

## **SECTION 03110 - CONCRETE FORMWORK**

### **PART 1 - GENERAL**

- A. The general provisions of the Contract, including General Conditions and Requirements, apply to the work specified in this section.

### **PART 2 - DESCRIPTION OF WORK**

- A. The extent of formwork is indicated by the concrete structures shown on the drawings.
- B. The work includes providing formwork and shoring for cast-in-place concrete, and installation into formwork of items furnished by others, such as anchor bolts, setting plates, bearing plates, anchorages, inserts, frames, nosings and other items to be embedded in concrete (but not including reinforcing steel).

### **PART 3 - QUALITY ASSURANCE**

- A. The Installer must examine the substrate and the conditions under which concrete formwork is to be performed, and notify the Contractor in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

### **PART 4 - CODES AND STANDARDS**

- A. Unless otherwise shown or specified, design, construct, erect, maintain, and remove forms and related structures for cast-in-place concrete work in compliance with the American Concrete Institute Standard ACI 347, "Recommended Practice for Concrete Formwork".
- B. Construct formwork to provide completed cast-in-place concrete surfaces complying with the tolerances specified in ACI 347, and as follows:
  - 1. Variation from plumb in lines and surfaces of walls, and arises; 1/4" per 10 ft., but not more than 1". For exposed control joint grooves, and other conspicuous lines, 1/4" in any bay or 20 ft. max; 1/2" max. in 40 ft. or more.
  - 2. Variation from level or grade in slab, walls and in arises 1/8" in 10 ft., 3/8" in any bay or 20 ft. max., and 3/4" in 40 ft. or more. For exposed horizontal grooves and other conspicuous lines, 1/4" in any bay or 20 ft. max. and 1/2" in 40 ft. or more.
  - 3. Variation from position of the linear building lines and related walls, and partitions, 1/2" in any bay or 20 ft. max., and 1" in 40 ft. or more.
  - 4. Variation in cross-sectional dimensions of thickness of slabs and walls, minus 1/4" and plus 1/2".

5. Variations in footings plan dimensions, minus 1/2" and plus 2"; misplacement or eccentricity, 2% of the footing width in direction of misplacement but not more than 2"; thickness reduction minus 2%.
  6. Variation in steps; in a flight of stairs, 1/8" for rise and 1/4" for treads; in consecutive steps, 1/16" for rise and 1/8" for treads.
- C. Before concrete placement check the lines and levels of erected formwork. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.
  - D. During concrete placement check formwork and related supports to ensure that forms are not displaced and that completed work will be within specified tolerances.

#### **PART 5 - SUBMITTALS**

- A. For information only, submit 2 copies of manufacturer's data and installation instructions for proprietary materials including form coatings, manufactured form systems, ties and accessories.
- B. Submit shop drawings for fabrication and erection of specific finished concrete surfaces as shown or specified.
- C. Architects review will be for general architectural applications and features only. Design of formwork for structural stability and sufficiency is the Contractor's responsibility.

#### **PART 6 - FORM MATERIALS**

- A. Unless otherwise shown or specified, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood-faced or other panel type materials acceptable to Architect, to provide continuous, straight, smooth as-cast surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.
  1. Use plywood complying with U.S. Product Standards PS-1, "B-B (Concrete Form) Plywood" Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing the legible trademark of an approved inspection agency.
- B. Form concrete surfaces which will be unexposed in the finished structure with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least 2 edges and 1 side for tight fit.
- C. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

- D. Unless otherwise shown, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1½" from the outer concrete surface. Unless otherwise shown, provide form ties which will not leave a hole larger than 1" diameter in the concrete surface.
- E. Form ties fabricated on the project site and wire ties are not acceptable.
- F. 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 the wetting of surfaces to be cured with water or curing compounds.
- G. Provide metal inserts for anchorage of materials or equipment to concrete construction, not supplied by other trades and as required for the work.

## **PART 7 - DESIGN OF FORMWORK**

- A. Design, erect, support, brace and maintain formwork so that it will safely support 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 formwork system and in-place construction that has attained adequate strength for that purpose. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.
- B. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, 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.
- C. Provide shores and struts with positive means of adjustment capable of taking up formwork 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.
- D. Support form facing materials by structural members spaced sufficiently close to prevent deflection. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances.
- E. Provide temporary openings in wall forms, and at other locations necessary to permit inspection and clean-out.
- F. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
- G. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

- H. Side forms of footings may be omitted and concrete placed directly against excavation only when requested by Contractor and accepted by Architect. When omission of forms is accepted, provide additional concrete required beyond the minimum design profiles and dimensions of the footings as detailed, at no cost to the Owner.

