ASTM C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
				7. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
				8. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
				9. ASTM C143/C143M, Test Method for Slump of Hydraulic-Cement Concrete.
				10. ASTM C150/C150M, Specification for Portland Cement.
				11. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
				12. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
				13. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
				14. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
				15. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.
				16. ASTM C579, Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
				17. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
				18. ASTM C989, Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
				19. ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
				20. ASTM C1077, Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
				21. ASTM D1752, Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
				22. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials
				23. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
				24. ASTM E1745, Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
			3. U.S. Army Corps of Engineers.
				1. CRD-C 572, Specification for Polyvinylchloride Waterstops.
			4. Concrete Reinforcing Steel Institute.
				1. CRSI 1MSP, Manual of Standard Practice.
			5. NSF International.
				1. NSF 61, Drinking Water System Components – Health Effects.
	1. QUALITY ASSURANCE

NTS: Edit Section “A” below for project requirements. Edit Section A below if manufacturer’s certificate of tests is not acceptable. Delete Section C below, as required, if less than 100 cyds of concrete is to be used or if trial batch testing is not required. Coordinate this section with submittal requirements in Section 1.5 and field quality control in Section 3.9

* + 1. Concrete Testing Laboratory Qualifications:
			1. All standard tests specified in this Section and elsewhere shall be arranged by the Contractor. They shall be conducted by an approved independent laboratory and will be made at the expense of the Contractor, unless specifically noted otherwise.
				1. Testing agency shall be in accordance with ASTM E329 and ASTM C1077.
				2. Testing laboratory shall have been inspected and passed within previous two years by Cement and Concrete Reference Laboratory (CCRL) of NIST for: testing concrete aggregates, and for preparing and testing concrete trial batches with or without admixtures. Testing laboratory shall provide documentation indicating how deficiencies, if any, in most recent CCRL inspection report were corrected.
				3. Selection of testing laboratory is subject to Owner’s acceptance.
		2. Concrete Material Testing:
			1. A test shall be made, in advance, of cement, fine aggregate, coarse aggregate, and reinforcing steel used in the Work covered by this specification; and unless specifically stated otherwise, the ASTM test and specification for the type and class of material indicated shall be used for the test. A manufacturer’s certificate of tests will generally be accepted by Engineer.
		3. Laboratory Trial Batch Testing
			1. Where more than 100 cubic yards of concrete are required for the entire Project, advance tests of each concrete mix design used shall be made by an independent laboratory in accordance with ASTM C39 and ASTM C33. Perform the following testing on each trial batch:
				1. Aggregate gradation for fine and coarse aggregates.
				2. Slump.
				3. Air content.
				4. Compressive strength based on 8 cylinders of each mix design; 4 tested at 7 days and 4 tested at 28 days.
				5. Water content for mix designs shall be varied to produce values for water to content-strength curves.
			2. Submit for each trial batch the following information:
				1. Project identification name and number (if applicable).
				2. Date of test report.
				3. Complete identification of aggregate source of supply.
				4. Tests of aggregates for compliance with the Contract Documents.
				5. Scale weight of each aggregate.
				6. Absorbed water in each aggregate.
				7. Brand, type, and composition of cementitious materials.
				8. Brand, type, and amount of each admixture.
				9. Amounts of water used in trial mixes.
				10. Proportions of each material per cubic yard.
				11. Gross weight and yield per cubic yard of trial mixtures.
				12. Measured slump.
				13. Measured air content.
				14. Compressive strength developed at 7 days and 28 days, from not less than 4 test cylinders cast for each 7 day and 28-day test, and for each design mix.

NTS: On small projects where structures are not liquid-retaining, Paragraph “D” may be retained so the Contractor has the option to use Paragraph “D” as an alternative to a trial batch. For larger projects and for projects with liquid-retaining structures delete Paragraph “D”.

* + 1. Certification of Concrete Mix:
			1. The requirement for trial batch will be waived upon compliance with requirements of this Paragraph. Verify compressive strength of each specified mix by data from series of at least 30 consecutive tests that have been made within previous 12 months. Test is the average strength of all specimens of the same age fabricated from sample taken from a single batch of concrete. Tests shall have been made on concrete with identical mix design to mix design proposed for the Work, including sources of aggregate and manufacturers of cementitious materials and admixtures. Tests shall average above specified strength with no individual test falling more than 500 psi below specified strength and no three consecutive tests averaging below specified strength. Standard deviation for series of tests shall not exceed 640 psi in accordance with ACI 214.
	1. SUBMITTALS
		1. Action Submittals: Submit the following:
			1. Shop Drawings:
				1. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI SP-66. For walls and masonry construction, provide elevations to a minimum scale of 1/4 inch to 1 foot. Show bar schedules, stirrup spacing, adhesive dowels, splice lengths, diagrams of bent bars, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing.

NTS: Delete Paragraph “b” below if not required

* + - * 1. Concrete placement Drawings showing the location and type of all joints.
			1. Product Data:
				1. List of concrete materials, concrete accessories, grout material, and concrete mix designs proposed for use. Include results of material tests or manufacturer certificate of tests performed to qualify the materials and to establish the mix designs.
				2. Manufacturers’ Specifications with application and installation instructions for proprietary material and items, including admixtures and bonding agents.

