

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT and applicable parts of DIVISION 1 - GENERAL REQUIREMENTS, as listed in Table of Contents, shall be included in and made a part of this Section.

1.2 WORK INCLUDED

- A. Labor, materials, equipment, services and transportation required to complete cast-in-place concrete work shown on Drawings, as specified herein, or both, including but not limited to items noted below.
 - 1. Furnishing, placing, curing, finishing, and protection of reinforced cast-in-place concrete (normalweight and lightweight) above and below grade, excluding slurry walls.
 - 2. Furnishing, placing and curing of concrete working mat.
 - 3. Furnishing and erection of formwork, shoring and removal of same.
 - 4. Furnishing and placing of reinforcing steel and related positioning and securing accessories, including galvanizing or epoxy coating where specified.
 - 5. Furnishing and installation of admixtures, inserts for connections to steel members, waterstops, flashing reglets, and similar items in conjunction with concrete work.
 - 6. Installation of anchor bolts.
 - 7. Furnishing and installation of non-shrink grout at pockets in concrete slabs, walls, or beams left open temporarily, and at other locations as applicable.
 - 8. Furnishing and installation of concrete housekeeping pads, inertia blocks, and foundations for mechanical, plumbing, and electrical equipment.
 - 9. Installation of items furnished by other sections (such as anchors, sleeves, bolts and plates), and required to be cast into concrete.
 - 10. Concrete fill in steel stairs.
 - 11. Make provisions in forms for proper location and installation of pipe sleeves, duct openings, keys, chases, electrical boxes, bolts, anchors, inserts, and similar items, as required by other trades. Notify appropriate trades when items noted are ready for installation.
 - 12. Unless specifically excluded, furnishing and installation of any other items of cast-in-place concrete work indicated on drawings, specified, or obviously needed to make work of this Section complete.

1.3 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
 - 1. Section 014529, Testing Laboratory Services
 - 2. Section 051000, Structural Metal Framing
 - 3. Section 053000, Metal Decking

4. Section 055000, Metal Fabrications
5. Section 071000, Dampproofing and Waterproofing
6. Section 079000, Joint Protection
7. Section 072000, Thermal Protection
8. Section 310000, Earthwork
9. Section 323000, Site Improvements

1.4 REFERENCES

- A. Except as otherwise specified herein, perform work in accordance with specifications noted below, including latest editions of applicable specifications, codes, and standards cited therein, and latest applicable addenda and supplements. Keep copies of these items available in shop and field.
1. "The Commonwealth of Massachusetts State Building Code", 9th Edition.
 2. "Building Code Requirements for Structural Concrete" (ACI 318-14), American Concrete Institute.
 3. "Specifications for Structural Concrete for Buildings" (ACI 301-05), American Concrete Institute.
 4. "Detailing Manual" (ACI SP-66), 2004, American Concrete Institute.
 5. "Manual of Standard Practice" (10MSP 28th Edition), Concrete Reinforcing Steel Institute (CRSI).
 6. "Structural Welding Code - Reinforcing Steel" (AWS D1.1-2011), American Welding Society.
 7. "Manual of Concrete Practice 2015", Volumes 1 through 5, American Concrete Institute for ACI Standards and Recommended Practices referred to in this Section.
 8. American Society for Testing and Materials (ASTM) Standards referenced in this Section.
- B. Any material or operation specified by reference to published specifications of manufacturer or published standard shall comply with said specification or standard. In case of conflict between referenced specifications, most stringent requirement shall govern. In case of conflict between referenced specifications and Project Specifications, Project Specifications shall govern.

1.5 SUBSTITUTIONS

- A. Substitutions for member sizes, type(s) of concrete, details or any other modifications proposed by the General Contractor will be considered by Architect only under following conditions:
1. That request has been made and accepted prior to submission of Shop Drawings.
 2. That there is a substantial cost advantage or time advantage to Owner; or that proposed revision is necessary to obtain required materials or methods at proper times to accomplish work in time scheduled.
 3. That sufficient sketches, engineering calculations, and other data have been submitted to facilitate checking by Architect, including cost reductions or savings in time to complete work.

1.6 SUBMITTALS

- A. Concrete Constituents:

1. Submit to Architect a detailed list of concrete materials, and corresponding sources, proposed for use in concrete for this project.
 2. See paragraph 2.02.B below for submittal of strength information related to mix design.
 3. If conveying concrete by pump is intended, submit related data regarding concrete materials, pumping device, and methods to Architect. Consider effects of slump loss if lightweight concrete will be pumped; provide HRWR rather than water to maintain workability.
 4. When high-range water reducing admixtures will be used for water-cement ratios equal to or less than 0.45, submit information from manufacturer and batching plant on dosage amounts; timing of dosage(s) (e.g., in plant, at site, repeat dosages); initial and final slumps; quality control of dosing and mixing.
 5. Tests for approval of concrete mixtures shall be paid for by the General Contractor.
- B. Methods of Construction: Submit to Architect, prior to starting work, description of methods, sequence of construction, and type of equipment proposed for use for performing cast-in-place concrete work. Submit typical layouts for shoring and reshoring and size and spacing of supports. Provide specific construction loads to be imposed on permanent structure.

Architect's review is only for the effects of methods on permanent structure. This submission shall not relieve General Contractor of his responsibility for providing structural design for methods and equipment, and the necessary methods, equipment, workmanship, and safety precautions.

- C. Shop Drawings: Submit to Architect detailed Shop Drawings, including erection drawings and schedules.
1. Reinforcement Drawings: prepare in accordance with ACI SP-66 Detailing Manual and show following: elevations; dimensions of concrete work with specified reinforcement clearances; ledges, brackets, openings, sleeves or other items furnished by other Sections, where interference with reinforcement may occur; bending diagrams; assembly diagrams; splices and laps of reinforcement; temperature and shrinkage reinforcement; construction joint reinforcement; and shapes, dimensions, grade designations, and details of reinforcement and accessories. Show dowels with concrete work to be placed first.
 2. Formwork Drawings: schedules of placement; construction joints and contraction joints with methods of forming; general arrangement, sizes and grades of lumber and wood panels; alignment and layout of form ties for exposed concrete: location of embedded items and pockets. Submittal is for verification of joint and surface appearance. Comply with ACI 303R-04 Guide to Cast-in-Place Architectural Concrete Practice where exposed concrete or special architectural treatment is required on the Drawings. This submission does not relieve General Contractor of his responsibility for providing structural design for formwork and the proper methods, equipment, workmanship and safety precautions.
 3. Architect's checking is only a review for conformance with the design concept of the project and compliance with the information given in the contract documents. The General Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating this work with that of all other trades; and performing the work in a safe and satisfactory manner.
 4. Do not proceed with fabrication of material or performance of work until corresponding item on Shop Drawing has been reviewed by Architect.