## **PART 8 - FORM CONSTRUCTION**

- A. General: Construct forms complying with ACI 347, to the exact sizes, shapes, lines and dimensions shown, and as required to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screens, bulkheads, anchorages and inserts, and other features required. Use selected material to obtain required finishes.
- B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.
- C. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Brace temporary closures and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms in as inconspicuous location as possible, consistent with project requirements.
- D. Form intersecting planes to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.
- E. Provide openings in forms to accommodate other work, including mechanical and electrical work. Accurately place and securely support items required to be built into the forms.

## **PART 9 - FORMS FOR EXPOSED CONCRETE**

- A. Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes.
- B. Do not use metal cover plates for patching holes or defects in forms.
- C. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
- D. Use extra studs, walers and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material which will produce bow.
- E. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.

- F. Form molding shapes, recesses and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.
- G. Form chamfers with 3/4" x 3/4" strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Extend terminal edges to required limit and miter chamfer strips at changes in direction.
- H. Unexposed corners may be formed either square or chamfered.

#### **PART 10 - CONTROL JOINTS**

- A. See 3A section for treatment of control and construction joints, including wood screeds, metal keyways and sawcuts. Locate as indicated.

#### **PART 11 - PROVISION FOR OTHER TRADES**

- A. Provide openings in concrete formwork to accommodate work of other trades, including those under separate prime contracts (if any). Size and location of openings, recesses and chases are the responsibility of the trade requiring such items. Accurately place and securely support items to be built into forms.

#### **PART 12 - CLEANING AND TIGHTENING**

- A. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Retighten forms immediately after concrete placement as required to eliminate mortar leaks.

#### **PART 13 - FORM COATINGS**

- A. Coat form contact surfaces with form-coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.
- B. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

#### **PART 14 - REMOVAL OF FORMS**

- A. General: Formwork not supporting concrete, such as sides of walls, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F for 24-hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided that curing and protection operations are maintained.

#### **PART 15 - RE-USE OF FORMS**

- A. Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated or

otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to the Architect.

## **PART 16 - CAST-IN-PLACE CONCRETE WALLS**

- A. Forms for concrete work shall be so constructed as to produce finished concrete of precise sizes, shapes, lines, and locations shown on drawings, as approved by the Architect.
- B. Forms shall be substantially built with sufficient strength and rigidity to support dead-weight of wet concrete, impact at pouring, force of vibration of concrete without spreading or buckling, accurately put together with tight joints to prevent leakage of cement and water.
- C. Forms shall be clean, free of papers, sawdust, dirt debris. Temporary clean-out panels shall be provided in column, interior side of wall forms and at other points where necessary to facilitate cleaning and inspection immediately before depositing concrete. Dust or debris will not be tolerated in forms when concrete is to be placed. Joints in forms for cleanout panels shall be located away from finished surfaces wherever possible. Such joints shall be neat, tight, and leave only marks of type which can be removed by light grinding finished concrete. Provide cover of polyethylene sheeting for column and wall forms to prevent accumulation of dirt, debris, etc., in forms.
- D. Form ties for finished walls, if used, must be lined up, uniformly spaced in each panel in both horizontal and vertical directions. Form tie patching shall be approved by the Architect for profile and finish. Where openings occur at right regular spacings do not use wall ties above, below or between openings. Use wall ties only through openings. Provide walers, bracing beams above, below, between openings as required to contain freshly placed concrete.
  - 1. This Contractor shall construct forms for openings, slots, beam pockets, light recesses, notches or chases required in concrete members for installation by other trades as directed by subcontractor requiring same.

End of Section

## SECTION 03210 - CONCRETE REINFORCEMENT

### PART 1 - GENERAL

- A. The general provisions of the Contract, including General Conditions and Requirements, apply to the work specified in this section.
- B. Codes and Standards: Comply with requirements of the following codes and standards, except as herein modified:
- C. Also, the work includes reinforcement for independent foundations and retaining walls.