NTS: Delete Paragraph “c” if not required under Section 1.4.

* + - * 1. Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.
		1. Informational Submittals: Submit the following:

NTS: Delete Paragraph “1” if not required.

* + - 1. Delivery Tickets: Copies of all delivery tickets for each load of concrete delivered to or mixed at the Site. Each delivery tickets shall contain the information in accordance with ASTM C94/C94M along with Project identification name and number (if any), date, mix type, mix time, quantity and amount of water introduced.
			2. Site Quality Control Submittals: Report of testing results for testing of field concrete cylinders for each required time period. Submit within 24 hours after completion of associated test. Test report shall include results of all testing required at time of sampling.
			3. When requested by Engineer, submit Shop Drawings showing and indicating general construction of individual forms, including:
				1. Jointing.
				2. Special formed joints or reveals.
				3. Location, pattern, and details of form tie placement, removal, and repair procedures.
				4. Location and details for temporary openings.
	1. PRODUCT DELIVERY, STORAGE AND HANDLING
		1. Transportation, Delivery, and Handling:
			1. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.
			2. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.
			3. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.
			4. Deliver grout materials from manufacturers in unopened containers that bear intact manu­facturer labeling.
			5. Comply with Section 01 65 00, Product Delivery Requirements.
		2. Storage:
			1. Store formwork materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.
			2. Store concrete reinforcing materials to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does not come into contact with the ground. Space framework or blocking supports to prevent excessive deformation of stored materials.
			3. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight.
			4. For storage of concrete materials, provide bins or platforms with hard, clean surfaces.
			5. Comply with Section 01 66 00, Product Storage and Handling Requirements.

NTS: In “Part 2”, delete material types not required. Edit materials to suit the project.

1. PRODUCTS
	1. GENERAL
		1. All cementitious materials, admixtures, curing compounds and other industrial produced material used in concrete, or for curing or repairing of concrete, that can contact potable water or water that will be treated to become potable shall be listed in NSF 61.
	2. CEMENTITIOUS MATERIALS

NTS: In Paragraph “A”, edit to require TYPE II or type II(MH) cement when the concrete will be subject to liquids, chemicals, or is in contact with soils with high sulfate content.

* + 1. Cement:
			1. Portland cement shall be Type I or Type I/II ASTM C150/C150M.
			2. Portland cement shall be produced by one facility. Alternate cement sources may be used provided that mix design has been approved and acceptable trial batch verifying performance has been made.
			3. Do not use cement that has deteriorated because of improper storage or handling.
	1. AGGREGATES

NTS: Class designation “4S” is for northern weather regions.

* + 1. General:
			1. Aggregate shall conform to ASTM C33, Class Designation 4S, and as specified in this Section.
			2. Do not use aggregates containing soluble salts or other substances, such as iron, sulfides, pyrite, marcasite, ochre or other materials that can cause stains on exposed concrete surfaces.
		2. Fine Aggregate:
			1. Provide clean, sharp, natural sand that is free of loam, clay, lumps and other deleterious substances is acceptable.

NTS: Delete Paragraph “2” below if other sand is allowed.

* + - 1. Dune sand, bank run sand and manufactured sand are unacceptable.
		1. Coarse Aggregate:
			1. Provide clean, uncoated, processed aggregate containing no clay, mud, loam or foreign matter, as follows:
				1. Crushed stone, processed from natural rock or stone.
				2. Washed gravel, either natural or crushed. Slag, pit gravel and bank run gravel are unacceptable.
	1. WATER
		1. Water: Water used in producing and curing concrete shall be clean and free of injurieous quantities of oils, acids, alkalis, organic materials and other substances that may be deleterious to concrete and steel.
	2. CONCRETE ADMIXTURES
		1. Provide admixtures in accordance with product manufacturer’s published instructions. Admixtures shall be compatible with each other. Admixtures shall not contain thiocyanates, shall not contain more than 0.05 percent chloride ion, and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise approved by Engineer.
		2. Air Entraining Admixtures: ASTM C260.
			1. Air entraining admixture shall be vinsol resin or vensol rosin-based.
		3. Water‑Reducing Admixture: ASTM C494, Type A.
			1. Proportion Class “A”, and Class “B” concrete with non‑air entraining, normal setting, water‑reducing, aqueous solution of modified organic polymer. Admixture shall not contain lignin, nitrates, or chlorides added during manufacturing.
		4. High Range Water‑Reducing Admixture (HRWR): ASTM C494, Type F/G.
			1. Use high range water‑reducing admixture in the concrete classifications so specified or indicated. Use of HRWR admixture is allowed at Contractor’s option in all other classifications of concrete. When used, HRWR admixture shall be added to concrete in accordance with admixture manufacturer’s published instructions. Specific admixture formulation shall be as recommended by admixture manufacturer for Project conditions.
		5. Set Control Admixtures: In accordance with ASTM C494. Use the following as required:
			1. Type B, Retarding.
			2. Type C, Accelerating.
			3. Type D, Water reducing and Retarding.
			4. Type E, Water reducing and Accelerating.
			5. Type F, Water-reducing, high range admixtures.
			6. Type G, Water-reducing, high range, and retarding admixtures.
		6. Calcium Chloride: Do not use calcium chloride.