5. All submittals shall be prepared with an action stamp which includes Structural Engineer's name and date-received and date-returned box.
- D. Samples: Submit to Architect samples and/or descriptive literature of materials, products, and methods as noted herein, and as otherwise requested by Architect: concrete constituents including admixtures; form ties (including cones) and spreaders; accessories for reinforcement; reglets; non-shrink cement grout; inserts; form release agents, and waterstops.
 1. Do not proceed with fabrication of material/product or performance of work until Sample has been approved by Architect.
 - E. Concrete Curing and Protection: Submit to Architect detailed methods proposed for curing and protecting concrete in normal, cold and hot conditions.
 - F. Mill Test Certification: Submit to Architect prior to delivery of reinforcing steel or concrete to job site, certified mill test reports of reinforcing steel and cement, (including names and locations of mills and shops, and analyses of chemical and physical properties), properly correlated to concrete to be used in this project. This submittal is for information and file record.
 - G. Corrective Work: Submit to Architect drawings showing details of any proposed corrective work prior to performing corrective work.
 - H. Affidavit: Submit to Architect, on request by Architect, manufacturer's and/or supplier's and/or installer's affidavit stating that material or product provided complies with Contract Documents.

1.7 QUALITY ASSURANCE

- A. Sample Panels: Before constructing structural formwork, a sample concrete panel shall be constructed and approved for finish construction described in paragraph Concrete Finishes below. Comply with ACI 303R-04 Guide to Cast-in-Place Architectural Concrete Practice. The panel shall be not less than 6 feet long and 4 feet high. Concrete shall be of the approved design mix. Forms shall include a typical joint between form panels. The sample concrete panel shall be representative of tie-rod hole patching and finish proposed for the structure. The panel shall be constructed at an approved location, not as part of the structure, and shall be protected from construction operations, weather, and other damage until acceptance of the completed concrete work.
- B. Pre-Construction Meeting
 1. Adopt a quality control program which will ensure compliance with specified requirements and industry standards. Appoint a person on the construction management team to be responsible for quality issues, and prepare a quality control manual which outlines proposed methods for monitoring reinforcing steel placement and concrete placement consolidation and curing.
 2. Prior to the start of concrete work, a pre-construction meeting shall be held at which representatives of the Owner, Architect, Structural Engineer and Testing Agency and key personnel of the General Contractor and Subcontractor shall be present. Key personnel shall include persons who will supply and mix special admixtures such as HRWR, DCI, silica fume; who will place reinforcing and concrete; who will consolidate and cure the concrete. Attendance at the meeting of all parties is mandatory.

Discussions at the meeting shall form the basis for the performance and inspection of concrete work.

3. Prior to the start of any item of new work, the specifications and drawings shall be reviewed at a formal meeting at which the General Contractor's and Subcontractor's key personnel are present. Key personnel shall include persons actually carrying out the work in the field.

PART 2 - PRODUCTS

2.1 CONCRETE CONSTITUENTS

- A. Cement: shall be domestic-made Portland Cement, free from water soluble salts or alkalis which will cause efflorescence on exposed surfaces. Portland Cement shall be Type II, ASTM C150 except in foundation mat where either Type II or Type IV, ASTM C150 may be used, as required, to meet heat gain requirements specified herein. Do not use air entraining cements. Use only one brand of cement for each type of cement throughout project. No visual variations in color shall result in exposed concrete.
- B. Fly Ash: ASTM C618, Type C or F; fly ash shall not exceed 25% of cement content by weight.
- C. Granulated Blast Furnace Slag: ASTM C989 Grade 100 or 120; granulated blast furnace slag shall not exceed 33% of cementitious materials content by weight, with the combined proportion of fly ash plus granulated blast furnace slag not exceeding 33% of cementitious materials.
- D. Normalweight Fine Aggregate: shall be washed, inert, natural sand conforming to ASTM C33 and following additional requirements:

Sieve	Retained Percent
#4	0 - 5
#16	25 - 40
#50	70 - 87
#100	93 - 97
Fineness Modulus	2.80 (Plus/Minus 0.20)
Organic	Plate 2 maximum
Silt	2.0 percent maximum
Mortar Strength	100 percent minimum compression ratio
Soundness	5 percent max. loss, magnesium sulfate, five cycles

- E. Normalweight Coarse Aggregate: shall be well-graded crushed stone or washed gravel conforming to ASTM C33 and following additional requirements:

Designated Size (inches)							
	3	2	1-1/2	1	3/4	1/2	3/8
FM (+/- 0.2)	7.95	7.45	7.20	6.95	6.70	6.10	5.50
Organic	Plate 1 maximum						
Silt	1.0 percent maximum						
Soundness	5 percent maximum loss, magnesium sulfate, five cycles.						

1. Maximum designated sizes for normalweight coarse aggregate to be used in concrete sections shall be as noted below, except that sizes shall also be chosen in conjunction with required clearances.
 - a. One and one-half inches for sections over ten inches in thickness.
 - b. One inch for sections more than eight and up to ten inches in thickness.
 - c. Three-quarter inch for sections more than three and up to eight inches in thickness.
 - d. For mat concrete, coarse aggregate size shall be as large as possible consistent with placement limitations and clearances but shall not exceed 3 inches.

- F. Concrete Fill for Steel Stair and Landing Pans: shall be composed of 1:2:2 mix with three-eighths inch maximum size aggregate and shall be placed with a 0 inch to 1 inch slump.

- G. Water: shall be from approved source, potable, clean and free from oils, acids, alkali, organic matter and other deleterious material.