### PART 2 - QUALITY ASSURANCE

- A. The Installer must examine the substrate and the conditions under which concrete reinforcement is to be placed, and notify the Contractor in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
- B. Codes and Standards: Comply with requirements of the following codes and standards, except as herein modified:
  - 1. Concrete Reinforcing Steel Institute, "Manual of Standard Practice."
  - 2. American Concrete Institute, ACI 318 "Building Code Requirements for Reinforced Concrete".
- C. For information only, submit 2 copies of steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.
- D. Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with the ACI 315, "Manual of Standard Practice for Detailing Reinforced concrete Structures". Show Bar schedules, stirrup spacing, diagrams of bent bars, arrangements and assemblies, as required for the fabrication and placement of concrete reinforcement.
- E. Deliver reinforcement to the project site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

### **PART 3 - MATERIALS**

- A. Reinforcing Bars (ReBar): ASTM A 615, ASTM A 616 or ASTM 617, as follows:
  - 1. Provide Grade 60 for Bars No. 2 to 11
- B. Steel Wire: ASTM A 82
- C. Welded Wire Fabric (WWF): ASTM A 185
- D. Supports for Reinforcements: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.
  - 1. Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, and other unacceptable materials.
- E. Over waterproof membranes, use precast concrete chairs to prevent penetration of the membrane.

### **PART 4 - FABRICATION**

- A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice". In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken the material.
- B. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the work:
  - 1. Bar lengths, depths and bends exceeding specified fabrication tolerances.
  - 2. Bend or kinks not indicated on drawings or final shop drawings.
  - 3. Bars with reduced cross-section due to excessive rusting or other cause.

### **PART 5 - INSTALLATION**

- A. Comply with the specified codes and standards, and Concrete Reinforcing Steel Institute recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
- B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.



- C. Position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.
- D. Place reinforcement to obtain the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports together with 16 gage wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with 16 gage wire. Do not make end laps midway between supporting beams, or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.
- F. Provide sufficient numbers of supports and of strength to carry reinforcement. Do not place reinforcing bars more than 2" beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
- G. Splices: Provide standard reinforcement splices by lapping ends, placing bars on contact, and tightly wire tying. Comply with requirements of ACI 318 for minimum lap of spliced bars.
- H. Welded wire fabric must have end laps of one full mesh plus two (2) inches between cross wires and edge laps. Welded wire fabric should extend into supporting beams and walls for anchorage unless an expansion joint is called for on the drawings.
- I. Provide dowels in walls at all construction joints and in wall footings, equivalent in size and number to vertical steel extending 30 bar diameters into footing and 30 bar diameters into wall. Lap vertical wall and column rebars 30 bar diameters unless otherwise shown.
- J. Reinforcing steel bends to be made as per diagram, and/or in accordance with the ACI Code.

End of Section

## **SECTION 03310 - CAST-IN-PLACE CONCRETE**

### **PART 1 - GENERAL**

- A. The general provisions of the Contract, including General Conditions and Requirements, apply to the work of this section.

### **PART 2 - DESCRIPTION OF WORK**

- A. Work includes furnishing, forming and placing of all concrete work as shown on the drawings, and specified herein, including the following:
  - 1. All anchor bolts required for anchoring steel columns to concrete installed only.
  - 2. All inserts, anchors, etc., that must be placed in forms for later attachment of work of other trades, except Mechanical-Electrical.
  - 3. Building-in of inserts, anchors, sleeves, etc., as furnished by the Mechanical-Electrical Contractors and Structural Steel Supplier.
  - 4. Expansion Joint Filler.
  - 5. Joint Filler and sealer at edge of slabs.
  - 6. Waterstops.
  - 7. Crushed stone fill under slabs on grade.
  - 8. Vapor barrier under slabs on grade.
    - a. 8 mil. polyethylene
    - b. Vapor Seal 1/8" Heavy Duty
  - 9. Curing Compound, Sealer and Hardener.
- B. The extent of cast-in-place concrete (CIP-Conc) work is shown on the drawings.
- C. The work includes providing cast-in-place concrete (CIP-Conc) consisting of portland cement, fine and coarse aggregate, water, and selected admixtures; combined, mixed, transported, placed, finished and cured as herein specified.