NTS: Edit concrete classifications to suite the project. Note that concrete mixes are commonly referred to by the number of cement bags included into the batch. For conversion, there are 94lbs of cement per bag.

* 1. PROPORTIONING AND DESIGN OF MIXES
		1. Prepare concrete design mixes in accordance with Table 03 00 05-A:

TABLE 03 00 05-A

CONCRETE DESIGN MIX CRITERIA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Concrete Class** | **Coarse Aggregate(1)** | **Minimum** | **Max. W/CM(4)** | **Slump(2)** | **Air****(%)** | **Min 28 day. Comp****Strength(3) (psi)** |
| **Size A** | **Size B** | **Cementitious (lbs/cu yd)** |
| Class “A” | No. 57 | No. 8 | 564 | 0.45 | 4" max. | 6 +/- 1 | 4,000 |
| Class “B” | No. 57 or No. 67 |  | 517 | 0.50 | 4" max. | 6 +/- 1 | 3,000 |

Notes Applicable to Table 03 00 05-A:

* + - 1. Coarse aggregate size numbers refer to ASTM C33. Where Size A and B are designated in Table 03 00 05-A, it is intended that the smaller Size B aggregate is to be added, replacing a portion of the coarse or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with sand content not exceeding 41 percent of total aggregate.
			2. Slumps indicated are prior to addition of high range water reducer (super plasticizer).
			3. Mix designs shall be made so that the compressive strength achieved for laboratory trial batches will not be less than 125 percent of specified design strength.
			4. Quantity of water to be used in the determination of water-cementitious materials (W/CM) ratio shall include free water on aggregates in excess of SSD and water portion of admixtures.
		1. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, Site conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as approved by Engineer. Before using adjusted concrete mixes, laboratory test data and strength results shall be submitted to and approved by Engineer.
		2. Admixtures:
			1. Use air-entraining admixture in concrete, unless otherwise shown or indicated. Add air-entraining admixture at admixture manufacturer’s prescribed rate to produce concrete at point of placement having air content within prescribed limits.
			2. Use water-reducing or high-range water-reducing admixtures in all Class “A” concrete.
			3. Use amounts of admixtures recommended by admixture manufacturer for climatic conditions prevailing at the Site at time of placing. Adjust quantities and types of admixtures as required to maintain quality.
		3. If adding water at the Site is desired, withhold water at the batch plant so that specified water-cement (or cementitious material) ratio is not exceeded. Addition of water shall be accordance with ASTM C94. After high-range water-reducing admixture is incorporated into the batch, addition of water is not allowed.

NTS: Edit Article “2.7” to include other specific form requirements, such as rustications, liners, etc., as required.

* 1. FORMS
		1. Design Criteria:
			1. Design, erect, support, brace and maintain forming in accordance with ACI 347 so that forming safely supports vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by forming system or in‑place construction that has attained adequate strength for the purpose. Construct forming so that concrete members and structures are of correct size, shape, alignment, elevation, and position.
			2. Design forms and falsework to include values of live load, dead load, weight of moving equipment operated on forming, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
			3. Provide shores and struts with positive means of adjustment capable of taking up forming settlement during concrete placing operations, using wedges or jacks, or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.
			4. Support form facing materials by structural members spaced sufficiently close to prevent beyond tolerance deflection, in accordance with ACI 117. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances. For long-span members without intermediate supports, provide camber in forming as required for anticipated deflections resulting from weight and pressure of fresh concrete and construction loads.
			5. Design and construct forming to be readily removable without impact, shock or damage to concrete surfaces and adjacent materials.
			6. Provide forming sufficiently tight to prevent leakage of cement paste during concrete placing. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.
		2. Form Materials:
			1. Forms for Smooth Finish Concrete:
				1. Unless otherwise shown or indicated in the Contract Documents, construct forming for smooth concrete surfaces with plywood, metal, metal‑framed plywood‑faced, or other panel type materials acceptable to Engineer, to provide continuous, straight, smooth as‑cast surfaces with no wood grain or other surface texture imparted by forming. Provide in largest practical sizes to minimize number of joints and to conform to joint system shown or specified in the Contract Documents. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.
			2. Forms for Standard Finish Concrete:
				1. Form concrete surfaces designated to have standard formed finish with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least two edges and one side.

NTS: Edit Section “3” below if “snap ties” are not allowed and only removable ties are to be used.