- H. Admixtures:
 1. Water-reducing admixture: Shall comply with ANSI/ASTM C494, Type A and contain no more than .05% chloride ions.
 - a. "WRDA with Hycol", W.R. Grace & Co.
 - b. "Eucon WR-75", The Euclid Chemical Co.
 - c. "Pozzolith 220N", Master Builders Co.
 - d. Or approved equivalent conforming to ASTM C494.
 2. Mid-range water-reducing admixture: ASTM C494, Type A. Subject to compliance with requirements, provide one of the following:
 - a. "Darcem-55", W.R. Grace & Co.
 - b. "Mid-Range Water Reducer", Master Builders Co.
 - c. "Eucon X26", The Euclid Chemical Co.
 3. High-Range Water Reducing (HRWR) admixture (Super Plasticizer): shall comply with ASTM C494, Type F or Type G and contain not more than 0.05% chloride ions:
 - a. "WRDA 19", W.R. Grace & Co.
 - b. "Daracem 100", W.R. Grace & Co.
 - c. "Eucon 37", Euclid Chemical Co.
 - d. "Sikament", Sika Chemical Corp.
 - e. "Rheobuild-1000", Master Builders Co.
 - f. Or approved equivalent.

4. Air-entraining admixture: shall comply with ANSI/ASTM C 260.
 - a. "Daravair", W.R. Grace & Co.
 - b. "Airmix or Perma-Air", The Euclid Chemical Co.
 - c. "MB-VR", Master Builders Co.
 - d. Or approved equivalent.
5. Silica fume admixture: shall be supplied in slurry form as one of the following and in strict accordance with manufacturer's instructions; use water-fog misting or evaporation retarder immediately after floating flatwork containing silica fume:
 - a. "Force 10,000", W.R. Grace & Co.
 - b. "MB-SF", Master Builders.
 - c. "Sikacrete 950", Sika Corp.
 - d. Or approved equivalent.
6. Evaporation retarder: use water-based monomolecular film; use one of the following with flatwork containing corrosion inhibitor or silica fume admixture:
 - a. "Confilm", Master Builders.
 - b. "Euco-bar", Euclid Chemical Co.
 - c. "E-Con", L & M Construction Chemicals
 - d. Or approved equivalent.
7. Corrosion Inhibitor admixture: calcium nitrite based inhibitor shall comply with AASHTO M194 Type C, such as W.R. Grace "DCI Corrosion Inhibitor" or approved equivalent at the rate of 3.0 gallons per cubic yard of concrete. Use water-fog misting or evaporation retarder immediately after floating flatwork containing corrosion inhibitor.
8. Water-reducing Set Retarders: shall conform with ASTM C494 Type D and may be used when ambient temperatures exceed 80 degrees F. Use one of the following or equivalent:
 - a. "Daratard-17"; W.R. Grace.
 - b. "Eucon Retarder"; Euclid Chemical Co.
 - c. Pozzolith 100-XR"; Master Builders.
9. Accelerator admixture: Non-chloride and non-corrosive accelerators shall conform to ASTM C494 Type C and may be used when temperatures are below 50 degrees F. Use one of the following or equivalent:
 - a. "Daraset"; W.R. Grace
 - b. "Accelguard 80"; Euclid Chemical Co.
 - c. "Pozzutec 20"; Master Builders.
10. Prohibited admixtures: Calcium chloride, thiocyanates and admixtures containing more than .05% chloride ions are not permitted.

2.2 CONCRETE MIXTURES

- A. Proportion concrete on the basis of previous field experiences or laboratory trial batches with the materials to be employed in the work. However, mixtures shall have the limiting quantities or values listed below for each strength concrete with coarse aggregate less than 1½ inches.

Compressive Strength at 28 days PSI	Maximum Allowable Net Water Content		Min. Cement Factor	
	Gal./Sack	W/C Ratio	Sacks/Cu.Yd.	Lbs./Cu.Yd.
Normalweight 6000	4.50	0.40	7.50	705
5000	4.50	0.40	7.00	650
4000	5.75	0.51	6.00	564
3000	6.50	0.58	5.00	470

1. Maximum allowable net water content is the total water in the mix at the time of mixing, including free water on aggregate.
 2. Consider any fly ash or silica fume as part of the cement content for purposes of establishing cement factor and w/c ratio.
 3. Use maximum water-cement equal to 0.45 for concrete subject to freezing and thawing, repeated surface wetting or deicers.
 4. Use High-Range Water Reducing admixture for water-cement ratios equal to or less than 0.45.
- B. Field Experience Method: when a concrete production facility has a record of consecutive strength tests that were made within the past 12 months, compute standard deviations and the required average compressive strength in accordance with ACI 301 Paragraph 3.9.1 and 3.9.2.
1. Analysis of standard deviation, average compressive strength and proposed concrete proportions shall be performed by Testing Agency paid by the General Contractor.
 2. Submit proposed concrete proportions and supporting documentation to Architect.
- C. When an acceptable record of field test results is not available, base concrete proportions on trial mixtures meeting the following restrictions:
1. Use the combination of materials proposed for use in the work.
 2. Make trial mixtures having proportions and consistencies suitable for the proposed work using at least three different water-cement ratios or, for lightweight concrete, cement contents that will produce a range of strengths encompassing those required for the proposed work.
 3. Design trial mixtures to produce a slump within 1 inch of the maximum permitted, and for air-entrained concrete, within 0.5 percent of the maximum allowable air content. Report the temperature of freshly mixed concrete in the trial mixtures.
 4. For each proposed mixture, make and cure at least three compressive test cylinders for each age in accordance with ASTM C192. For normal, heavyweight, and mass concrete, each change of water-cement ratio shall be considered a new mixture. Test the cylinders for strength in accordance with ASTM C39 at 28 days or at a specified earlier or later age.
 5. From the results of these cylinder tests, plot a curve showing the relationship between compressive strength and either the water-cement ratio for normal, heavyweight, or mass concrete, or cement content for lightweight concrete.
 6. From this curve, the water-cement ratio for normal, heavyweight, or mass concrete, or cement content for lightweight concrete for the concrete to be used in the proposed work, shall be selected to produce an average compressive strength 1200 psi higher

than the specified strength. The cement content and mixture proportions to be used shall be such that the selected water-cement ratio or cement content is not exceeded when slump is the maximum permitted. Maintain proper cement content, slump, and air content.