### **PART 3 - RELATED WORK SPECIFIED ELSEWHERE**

- A. Concrete Formwork: Section 03110.
- B. Concrete Reinforcement: Section 03210.

### **PART 4 - CODES AND STANDARD**

- A. Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified.
  - 1. ACI 301 "Specifications for Structural Concrete for Buildings".
  - 2. ACI 318 "Building Code Requirements for Reinforced Concrete".
  - 3. ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete".
  - 4. ACI 311 "Recommended Practice for Concrete Inspection".

- B. Where provisions of the above codes and standards are in conflict with building code in force for this project, the building code shall govern.
- C. The Contractor shall employ, at his own expense, a testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
  - 1. Testing agency shall meet the requirements of ASTM E329.
- D. Selection of a testing laboratory is subject to the Architect's acceptance.
- E. The testing laboratory shall perform field quality control testing. The Contractor shall provide free access and facilities at any time during the progress of the work.
- F. Materials and installed work may require testing and retesting, as directed by the Architect, at any time during the progress of the work. Allow free access to material stockpiles and facilities at all times. Tests, including the retesting of rejected materials and installed work, shall be done at the Contractor's expense.

#### **PART 5 - TESTS FOR CONCRETE MATERIALS**

- A. For normal weight concrete, test aggregates by the methods of sampling and testing of ASTM C33.
- B. For portland cement, sample the cement and determine the properties by the methods of test of ASTM C150.
- C. Submit written reports to the Architect for each material sampled and tested, prior to the start of work. Provide the project identification name and number, date of report, name of contractor, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for intended use.

#### **PART 6 - SUBMITTALS**

- A. For information only, submit 2 copies of manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures, bonding agents, waterstops, joint systems, chemical floor hardeners, and dry shake finish materials.
- B. Submit samples of materials as specified and as otherwise may be requested by the Architect, including names, sources and descriptions as required.
- C. Submit 2 copies of laboratory test reports for concrete materials and mix design tests. The Architect's review will be for general information only. Production of concrete to comply with specified requirements is the Contractor's responsibility.
- D. Provide materials certificates in lieu of materials laboratory test reports only when permitted by the Architect. Material certificates shall be signed by the material manufacturer and the Contractor, certifying that each material item complies with, or exceeds, the specified requirements.

- E. Delivery Tickets: Furnish copies of delivery tickets for each load of concrete delivered to the site. Provide items of information as specified.

## PART 7 - CONCRETE

- A. All concrete shall conform and be designed, mixed, placed, tested and cured in accordance with the ultimate strength provisions of the American Concrete Institute Building Code. All concrete shall develop the following compressive strength in 28 days.

	<u>Compressive Strength Concrete Schedule</u>		
	Minimum 28-Day Compressive Strength	Max. - Min. Slump (inch)	Air Content (%)
All concrete not otherwise indicated	3,500	4-1	2%-4%
Exterior plaza slabs	4,000	3-1	4%-7%

## PART 8 - CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, as follows:
1. Provide Type 1 cement, except as otherwise indicated. Type 3 cement may be used in lieu of Type 1 at Contractor's option, when acceptable to the Architect.
  2. Provide Type 3 cement for High-Early Strength concrete for exterior concrete when acceptable to the Architect.
- B. Use only one brand of cement for each required type throughout the project, unless otherwise accepted by the Architect.
- C. Aggregates: ASTM C 33, and as herein specified.
1. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to the Architect.
  2. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite or ochre which can cause stains on exposed concrete surfaces.
  3. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
  4. Dune sand, bank run sand and manufactures sand are not acceptable.
  5. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter.
  6. Crushed stone, processed from natural rock or stone.
  7. Washed gravel, either natural or crushed. Use of pit or bank run gravel is not permitted.
  8. Maximum Aggregate Size: Not larger than one-fifth of the narrowest dimension between sides of forms, one-third of the depth of slabs, nor three-fourths of the minimum clear spacing between individual reinforcing bars or bundles of bars.