* + - 1. Form Ties:
				1. Provide factory‑fabricated metal form ties, designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal.
				2. Unless otherwise shown or indicated in the Contract Documents, provide ties so that portion of tie remaining within concrete after removal of exterior parts of tie is at least 1.5 inches from the outer concrete surface. Unless otherwise shown or indicated in the Contract Documents, provide form ties that will leave a hole no larger than one‑inch diameter in concrete surface.
				3. Ties shall have waterstops on all exterior, below-grade walls, and walls subject to hydrostatic pressure.
				4. Ties shall leave a uniform, circular hole when forms are removed.
				5. Do not use removable ties unless accepted by Engineer. Removable ties are not allowed on exterior below-grade walls or walls subject to hydrostatic pressure. If removable ties are accepted, Contractor shall submit hole repair details for Engineer approval.
				6. Wire ties are not allowed.
				7. Do not use reinforcing bars shown by the Drawings as part of the form tie system unless approved by Engineer.
			2. Form Coatings:
				1. Provide commercial formulation form‑coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compounds. For concrete surfaces that will be in contact with potable water or water that will be treated to become potable, form coating shall be a mineral oil base coating.

NTS: Edit section “2.8” below based on project requirements. Delete if not used.

* 1. REINFORCING MATERIALS
		1. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed bars.
		2. Welded Wire Fabric: ASTM A185/A185M.
		3. Provide supports for reinforcing including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing in place.
			1. Use wire bar-type supports complying with CRSI MSP1 recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
			2. For slabs on grade, use precast concrete blocks, four inches square minimum with compressive strength equal to or greater than the surrounding concrete, or supports with sand plates or horizontal runners where base materials will not support chair legs.
			3. For all concrete surfaces where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic-protected, or stainless steel legs in accordance with CRSI MSP1.
			4. Provide precast concrete supports over waterproof membranes.

NTS: Delete Section “D” below if dowels are not used on project. If dowels are to be used; insert at (--1--) below adhesive product and installation requirements and specifications for each specific type of installation to be used.

* + 1. Adhesive Dowels:
			1. Dowels:
				1. Dowel reinforcing bars shall be deformed in accordance with ASTM A615, Grade 60.
			2. Adhesive:
				1. (--1--)

NTS: Delete from Article “2.9” materials that are not required.

* 1. RELATED MATERIALS
		1. Waterstops:
			1. PVC Waterstops:
				1. Manufacturers: Provide products of one of the following:

W.R. Meadows, Inc.

Greenstreak Plastic Products Company.

Or equal.

* + - * 1. Waterstops shall comply with CRD-C 572. Do not use reclaimed or scrap material.
				2. Minimum Thickness: 3/8 inch.
				3. Provide waterstops with minimum of 7 ribs equally spaced at each end on each side with the first rib located at the edge. Each rib shall be minimum 1/8 inch in height.
				4. Construction Joints: Waterstops shall be 6 inch wide flat-strip type.
				5. Expansion Joints: Waterstops shall be 9 inch wide centerbulb type.
			1. Hydrophilic Waterstops:
				1. Products and Manufacturers: Provide one of the following:

Duroseal Gasket, by BBZ USA, Inc.

Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.

Hydrotite, by Greenstreak Plastic Products Company.

Or equal.

* + - * 1. Hydrophilic waterstop materials shall be bentonite-free and shall expand by minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
				2. Waterstop material shall be composed of resins and polymers that absorb water and cause a completely reversible and repeatable increase in volume.
				3. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
				4. Select material in accordance with manufacturer’s recommendations for type of liquid to be contained.
				5. Minimum cross-sectional dimensions: 3/16 inch by 3/4 inch.
				6. Location of hydrophilic waterstops shall be as shown or indicated on the Drawings, or where approved by Engineer.
				7. Hydrophilic Sealant: Shall adhere firmly to concrete, metal, and PVC in dry or damp condition and be indefinitely elastic when cured.

Products and Manufacturers: Provide one of the following:

Duroseal Paste, by BBZ USA, Inc.

Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.

Hydrotite, by Greenstreak Plastic Products Company.

Or equal.

NTS: The vapor retarder must be compatible with other applied finishes. Refer to vapor retarder manufacturers’ literature. Use caution when coordinating use of vapor retarders with the requirements of chemical resistant coatings and concrete hardeners. Coordinate with project architect, together with coating requirements to determine if vapor retarders are required.

* + 1. Vapor Retarder:
			1. Products and Manufacturers: Provide one of the following:
				1. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.
				2. Griffolyn 10-mil, by Reef Industries.
				3. Moistop Ultra, by Fortifiber Industries.
				4. Or equal.
			2. Vapor retarder membrane shall comply with the following.
				1. Water Vapor Transmission Rate, ASTM E96/E96M: 0.04 perms or lower.
				2. Water Vapor Retarder, ASTM E1745: Meets or exceeds Class C.
				3. Thickness of Retarder (plastic), ACI 302 1R: Not less than 10 mils.
				4. Provide accessories by same manufacturer as vapor retarder.

NTS: Confirm the curing methods are compatible with any applied floor finishes or treatments. Coordinate with the project architect to determine if special floor treatments are required and edit Paragraph “C” accordingly or reference other section(s) as appropriate.