D. Admixtures

1. Use air entrainment admixture in concrete exposed to exterior environment and in accordance with manufacturer's written instructions. Interior protected concrete may be air entrained for improved workability. See ACI 301 Table 4.2.2.4 for required air content except that minimum for all sizes of aggregate shall be 6 percent in exterior environment.
2. Use water reducing admixture in concrete and in accordance with manufacturer's written recommendations and instructions.
3. Use high-range water reducing (HRWR):
 - a. In concrete with water-cement ratios equal to or less than 0.45, but do not exceed 8 inches slump.
 - b. In concrete where anticipated slump losses in transit prevent proper pumping, placing and finishing. Use HRWR instead of adding water at the site. Do not exceed 8 inches slump.
4. Use corrosion inhibitor admixture in concrete that will be exposed to a corrosive environment.

E. Slump shall be in accordance with Part 3 of this Section.

F. Normalweight concrete shall have an air dry weight not exceeding 150 lbs. per cubic foot.

1. Design 28 day strengths as shown in the Drawings.

G. Any deviation from approved mix design will not be allowed without written approval of Architect. Cost of any additional testing by Testing Agency associated therewith shall be paid for by the General Contractor.

2.3 FORM MATERIALS

A. Exposed-to-View Surfaces:

1. Use new Class 1 B-B High Density Overlaid Plyform, exterior grade, not less than five ply nor less than 5/8 inch thick conforming to U.S. Product Standard P-1-83. Design and maintain forms in accordance with instructions in American Plywood Association (APA) Manual "Concrete Forming" (Form No. V345N/Revised June 87/5000).
2. Forms for Textured Finish Concrete: Form textured finish concrete surfaces with units of face design, size, arrangement and configuration as shown on drawings or as required to match Architect's control sample. Provide solid backing and form supports to ensure stability of textured form liners.
3. Domes for waffle construction shall be factory-finished 16 ga. steel or 0.11 inch thick fiberglass forms of a type approved by the Architect. Form surfaces shall be smooth and free from dents, holes, and tears. Form edges shall be straight and true. Intent is that when forms are removed, the exposed concrete surface shall be free from all blemishes.
4. Pan-forms for joist construction shall be factory-fabricated 16 ga. steel or 0.11 inch (minimum) thick fiberglass forms of a type approved by the Architect. Form surfaces shall be smooth and free from dents, holes, and tears. Form edges shall be straight

and true. Intent is that when forms are removed, the exposed concrete surfaces shall be free from all blemishes.

5. Cylindrical Columns and Supports: Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant adhesive with wax impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
 6. Chamfer Strips: Use ½ inch, 45 degree wood strips, nailed six inches on center, and installed in inside corners of all forms, unless otherwise directed by Architect.
- B. Not-exposed-to-view Concrete Surfaces: Use forms of wood, metal, or other material subject to approval of Architect.
- C. Form Ties and Spreaders: Use products by Richmond Screw Anchor Co.; Superior Concrete Accessories, Inc.; Dayton Sure-Grip and Shore Co.; or equivalent approved by Architect. Wire ties shall not be used. Ties for concrete exposed to public view shall have removable set-back cones. Ties for foundation walls shall have water seal washers on the earth side.
- D. Form Release Agent: Use a non-staining and non-emulsifiable type. Form release agent shall not impart any stain to concrete nor interfere with adherence of any material to be applied later to concrete surfaces.

2.4 REINFORCEMENT AND ACCESSORIES

- A. Reinforcing Steel Bars: shall be newly rolled billet steel conforming to ASTM A615. (See Structural Drawings for grades.) Bars shall be bent cold.
- B. Mechanical Splice Devices: Use splice devices in columns for #9 through #18 bars.
1. Compression splices: Use sleeves with bolted or wedge locking devices to engage butted bars sawcut square (\pm) 1½ degrees.
 2. Tension splices: Use sleeves with filler materials or use threaded couplers. Provide splice with 125 percent of yield capacity of the spliced bars. Submit ICBO endorsement.
- C. Welded Wire Fabric: shall conform to ASTM A185.
- D. Galvanizing: hot-dip galvanize reinforcing steel so designated on the drawings after fabrication in compliance with ASTM A-767. Hot-dip galvanized steel shall be inspected for compliance with ASTM A-767 and shall be tagged indicating the name of the galvanizer, the ASTM Number and the ounces of zinc per square foot of surface. Immediately before galvanizing, steel shall be dipped into a solution of zinc ammonium chloride. The type of process using a flux blanket overlaying the molten zinc shall not be permitted. A notarized Certificate of Compliance with all of the above shall be required from the galvanizer. Safeguard against embrittlement in conformance with ASTM A-143.
- E. Reinforcement Accessories: Reinforcement accessories shall include spacers, chairs, ties, slab bolsters, clips, chair bars, and other devices for properly assembling, placing, spacing, supporting, and fastening reinforcement. Tie wire shall be annealed wire of sufficient strength for intended purpose, but not less than No. 18 gage. Bar supports shall conform to Chapter 3, "Bar Supports" or CRSI Manual of Standard Practice. Supports touching interior formed surfaces exposed to view shall be CRSI Class 1, plastic protected. When epoxy coated reinforcing is used, accessories shall be epoxy coated and tie wire shall be nylon, epoxy or plastic coated.