- D. Supply of Aggregates: Provide aggregates from one source of supply to ensure uniformity in color, size and shape.
- E. Water: Clean, fresh, drinkable.
- F. Provide admixtures produced by established reputable manufacturers and use in compliance with the manufacturer's printed directions. Do not use admixtures which have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by the Architect.
  - 1. Air-Entraining Admixtures: ASTM C 260.
  - 2. Water-Reducing Admixture: ASTM C 494, Type A.
- G. Calcium Chloride: Do not use calcium chloride in concrete, unless otherwise authorized in writing by the Architect. Do not use admixtures containing calcium chloride where concrete is placed against galvanized steel, or in mix using high-early strength cement.

## **PART 9 - PROPORTIONING AND DESIGN OF MIXES**

- A. Prepare design mixes for each type of concrete. Use an independent testing facility acceptable to the Architect for preparing and reporting proposed mix designs.
- B. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each class of concrete required, complying with ACI 211.1 and report to the Architect the following data:
  - 1. Complete identification of aggregate source of supply.
  - 2. Tests of aggregates for compliance with specified requirements.
  - 3. Scale weight of each aggregate.
  - 4. Absorbed water in each aggregate.
  - 5. Brand, type and composition of cement.
  - 6. Brand, type and amount of each admixture.
  - 7. Amounts of water used in trial mixes.
  - 8. Proportions of each material per cu. yd.
  - 9. Gross weight and yield per cu. yd of trial mixtures.
  - 10. Measured slump.
  - 11. Measured air content.
  - 12. Compressive strength developed at least 7 days and 28 days, from not less than 3 test cylinders cast for each 7 and 28-day test, and for each design mix.
- C. Submit written reports to the Architect of each proposed mix for each type of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by the Architect.
- D. Laboratory Trial Batches: When laboratory trial batches are used to select concrete proportions, prepare test specimens in accordance with ASTM C 192 and conduct strength tests in accordance with ASTM C 39, as specified in ACI 301.
- E. Establish a curve showing relationship between water-cement ratio (or cement content) and compressive strength, with at least 3 points representing batches which produce strengths above and below that required. Use not less than 3 specimens tested at 28-days, or an earlier age when acceptable to the Architect, to establish each point on the curve.

- F. Field Experience Method: When field experience methods are used to select concrete proportions, establish proportions as specified in ACI 301.
- G. Strength data for establishing standard deviation will be considered suitable if the concrete production facility has certified records consisting of at least 30 consecutive tests in one group or the statistical average for 2 groups totaling 30 or more tests, representing similar materials and project conditions.
1. Standard Deviation: If standard deviation exceeds 600 psi or if no suitable records available, select proportions to produce an average strength of at least 1200 psi greater than the required compressive strength concrete.
  2. After sufficient experience and test data become available from the job, using ACI 214 methods of evaluation, the standard deviation may be reduced when the probable frequency of tests more than 500 psi below required compressive strength will not exceed 1 in 100, and that the probable frequency of an average of 3 consecutive tests below required compressive strength will not exceed 1 in 100.
- H. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the Owner and as accepted by the Architect. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by the Architect before using in the work.
- I. Use air-entraining admixture in exterior exposed concrete, unless otherwise shown or specified. Add air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the following limits:
1. Concrete structures and slabs exposed to freezing and thawing or subjected to hydraulic pressure:
    - a. 4% for maximum 2" aggregate.
    - b. 6% for maximum 3/4" aggregate.
    - c. 7% for maximum 1/2" aggregate.
  2. Other Exterior Concrete: 2% to 4% air.
- J. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control
- K. Proportion and design mixes to result in concrete slump at the point of placement as follows:
1. Ramps and Sloping Surfaces: Not more than 3".
  2. Reinforced Foundation Systems: Not less than 1" and not more than 3".
  3. All Other Concrete: Not less than 1" and not more than 3".