* + 1. Concrete Curing Materials:
			1. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.
			2. Curing Mats: Shall be heavy carpets or cotton mats, quilted at 4 inches on centers, and weighing minimum of 12 ounces per square yard when dry.
			3. Moisture-Retaining Cover: Provide one of the following, complying with ASTM C171:
				1. Waterproof paper.
				2. Polyethylene film.
				3. White burlap polyethylene sheet.

NTS: Paragraph “4” below specifies liquid membrane-forming curing compound. The curing compound must be compatible with other applied finishes. Refer to curing compound manufacturer’s literature. Use caution when coordinating the use of curing compounds with the requirements of chemical-resistant coatings and concrete hardeners.

* + - 1. Liquid Curing Compound: ASTM C309 Type 1‑D (water retention requirements):
				1. Provide fugitive dye.
				2. Curing compound shall be applied by roller or power sprayer.

NTS: Delete Paragraph “3” if not required.

* + - * 1. Product shall be listed in NSF 61.
		1. Epoxy Bonding Agent:
			1. Two-component epoxy resin bonding agent.
			2. Products and Manufacturers: Provide one of the following:
				1. Sikadur 32, Hi-Mod LPL, by Sika Corporation.
				2. Eucopoxy LPL, by the Euclid Chemical Company.
				3. Or equal.
		2. Epoxy-Cement Bonding Agent:
			1. Three-component blended epoxy resin-cement bonding agent.
			2. Products and Manufacturers: Provide one of the following:
				1. Sika Armatec 110 EpoCem, by Sika Corporation.
				2. Duralprep A.C., by Euclid Chemical Company.
				3. Or equal.
		3. Preformed Expansion Joint Filler:
			1. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).

NTS: Edit Section “G” below for specific project installation requirements. If joint sealants are to be used on water retaining structures or may be submerged in potable water, provide a separate joint sealant specification with additional requirements.

* + 1. Joint Sealant and Accessories Used on Isolation Joints, Control Joints, and Expansion Joints:
			1. Before purchasing each sealant, investi­gate its compatibility with joint surfaces, joint fillers, and other materials in joint system. Provide products that are fully compatible with actual installation condition, verified by manufacturer’s published data or certifica­tion, and as shown on approved Shop Drawings and other approved submittals.
			2. Do not install joint sealants when temperatures are below or above manufacturer’s recommended limitations for installation.
			3. Provide elastomeric joint sealants for interior and exterior joint applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
			4. Exterior and Interior Horizontal and Vertical Joints; Submerged and Intermittently Submerged in Wastewater:
				1. Provide one of the following two‑component Polyurethane Sealant:

Sikaflex- 2c NS by Sika Corporation.

Vulkem 227 by Tremco Sealant/Waterproofing Division of RPM International, Inc.

Or equal.

* + - 1. Exterior and Interior Vertical Joints; Non-submerged:
				1. Provide one of the following two‑component Polyurethane Sealant:

Sikaflex- 2c NS by Sika Corporation.

Dymeric 240 FC by Tremco Sealant/Waterproofing Division of RPM International, Inc.

Or equal.

* + - 1. Exterior and Interior Horizontal Joints; Non-submerged:
				1. Provide one of the following two‑component Polyurethane Sealant:

Sikaflex- 2c SL by Sika Corporation.

THC/900 by Tremco Sealant/Waterproofing Division of RPM International, Inc.

Or equal.