2.5 RELATED MATERIALS

- A. Vapor Retarder: Provide Class A vapor barrier over rigid insulation beneath slabs on ground. Use only materials which have a moisture transmission rate of less than 0.01 grains per square foot per hour and meet the requirements of ASTM E1745 and ASTM E1643. Use polyethylene sheet not less than 15 mils thick or approved equivalent such as the following:
1. "Vapor Block VB15" By Raven Industries
 2. Griffolyn "15-mil Green" by Reef Industries
 3. "15 mil Stego Wrap" by Stego Industries
- B. Non-shrink Grout: Use CRD-C 621, factory pre-mixed grout, Type D, non-metallic, such as one of the following or an approved equivalent:
1. "Masterflow 928"; Master Builders.
 2. "Euco-NS"; Euclid Chemical Co.
 3. "Five Star Grout"; Five Star Products.
- C. Parking Garage Floor Sealer: Apply sealer to new floor surfaces. Use one of the following or an equivalent approved by Architect.
1. "Hydrozo Clear 650"; Hydrozo Chemical Co.
 2. "Euco-Guard"; Euclid Chemical Co.
 3. "Scotch-Clad Sealer 6000V and 6000H"; 3M Contractor Products.
 4. "Masterseal SL"; Master Builders.
- D. Non-slip Aggregate Finish: Use fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40% aluminum oxide and not less than 25% ferric oxide. Use material that is factory-graded, packaged, rustproof and non-glazing, and is unaffected by freezing, moisture and cleaning materials.
- E. Absorptive Cover: Use burlap cloth weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- F. Moisture-retaining Cover: Use one of the following, complying with ANSI/ASTM C 171:
1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.
- G. Curing Compounds: Verify that products listed below meet regulations of jurisdiction for Volatile Organic Compounds (VOC) emissions. Notify Architect if listed products do not comply and submit information about equivalent products that do comply.
1. Curing and Sealing Compound: Use a clear acrylic type conforming to ASTM C309, Type I, Class B. Use one of the following or equivalent where concrete surfaces will remain exposed.
 - a. "Masterkure"; Master Builders.
 - b. "Super Rez Seal"; Euclid Chemical Co.
 - c. "Dress & Seal #30"; L & M
 2. Curing and Hardening Compound: Use colorless solution containing 35% of a 42 degree Baume sodium silicate solution. Use where shown on drawings. Use one of the following or equivalent:

- a. "Chem-Hard"; L & M
 - b. "Eucosil" Euclid Chemical Co.
 - c. "Cure-hard"; W.R. Meadow
3. Dissipating Resin Curing Compound: Use a dissipating resin type compound, conforming to ASTM C309, Type I. The film must chemically break down in a two-to-four week period. Use one of the following or equivalent where concrete surfaces will receive other materials:
- a. "Kurez DR"; Euclid Chemical Co.
 - b. "3100"; W.R. Meadows
 - c. "Cure Resin"; L & M
- H. Bonding Agent, Patching Mortar: Cementitious slurry containing polymer-modified latex admixture, such as one of the following:
1. "SikaTop 121, 122 or 123"; Sika Corporation
 2. "Flexcon"; Euclid Chemical Co.
 3. "Everbond"; L & M
- I. Threaded Inserts: Use galvanized structural concrete inserts of type shown on the drawings, similar and equivalent to strut and loop inserts with coil-threaded rods as supplied by Richmond Screw Anchor, having yield strength $F_y = 85,000$ psi.
- J. Expansion Bolts: Use hot-dipped galvanized bolt conforming to Federal Spec. FF-S-325, Group II, Type 4, Class 1. Allowable pullout and shear values shall be based on ASTM E 488 test methods. See Drawings for diameters, edge distances, embedments and center-to-center spacings. Use one of the following or equivalent approved by Architect:
1. "Molly Parabol"; USM Corp.
 2. "Kwik Bolt II"; Hilti Inc.
 3. "Red Head Trubolt Wedge Anchor"; ITW Ramset/Redhead
- K. Waterstops: Provide one of the following types of waterstops where shown on the drawings:
1. Provide flat, dumb-bell type or centerbulb type waterstops at construction joints and other joints as indicated, of size to suit joints. Waterstops shall be rubber neoprene conforming to Corps of Engineers CRD-C513 or PVC conforming to CRD-C572. Install in accordance with manufacturer's instruction. Use products manufactured by one of the following or equivalent:
 - a. Afco Products.
 - b. W.R. Meadows.
 - c. Williams Products.
 2. Provide laminate of bentonite and high density polyethylene, such as "Parastop" by Paramount Technical Products, between the contact faces of construction joints. Install in strict accordance with manufacturer's instructions.
- L. Electrodes for Welding: E90XX low hydrogen filler rods or equivalent based on welding technique. See Tables 2.2 and 5.1 of AWS D1.4-92.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine work prepared by other trades to receive work of this Section and report any defects affecting installation to the General Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.
- 3.2 HANDLING, STORAGE, AND PROTECTION OF MATERIALS
- A. Handle and store materials separately in such manner as to prevent intrusion of foreign matter, segregation, or deterioration. Do not use foreign materials or those containing ice. Remove improper and rejected materials immediately from point of use. Cover materials, including steel reinforcement and accessories, during construction period. Stockpile concrete constituents properly to assure uniformity throughout project.
- 3.3 ERECTION OF FORMWORK
- A. Set and maintain formwork to ensure complete concrete work within tolerance limits listed in ACI 117, Class B, unless noted otherwise.
 - B. At construction joints, overlap and clamp forms (using gaskets if necessary) to prevent offsets or loss of mortar at joints.
 - C. Before reusing form materials, thoroughly clean surfaces that will be in contact with freshly cast concrete, repair damaged areas and withdraw projecting nails. Recoat form with release agent. Re-use of form material for architecturally exposed concrete shall be subject to approval by Architect.
- 3.4 PLACING OF REINFORCEMENT
- A. Place reinforcement in accordance with requirements of CRSI "Placing Reinforcing Bars".
 - B. Place reinforcement in accordance with ACI 117 (Tolerances) and with Contract Documents and secure firmly in position by wire ties, chairs, spacers, and hangers, each of type approved by Architect.
 - C. Welding Reinforcement: Comply with AWS D1.4-98 for welding practices. Preheat and interpass temperatures shall comply with Table 5.2 of AWS D1.4-98. Provide mill reports to Architect showing carbon content of reinforcing being welded.
 - D. Do not bend, tack-weld or cut reinforcement in field in any manner other than as shown on Drawings unless specific approval for each case is given by Architect.
 - E. Continue reinforcement through construction joints unless otherwise indicated on Drawings.
 - F. Splice reinforcement only in accordance with requirements of Contract Documents or as otherwise specifically approved by Architect. Do not splice reinforcement at points of maximum stress unless shown on the Drawings. Welded wire fabric shall be lapped six inches or one and one-half spaces, whichever is larger, and shall be wired together.
 - G. At time concrete is placed, reinforcement shall be free of excessive rust, scale, or other coatings that will destroy or reduce bond. Paint reinforcement expected to be exposed to weather for a considerable length of time with a heavy coat of cement grout. Protect stored materials so as not to bend or distort bars in any way. Bars that become damaged will be rejected. Repair damage to coating of epoxy coated rebars in strict accordance with epoxy manufacturer's published instructions.

- H. Before concrete is cast, check all reinforcement after it is placed to ensure that reinforcement conforms to Contract Documents and approved Shop Drawings. Such checking shall be done only by qualified experienced personnel. In addition, notify the Architect at least 36 hours prior to concrete placement so a visit may be made to observe completed reinforcement and formwork before concrete placement.

3.5 JOINTS

- A. Construction and contraction joints indicated on Drawings are mandatory and shall not be omitted.
 - 1. Slab Contraction Joints: may be constructed by inserting hard-pressed fiberboard or plastic strips into the plastic concrete, or by cutting the concrete with a saw after it has set. Make joints 1/8 inch wide and the depth of 1/4 the slab thickness or the maximum size of the coarse aggregate, whichever is greater.
 - a. Insert fiberboard or plastic strips into a groove tooled into the concrete after the first floating. Use a U-shaped sheet metal device fitted over the top to insert the strips.
 - b. Saw joint early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Cut joints to true alignment and in sequence of concrete placement. Remove sludge and cutting debris.
- B. Wall Contraction Joints: Suspend preformed key in center of wall form and directly opposite any vertical reglets on face of form.
- C. Joints not indicated or specified shall be placed to least impair strength of structure and shall be subject to approval of Architect.

3.6 INSTALLATION OF EMBEDDED ITEMS

- A. Conform to requirements of ACI-318, paragraph 6.3, "Conduits and Pipes Embedded in Concrete", and as specified below.
- B. Install steel sleeves, furnished by other trades, at locations shown on the drawings.
- C. Install anchor bolts for column baseplates in accordance with AISC Code of Standard Practice, Paragraph 7.5 and the following: Use setting plate templates. Maintain elevations and plan locations of bolt groups within one-quarter inch of the locations shown on the drawings. Place individual bolts in a bolt group within one-eighth inch of center-to-center dimensions shown on the drawings.

3.7 MIXING, CONSISTENCY, AND DELIVERY OF CONCRETE

- A. Use ready-mixed concrete produced by plant acceptable to Architect. Hand or site mixing shall not be done. Batch constituents, including admixtures, at central plant. Admixtures shall be premixed in solution form and dispensed as recommended by manufacturer.
- B. Concrete shall arrive at the job site at a slump of 2 to 3 inches and at the time of deposit shall be as follows:

Portion of Structure	S L U M P	
	Recommended	Maximum Range
Mat	2"	1" - 3"
Slurry Walls	8"	7" - 10"
Walls, Columns	4"	3" - 5"
Slabs, Beams	3"	2" - 4"

1. If high-range water reducing admixture (superplasticizer) is used, it may be added at the job site after verifying that the delivery slump is 2 to 3 inches. Maximum slump after adding HRWR shall be 8 inches.
 2. For normalweight concrete, water may be added at the site only to make up water withheld at the plant. Batching plant shall document on the driver's delivery ticket any water withheld at the plant. When water has not been withheld and slump is too low for proper handling of concrete, use HRWR to bring slump within specified range.
- C. Transport ready mixed concrete to site in watertight agitator or mixer trucks loaded not in excess of rated capacities. Discharge at site within one and one-half hours after cement was first introduced into mix. Do not use concrete with a temperature greater than 85 degrees F. Central mixed concrete shall be plant mixed a minimum of five minutes. Agitation shall begin immediately after premixed concrete is placed in truck and shall continue without interruption until discharged. Transit mixed concrete shall be mixed at mixing speed for at least ten minutes immediately after charging truck followed by agitation without interruption until discharged.
- D. Do not retemper (mixing with or without additional cement, aggregates, or water) concrete which has partially hardened.

3.8 PLACING CONCRETE

- A. If concrete pumping is proposed, refer to "Submittals, Concrete Constituents", in this Section for requirements. If lightweight concrete pumping is proposed, use a pipe diameter of 5 inches. Concrete may be placed into the pump at the maximum but not more than the specified slump.
- B. Remove water and foreign matter from forms and excavations and, except in freezing weather or as otherwise directed, thoroughly soak wood forms just prior to placing concrete. Place no concrete on frozen soil and provide adequate protection against frost action during freezing weather.
- C. To secure bond at construction joints, thoroughly clean concrete surfaces with water jet or compressed air. Before new concrete is deposited, saturate joint surface with water.
- D. Do not place concrete having slump outside of allowable slump range. The loss of slump between pump and discharge end of pipeline shall not exceed two inches.
- E. Transport concrete from mixer to place of final deposit as rapidly as practical by methods which prevent separation of ingredients and displacement of reinforcement, and which avoid re-handling. Deposit no partially hardened concrete. When concrete is conveyed by chutes,

equipment shall be of such size and U-shaped design as to ensure continuous flow in chute. Do not use flat (coal) chutes. Use metal or metal lined chutes with different portions having approximately the same slope. Slope shall not be less than 25 degrees nor more than 45 degrees from horizontal. Use a baffle or spout at the discharge end of the chute to prevent segregation. If discharge end of chute is more than five feet above surface of concrete in forms, use spout with its lower end at surface of deposit. When operation is intermittent, discharge chute into hopper. Do not allow concrete to flow horizontally over distances exceeding five feet.

- F. Place concrete in such manner as to prevent segregation and accumulations of hardened concrete on forms or reinforcement above mass of concrete being placed. To achieve this end, use suitable hoppers, spouts with restricted outlets and tremies as required.
- G. During and immediately after depositing, compact concrete in accordance with ACI 309 by means of internal type mechanical vibrators or other tools to produce required quality of finish. Vibration shall be done by experienced operators under close supervision and shall be carried on only enough to produce homogeneity and optimum consolidation without permitting segregation of constituents or "pumping" of air. Vibrators used for normalweight concrete shall operate at speed of not less than 7,000 rpm and be of suitable capacity. Do not use vibrators to move concrete. Keep at least one vibrator on hand for every 10 cubic yards of concrete placed per hour, plus one spare. Vibrators shall be operable and on site prior to starting placement.
- H. Place vertical lifts not to exceed 18 inches. Vibrate through successive lifts to avoid pour lines. Vibrate first lift thoroughly until top of lift glistens to avoid stone pockets, honeycomb, and segregation.
- I. Deposit concrete continuously, and in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause formation of seams and planes of weakness within section. If section cannot be placed continuously between planned construction joints, as specified, introduce a joint and additional reinforcement so as to preserve structural continuity. Notify Architect in any such case.
- J. Cold joints, particularly in exposed concrete, including "honeycomb", are unacceptable. If they occur in concrete surfaces exposed to view, Architect will require that entire section in which blemish occurs be removed and replaced with new materials at the General Contractor's expense.
- K. When placing exposed concrete walls or columns, strike corners of forms rapidly and repeatedly from outside along full height while depositing concrete and vibrating.
- L. Clean chutes, hoppers, spouts, and adjacent work before and after each run; discharge water and debris outside form.
- M. Place slabs-on-grade in long, alternating strips. Subdivide strips with contraction joints in accordance with maximum spacing dimensions shown in the Drawings.
- N. Place concrete level on steel deck to elevations shown on drawings but not less than specified thickness at cambered beams. Thickness of concrete at midspans may exceed specified minimum thickness due to steel beams and deck deflecting during placing of concrete.