* 1. GROUT
		1. Non-shrink Grout:
			1. Pre-packaged, non-metallic, cementitious grout requiring only the addition of water at the Site.
			2. Minimum 28-day Compressive Strength: 7,000 psi.
			3. Products and Manufacturers: Provide one of the following:
				1. NS Grout by Euclid Chemical Company.
				2. Set Grout by Master Builders, Inc.
				3. NBEC Grout by Five Star Products, Inc.
				4. Or equal.
		2. Epoxy Grout:
			1. Pre-packaged, non-shrink, non-metallic, 100 percent solids, solvent-free, moisture-insensitive, three-component epoxy grouting system.
			2. Minimum Seven-day Compressive Strength: 14,000 psi, when tested in accordance with ASTM C579.
			3. Products and Manufacturers: Provide one of the following:
				1. Euco High Strength Grout, by Euclid Chemical Company.
				2. Sikadur 42, Grout Pak, by Sika Corporation.
				3. Five Star Epoxy Grout, by Five Star Products, Inc.
				4. Or equal.
		3. Grout Fill:
			1. Grout mix shall consist of cement, fine and coarse aggregates, water, and admixtures complying with requirements specified in this Section for similar materials in concrete.
			2. Proportion and mix grout fill as follows:
				1. Minimum Cement Content: 564 pounds per cubic yard.
				2. Maximum Water-Cement Ratio: 0.45.
				3. Maximum Coarse Aggregate size: 1/2 inch, unless otherwise indicated.
				4. Minimum 28-day Compressive Strength: 4,000 psi.
1. EXECUTION
	1. INSPECTION
		1. Concrete shall not be placed until the forms and reinforcement have been inspected and approved by the Engineer or their authorized representative.
	2. FORMWORK
		1. Construct formwork in accordance with ACI 347 such that concrete members and structures are of correct size, shape, alignment, elevation, and position.
		2. Provide openings in formwork to accommodate the Work of other trades. Accurately place and securely support items required to be built into formwork.
		3. Clean and adjust forms prior to placing concrete. All debris and ice shall be removed from the space to be occupied by the concrete. Apply form release agents or wet forms as required. Re-tighten forms during and after concrete placing, when required, to eliminate cement paste leaks.
		4. Removing Formwork:
			1. Comply with ACI 301 and ACI 347, except as otherwise indicated in the Contract Documents.
			2. Do not remove formwork and shoring until supported concrete members have acquired minimum of 90 percent of specified compressive strength. Results of suitable quality control tests of field-cured specimens may be submitted to Engineer for review as evidence that concrete has attained sufficient strength for removal of supporting formwork and shoring prior to removal times indicated in the Contract Documents.
			3. Removal time for formwork is subject to Engineer’s acceptance.
			4. Repair form tie-holes following in accordance with ACI 301.
	3. REINFORCING, JOINTS, AND EMBEDDED ITEMS
		1. Comply with the applicable recommendations of Laws and Regulations and standards referenced in this Section, including CRSI MSP1, for details and methods of placing and supporting reinforcing.
		2. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials which act to reduce or destroy bond between reinforcing material and concrete.
		3. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by means of metal chairs, runners, bolsters, spacers, and hangers, as required.
			1. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set with ties so that twisted ends are directed away from exposed concrete surfaces.
			2. Do not secure reinforcing to formwork using wire, nails or other ferrous metal. Metal supports subject to corrosion shall not be in contact with formed or exposed concrete surfaces.
		4. Provide sufficient quantity of supports of strength required to carry reinforcing. Do not place reinforcing more than two inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
		5. Splices: Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Provide sufficient lap to transfer the stress between bars by bond and shear (minimum 24 diameters).
		6. Install welded wire fabric in lengths as long as practical, lapping adjoining sections a minimum of one full mesh.
		7. Do not place concrete until reinforcing is inspected and Engineer indicates that conditions are acceptable for placing concrete. Concrete placed in violation of this paragraph will be rejected. Notify Engineer in writing at least two working days prior to proposed concrete placement.

NTS: Edit or add to Paragraph “H” below to suit the project.

* + 1. Joints:
			1. Provide construction, isolation, expansion, and control joints as indicated or required. Locate construction joints so as to not impair the strength and appearance of the structure. Place isolation and control joints in slabs-on-grade to stabilize differential settlement and random cracking.
			2. Locations of joints shall be in accordance with the Contract Documents and as approved by Engineer in the Shop Drawings.
			3. Where construction joints are indicated to be roughened, intentionally roughen surfaces of previously-placed concrete to amplitude of 1/4 inch.
		2. Installation of Embedded Items: Set and build into the Work anchorage devices and embedded items required for other Work that is attached to, or supported by, cast-in-place concrete. When applicable, coordinate with other sections and other contracts for locating and setting. Refer to Paragraph 1.1.B of this Section. Do not embed in concrete uncoated aluminum items. Where aluminum items are in contact with concrete surfaces, coat aluminum to prevent direct contact with concrete.

NTS: Delete Section “J” below if not required for project. If used coordinate with Section “2.4 e”.

* + 1. Adhesive Dowels:
			1. Adhesive dowels shall be reinforcing bar dowels set in an adhesive in hole drilled into hardened concrete. Comply with adhesive system manufacturer’s installation instructions regarding hole diameter, drilling method, embedment depth required to fully develop required tensile strength, and hole cleaning and preparation instructions. Unless more-stringent standards are required by adhesive system manufacturer, comply with the following.
			2. Drill holes to adhesive system manufacturer’s recom­mended diameter and depth to develop required tensile strength. Holes shall not be more than 1/4 inch greater than nominal bar diameter, and hole depth shall not be less than twelve times nominal bar diameter. Hammer-drill holes. Cored holes are not allowed.

NTS: Revise Paragraph “3” when the Engineer has test data that confirms the strength of existing concrete is 4,000 psi or greater; suggested revision is to replace “2,000 psi” with, “4,000 psi.”