3.9 CONCRETE FINISHES

- A. Finish of Formed Surfaces:
1. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work. This is the concrete surface imparted by stock form facing material used with tie holes and defective areas repaired and patched and fins and other projections exceeding ¼" in height rubbed down or chipped off.
 2. Smooth Form Finish: For formed concrete surfaces exposed-to-view and surfaces that are to be covered with a coating material applied directly to concrete, such as waterproofing, dampproofing paint. This is the as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of joints and with a systematic pattern of ties with set-back cones. Grout tie holes; remove and rub smooth fins or other projections. Surfaces remaining exposed-to-view shall have uniform color and texture acceptable to the Architect.
 3. Related Unformed Surfaces: At tops of walls, horizontal offsets surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces.
- B. Monolithic Slab Finishes: Floor Flatness (FF) and Levelness (FL) tolerances shall conform to the criteria listed below except Floor Levelness (FL) does not apply to slabs on unshored steel deck. Measure (FL) on shored floor slabs prior to removing shores.
1. Scratch Finish:
 - a. Scratch finish slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, stone and other bonded applied cementitious finish flooring material.
 - b. After placing slabs, plane surface to a tolerance not exceeding ½" in 10' when tested with a 10' straightedge, or to flatness numbers for the floor surface (FF) not less than 15 and a levelness number (FL) not less than 13. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms or rakes.
 2. Float Finish:
 - a. Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, and as otherwise indicated.
 - b. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance not exceeding 5/16" in 10' when tested with a 10' straightedge or to a flatness number for the floor surface (FF) not less than 20 and a levelness number (FL) not less than 15. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
 3. Trowel Finish:
 - a. Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with wood flooring, resilient flooring, carpet, thin-set tile and stone, paint or other thin film finish coating system.
 - b. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is

moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 3/16" in 10' when tested with a 10' straightedge or to a flatness number for the floor surface (FF) not less than 30 and levelness number (FL) not less than 20. Grind smooth surface defects which would telegraph through applied floor covering system.

4. Non-slip Broom Finish:
 - a. Apply non-slip broom finish to exterior concrete platforms, steps and ramps, loading dock, and elsewhere as indicated.
 - b. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
5. Sealing and Hardener Finishes:
 - a. Apply a coat of the specified Curing and Sealing or Curing and Hardening Compound to exposed interior concrete floors where compound is indicated on the Drawings. Apply the compound in strict accordance with the directions of the manufacturer.
6. Non-slip Aggregate Finish:
 - a. Apply non-slip aggregate finish to interior exposed concrete stair treads, platforms, ramps, including cement-filled steel pan stair treads and platforms.
 - b. After completion of float finishing, and before starting trowel finish, uniformly spread 25 lbs. of dampened non-slip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.
 - c. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose non-slip aggregate.

3.10 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Where corrosion inhibitor or silica fume admixture have been used, provide continuous water-fog spray or mist or evaporation retardant to prevent plastic shrinkage cracks during initial setting time.
- B. Start curing before concrete has dried and immediately after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- C. Curing Methods: Keep concrete surface continuously wet by moist curing, by moisture-retaining cover curing, by curing compound, and by combinations thereof, as herein specified.
 1. Provide moisture curing by any of the following methods at the General Contractor's option:
 - a. Covering with water.
 - b. Continuous water-fog spray.
 - c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
 2. Provide moisture-cover curing as follows:

- a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 3. Provide curing compound as follows:
 - a. Apply specified curing compound to exterior and exposed interior concrete slabs as soon as final finishing operations are complete (within 2 hours) and to formed surfaces immediately after forms are removed.
 - b. Apply uniformly in two continuous operations at right angles to each other by power-spray or roller in accordance with manufacturer's directions. Re-coat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - c. Use dissipating resin type curing compounds on surfaces which are to be covered with finish or coating material applied directly to concrete, such as liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials. If curing compound is not compatible with coating materials, moisture or moisture-cover curing shall be used.
 - D. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 2. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
 - E. Hot weather placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
 1. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 2. Wet forms thoroughly before placing concrete.
 - F. Keep permanent temperature record showing date and outside temperature for concreting operations. Take thermometer readings at start of work in morning, at noon, and again late in afternoon. Record locations of concrete placed during these periods so any effect temperatures may have had on construction can be correlated. Distribute copies of temperature record daily to Architect.
- 3.11 REMOVAL OF FORMWORK, SHORING AND RESHORING
- A. The General Contractor shall be responsible for proper removal of formwork shoring, and re-shoring. Comply with ACI 347 for shoring and re-shoring in multi-story construction.
 - B. Remove vertical forms as soon as concrete has attained sufficient strength to support its own weight and their removal can be done without damage to the concrete. Apply curing compound immediately after removing forms.
 - C. Keep horizontal forms and supports in place for not less than minimum periods of time noted below or until concrete has reached 60 percent of its specified strength.