* + - 1. Embedment depths shall be based on concrete compressive strength of 2,000 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.
			2. Determine location of existing reinforcing steel in vicinity of proposed holes prior to drilling. Adjust location of holes to be drilled to avoid drilling through or damaging existing reinforcing bars only when approved by Engineer.
			3. Before setting adhesive dowel, hole shall be free of dust and debris using method recommended by adhesive system manufacturer. Hole shall be brushed, with manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
			4. Inject adhesive into hole through injection system mixing nozzle and necessary extension tubes, placed to bottom of hole. Withdraw discharge end as adhesive is placed, but keep end of tube immersed to prevent forming air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placement.
			5. Twist dowels during insertion into partially-filled hole to guarantee full wetting of bar surface with adhesive. Insert bar slowly to avoid developing air pockets.
	1. CONCRETE PLACING
		1. Site Mixing: Use drum-type batch machine mixer, mixing not less than 1.5 minutes for one cubic yard or smaller capacity. Increase required mixing time by minimum of 15 seconds for each additional cubic yard or fraction thereof.
		2. Ready-Mixed Concrete: Comply with ASTM C94/C94M.
		3. Concrete Placing:
			1. Place concrete in a continuous operation within planned joints or sections in accordance with ACI 304R.
			2. Do not begin placing concrete until Work of other trades affecting concrete is completed.
			3. Wet concrete and subgrade surfaces to saturated surface dry condition immediately prior to placing concrete.
			4. For Structures other than precast manholes, deposit concrete as near its final location as practical to avoid segregation due to re-handling or flowing.
			5. Avoid separation of the concrete mixture during transportation and placing. Concrete shall not free-fall for distance greater than three feet during placing.
			6. Complete concrete placing within 90 minutes of addition of water to the dry ingredients.
		4. Consolidate placed concrete in accordance with ACI 309R using mechanical vibrating equipment supplemented with hand rodding and tamping, such that concrete is worked around placing and other embedded items and into all parts of formwork. Insert and withdraw vibrators vertically at uniformly-spaced locations. In no case shall a vibrator be extended into previously placed batches. Do not use vibrators to transport concrete within the formwork. Vibration of formwork or placing is not allowed.

NTS: Delete Section “E” below if cold weather placing is not expected on the project.

* + 1. Cold Weather Placing:
			1. Protect concrete Work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures, in compliance with ACI 306R and the Contract Documents.
			2. When air temperature has fallen to or may be expected to fall below 40 degrees F, provide adequate means to maintain tempera­ture in area where concrete is being placed between 50 degrees F and 70 degrees F for a period of seventy-two hours after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain temporary heating and protection as necessary so that ambient temperature does not fall more than 30 degrees F in the 24 hours following the seventy-two hour period. Avoid rapid dry‑out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
			3. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing for concrete as required to obtain concrete mixture temperature not less than 70 degrees F and not more than 90 degrees F at point of placement.
			4. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Before placing concrete, verify that forms, reinforcing, and adjacent concrete surfaces are entirely free of frost, snow, and ice.
			5. Do not use salt or other materials containing antifreeze agents. Do not use chemical accelerators or set‑control admixtures unless approved by Engineer and tested in mix design proposed for use.
			6. During pouring and curing periods, a permanent temperature record shall be kept showing the date, hour outside temperature at several points within the enclosure to show the most favorable and unfavorable conditions to which the concrete is subjected. Thermometer readings shall be taken at the start of Work in the morning and again in the late afternoon, and the data so obtained shall be recorded in such a manner that it will show the location of each reading and any conditions which might have an effect on the temperature. A copy of the temperature record shall be made available to the Engineer.
			7. Before concreting any section of a structure, the section shall be completely housed or enclosed in a manner that will provide the maintenance of the specified temperatures. The housing shall be left in place for the curing period specified. except that sections may be temporarily removed as required to accommodate the placing of column forms or concrete, provided that they are replaced immediately after the form or concrete is in its final position.
			8. In placing floor slabs, tarpaulins supported on horses or other framework shall follow closely the placing of the concrete so that only a few feet of the finished slab is exposed to the outside atmosphere at any one time. Such tarpaulins shall be arranged so that the heated air from the space below can circulate freely in the space between the tarpaulin and the freshly placed concrete. If necessary, in order to maintain the proper temperature between the slab and the tarpaulins, temporary openings may be left in the floor and forms to facilitate the circulation of warm air in this space. Such openings shall not exceed 18 inches in their greatest dimension.
			9. Top covers may be removed between the hours of 8:00 a.m. and 5:00 p.m. on days when the temperature is above 35 degrees F to permit erection of forms, but they shall be replaced not later than 5:00 p.m.
			10. Within the enclosure, such means of artificial heat shall be provided as will maintain the temperatures specified continuously and with reasonable degree of uniformity in all parts of the enclosure. All exposed concrete surfaces within the heated area shall be wet with a hose stream at least once every 24 hours during the hardening period, except where a stream curing is provided.
			11. The Contractor shall provide adequate fire protection accessible at all times where heating is in progress and shall maintain watchmen or other attendants to keep the heating units in continuous operation.
			12. Heating appliances shall not be placed in such a manner as to endanger form work or centering or expose any area of concrete to drying out or other injury due to excessive temperatures.

NTS: Delete Section “F” below if hot weather placing is not expected on the project.

* + 1. Hot Weather Placing:
			1. When hot weather conditions exist that would impair the quality and strength of concrete, place concrete in compliance with ACI 305R and the Contract Documents.

NTS: Edit concrete placement temperatures to suit the project.

* + - 1. When ambient air temperature is at or above 90 degrees F and rising, cool ingredients before mixing concrete to maintain concrete temperature at time of placement below 80 degrees F. When ambient air temperature is at or above 90 degrees F and falling, cool the ingredients before mixing concrete to maintain concrete temperature at time of placement below 85 degrees F. In no case shall the concrete temperature at time of placement exceed 90 degrees F.
			2. Mixing water may be chilled, or chopped ice may be used to control concrete temperature provided the water equivalent of ice is calculated in total amount of mixing water. If required, reduce the time from addition of mix water to placement, or use set-retarding admixture.
			3. Cover reinforcing materials with water‑soaked burlap if ambient air temperature becomes too hot, so that reinforcing material temperature does not exceed ambient air temperature immediately before embedment of reinforcing in concrete.
			4. Wet forms thoroughly before placing concrete.
			5. Do not place concrete at temperature that causes difficulty from loss of slump, flash set, or cold joints.
			6. Do not use set‑control admixtures unless approved by Engineer in mix design.
			7. Obtain Engineer's approval of substitute methods and materials proposed for use.
	1. QUALITY OF CONCRETE WORK
		1. Make concrete solid, compact, smooth, and free of laitance, cracks, and cold joints.
		2. Concrete for liquid-retaining structures and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
		3. Cut out and properly replace to the extent directed by Engineer, or repair to satisfaction of Engineer, surfaces that contain cracks or voids, are unduly rough, or are in defective in any way. Patches or plastering are unacceptable.
		4. Repair, removal and replacement of defective concrete directed by Engineer shall be at no additional cost to Owner.
	2. CURING
		1. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours. Continue curing by using moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until formwork is removed. Provide protection, as required, to prevent damage to exposed concrete surfaces. Total curing period shall not be less than seven days. Curing methods and materials shall be compatible with scheduled finishes.

NTS: Add to Article “3.7” other specific finish requirements, and delete finishes not required. Special finishes can include rubbed, grout cleaned, sandblasted, etc.

* 1. FINISHING
		1. Slab Finish:
			1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Use a wood float only. Check and level surface plane to a tolerance not exceeding 1/4 inch in ten feet when tested with a 10 foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, re-float the surface to a uniform, smooth, granular texture. Slab surfaces shall receive a float finish. Provide additional trowel finishing as required in this Section.
			2. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
			3. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8 inch in 10 feet when tested with a 10 foot straightedge. Grind smooth surface defects that would telegraph through applied floor covering system.
			4. Use trowel finish for the following:
				1. Interior exposed slabs, unless otherwise shown or indicated.
				2. Apply non-slip broom finish, after troweling, to exterior concrete slab and elsewhere as shown.
		2. Apply chemical floor hardener to exposed interior concrete floor areas when cured and dry, in accordance with hardener manufacturer’s instructions.
		3. Formed Finish:
			1. Provide smooth form concrete finish at exposed surfaces. Use largest practical form panel sizes to minimize form joints. Exposed surfaces include interior water-contacting surfaces of tanks, whether or not directly visible. All surfaces shall be considered as exposed, unless buried or covered with permanent structural or architectural material. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/8 inch in height. Where surface will be coated or will receive further treatment, remove all fins flush with concrete surface.
			2. Provide rough form finish at all unexposed surfaces. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/2 inch in height.

NTS: Delete Article “3.8” below when not required.

* 1. GROUT PLACING
		1. Place grout as shown and indicated, and in accordance with grout manufacturer’s instructions and recommendations. If grout manufacturer’s instructions conflict with the Contract Documents, notify Engineer and do not proceed until obtaining Engineer’s clarification.
		2. Dry-packing is not allowed, unless otherwise indicated.
		3. Manufacturers of proprietary grout materials shall make available upon 72 hours notice the services of qualified, full‑time, factory-trained employee to aid in providing proper use of grout materials at the Site.
		4. Placing grout shall comply with temperature and weather limitations described in Article 3.4 of this Section.
	2. FIELD QUALITY CONTROL
		1. Site Testing Services:
			1. Contractor shall employ independent testing laboratory to perform field quality control testing for concrete. Engineer will direct where Samples are obtained.
			2. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
			3. Contractor shall provide curing and necessary cylinder storage. Actual curing in the structure shall be closely paralleled.

NTS: Edit Section “B” below for project requirements. Add additional quality control tests as required, such as adhesive dowel testing, etc.

* + 1. Quality Control Testing During Construction:
			1. Perform sampling and testing for field quality control during concrete placing, as follows:
				1. Sampling Fresh Concrete: ASTM C172.
				2. Slump: ASTM C143/C143M; one test for each concrete load at point of discharge.
				3. Concrete Temperature: ASTM C1064/C1064M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
				4. Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
				5. Unit Weight: ASTM C138/C138M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
				6. Compression Test Specimens:

In accordance with ASTM C31/C31M, make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be four standard cylinders, unless otherwise directed by Engineer.

Cast, store, and cure specimens in accordance with ASTM C31/C31M.

* + - * 1. Compressive Strength Tests:

In accordance with ASTM C39/C39M; 1 specimen tested at 7 days, and 3 specimens tested at 28 days.

Concrete that does not comply with strength requirements will be considered as defective Work.

* + - * 1. Within 24 hours of completion of test, testing laboratory will transmit certified copy of test results to Contractor and Engineer.
				2. When there is evidence that strength of in‑place concrete does not comply with the Contract Documents, Contractor shall employ the services of a concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42/C42M.

+ + END OF SECTION + +