1. Soffits of beams or girders shall remain in place until concrete has attained 600 day degrees.
 2. Forms of floor slabs shall remain in place until concrete has reached 400 day-degrees.
 3. Definition of day-degrees: Total number of days or fractions of days times mean daily air temperature at surfaces of concrete; where concrete surface is protected by insulated blankets or formwork, temperature may be taken under the blankets or formwork. For example, five days at temperature of 60 degrees F. equals 300 day degrees. Days or fractions of days in which temperature is below 50 degrees F. shall not be included in calculation of day-degrees.
- D. When forms are removed, place reshores at same time as stripping operations so that no unshored area is larger than one-fourth of a slab panel. Allow no live load on slab when stripping and shoring are being done.
- E. Field cure test cylinders under same conditions as concrete they represent in order to verify minimum strengths for form removal. Such cylinders and testing shall be at the General Contractor's expense.

3.12 ACCEPTANCE AND REPAIRING OF CONCRETE SURFACES

- A. Intent of this Specification is to require forms, mixtures of concrete, and workmanship so that concrete surfaces will require no patching, except for plugging of tie holes.
1. Remove and replace architectural concrete with surface defects exceeding the limitations of ACI 301, Section 13.3.1 or having honeycombs, excessive air voids (bugholes), mismatched coloring, pour lines or sand streaking. The standard of acceptability shall be the surface quality of the approved test panel; or, where no test panel has been made, the standard of unacceptability shall be the photographs shown with paragraphs 7.6 and 7.7 or ACI 309R-96 "Guide for Consolidation of Concrete".
 2. Where patching is acceptable to Architect, procedure shall comply with ACI 301-99, Section 5.3.7 and as described below.
- B. Clean and dampen tie holes and fill solid with patching mortar immediately after form removal.
- C. Do not patch defective concrete and honeycombed areas unless examined and approval is given by Architect. If such approval is received by the General Contractor, areas involved shall be chipped down square and at least one inch deep to sound concrete by means of cold chisels or pneumatic chipping hammers. If honeycomb exists around reinforcement, chip to provide clear space at least three-quarter inch wide all around steel to ensure proper bond thereto. Repairs thicker than one and one-half inches shall be built-up on successive days, each layer of one and one-half inches being applied as described in ACI 301-99, Section 5.3.7. Use specified bonding agent.
- D. Remove and replace patches which become crazed, cracked, or sound hollow upon tapping, at the General Contractor's expense.

3.13 CLEANING

- A. Clean concrete surfaces of objectionable stains as determined by the Architect. Do not use materials containing acid in any form or methods which will damage "skin" of concrete surfaces.

3.14 INSPECTION AND TESTING

- A. Inspection and testing of cast-in-place concrete work will be performed by an independent Testing Agency, under a separate contract with the Owner. Materials and workmanship shall be subjected to inspection and testing in mill, shop and/or field by testing Agency and shall be subjected to periodic observation by the Architect. Such inspection and testing shall not relieve the General Contractor of his responsibility to provide his own inspection, testing, and quality control as necessary to furnish materials and workmanship in accordance with requirements of these Contract Documents.
- B. Requirements of this section are generally written for purpose of securing best workmanship and end result. Certain deviations may be desirable under certain project conditions, however, and may be allowed after examination by and upon written approval of Architect. Any such approved deviation shall not be construed as a waiver of requirements of Specifications.
- C. Notify Architect and Testing Agency prior to start of any phase of concrete work so as to afford them reasonable opportunity to schedule site visit. Such notification shall be made at least 36 hours in advance.
- D. Facilitate inspection and testing by Testing Agency. Furnish Testing Agency upon request with:
 - 1. Information as to time and place of shipments of materials to plant and project site.
 - 2. Free and safe access and assistance for testing materials and proper facilities for inspection of work in plant and at proper site.
 - 3. Covered box large enough to contain twenty-four standard concrete cylinders. At temperatures below 60 degrees F., box shall be electrically heated to maintain inside temperature of 60 to 80 degrees F. Place cylinders in box immediately after molding and cover with moist burlap until delivery to laboratory, 24 to 72 hours after molding.
 - 4. Copies of mill test reports of shipments of cement and reinforcing steel.
- E. Promptly replace concrete materials or redo work which has been rejected by Architect and/or Testing Agency, either at plant or at job site, to satisfaction of Architect and/or Testing Agency and at no expense to the Owner.
- F. Correct, or remove and replace concrete work which does not meet requirements of Contract Documents for aesthetic appearance as directed by Architect. Criteria for acceptance shall be based on a mockup pre-approved by the Architect. Cost of such correction or removal and replacement shall be at the General Contractor's expense.
- G. Sampling and testing for quality assurance during placement of concrete may include the following, as directed by Architect. Samples will be made at the point of discharge from the ready-mix truck.
 - 1. Sampling Fresh Concrete: ASTM C172, except modified for slump to comply with ASTM C94.
 - a. Slump: ASTM C143; one test for each concrete load and one test for each set of compressive strength test specimens.
 - b. Air Content: ASTM C173, volumetric method for lightweight or normalweight concrete; ASTM C231 pressure method for normalweight concrete; one for each set of compressive strength test specimens.

- c. Concrete Temperature: Test hourly when air temperature is 40 degrees F. (4 degrees C.) and below, and when 80 degrees F. (27 degrees C.) and above; and each time a set of compression test specimens made.
 - d. Compression Test Specimen: ASTM C31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required. One set of cylinders shall be taken for every 50 cubic yards or fraction thereof.
 - 2. Compressive Strength Tests: ASTM C39; one set for each 50 cu. yds. or fraction thereof, of each concrete class placed in any one day or for each 5,000 sq. ft. of surface area placed; one specimen tested at 7 days, 2 specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
 - a. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, Architect may direct the General Contractor to evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete or to redesign the mix.
 - b. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
 - c. Test results will be reported in writing to the Architect and the General Contractor on same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
 - d. Additional Tests: The testing agency will make additional tests of in-place concrete when test results show specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect.
 - e. Testing Agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed, including load testing. The General Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.
- H. Nondestructive Testing of Welded Reinforcing Steel: The Testing Agency will make tests of welded reinforcing in accordance with AWS D1.4-98. Butt welded reinforcing shall be tested by radiographic or magnetic particle methods. Parallel-welded reinforcing shall be visually inspected.
- I. Floor flatness and levelness: The Testing Agency will measure floor surface profiles within 72 hours after concrete placement and calculate Floor Profile Numbers in accordance with ASTM 1155. Floor profilograph or digital readout floor profiler instrument such as a "Dipstick Auto-Read Floor Profiler" (manufactured by FACE Construction Technologies) should be used.

END OF SECTION