## PART 10 - CONCRETE MIXING

- A. Concrete may be mixed at batch plants or it may be transit-mixes as specified herein. Batch plants must comply with the requirements of ACI 304, with sufficient capacity to produce concrete of the qualities specified in quantities required to meet the construction schedule. All plant facilities are subject to testing laboratory inspection and acceptance of the Architect.
- B. Comply with the requirements of ASTM C 94, and as herein specified, provided the quantity and rate of delivery will permit unrestricted progress of the work in accordance with the placement schedule. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required, as specified below. Proposed changes in mixing procedures, other than herein specified, must be accepted by the Architect before implementation.
1. Plant equipment and facilities: Conform to National Ready-Mix Concrete Association "Check List for Certification of Ready-Mixed Concrete Production Facilities.
- C. Modifications to ASTM C 94 are as follows:
1. Quality of Concrete: Provide concrete materials, proportions, and properties as herein specified, in lieu of ASTM Section 4.
  2. Tolerances in Slump: Provide slump of not more than the values as herein specified, in lieu of ASTM Section 5.1. Comply with other criteria of ASTM Section 5.
  3. Mixing and Delivery: Delete the references for allowing additional water to be added to the batch for material with insufficient slump. Addition of water to the batch will not be permitted as specified in ASTM Section 9.7, when the air temperature is between 85 degrees F. and 90 degrees F., reduce the mixing and delivery time to 60 minutes. When a truck mixer is used for the complete mixing of the concrete, begin the mixing operation within 30 minutes after the cement has been intermingled with the aggregates.
  4. Certification: Furnish duplicate delivery tickets with each load of concrete delivered to the site, one for the Architect and one for the Contractor. In addition to the requirements of ASTM Section 14.1, provide the following information on delivery tickets:
    - a. Type and brand of cement.
    - b. Cement content per cu. yd. of concrete.
    - c. Maximum size of aggregate.
    - d. Amount and brand name of each admixture.
    - e. Total water content expressed as water/cement ratio.
  5. Strength: Delete ASTM Section 15; comply with concrete testing requirements as herein specified.

- D. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.

## **PART 11 - FIELD QUALITY CONTROL**

- A. Perform sampling and testing for field quality control during the placement of concrete, as follows:
1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
  2. Slump: ASTM C 143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
  3. Air Content: ASTM C 231, pressure method; one for every other concrete load at point of discharge, or when the indicating of change requires.
  4. Compression Test Specimens: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed.
    - a. Cast and store cylinders for laboratory cured test specimens and field-cured test specimens as specified in ASTM C 31.
  5. Concrete Temperature: Test hourly when air temperature is 40 degrees F. and below, and when 80 degrees F. and above and each time a set of compression test specimens made.
  6. Compressive Strength Tests: ASTM C 39; one set for each 25 cu. yds. or fraction thereof, of each mix design placed in any one day ; 1 specimen tested at 7 days, 2 specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
    - a. When the frequency of testing will provide less than 5 strength tests for a given mix design, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
    - b. When the strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
- B. Report test results in writing to the Architect, Contractor, and Ready-Mix supplier on the same day that tests are made. Reports of compressive strength tests shall contain the project identifications name and number, date of concrete placement, name of contractor, name of concrete supplier and truck number, name of concrete testing service, concrete type and class, location of concrete batch in the 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.



- C. The testing service will make additional tests of in-place concrete when test results indicate the specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Architect. The testing service shall conduct tests to determine the strength and other characteristics of the in-place concrete by compression tests on cored cylinders complying with ASTM C 42, or by load testing specified in ACI 381, or other acceptable non-destructive testing methods, as directed. The Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.
- D. Do not use concrete delivered to the final point of placement which has slump or total air content outside the specified values.
- E. Compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength test results equal or exceed the 28-day design compressive strength of the type or class of concrete; and, no individual strength test falls below the required compressive strength by more than 500 psi.
- F. Strength tests of specimens cured under field conditions may be required by the Architect to check the adequacy of curing and protection of the concrete places. Specimens shall be molded by the filed quality control laboratory at the same time and from the same samples as the laboratory cured specimens.
- G. Provide improved means and procedures for protecting concrete when the 28-day compressive strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders.
- H. When laboratory-cured cylinder strengths are appreciably higher than the minimum compressive strength, field-cured cylinder strengths need not exceed the minimum required compressive strength by more than 500 psi even though the 85% criterion is not met.
- I. If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection curing, provide additional measures to assure that the load-bearing capacity of the structure is not jeopardized. If the likelihood of low-strength concrete is confirmed and computations indicate the load-bearing capacity may have been significantly reduced, tests of cores drilled from the area in question may be required.
- J. If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and subject to additional testing as herein specified.

## **PART 12 - FORMED CONCRETE DIMENSIONAL TOLERANCES**

- A. Formed concrete having any dimension smaller or greater than required, and outside the specified tolerance limits, will be considered deficient in strength and subject to additional testing as herein specified.

- B. Formed concrete having any dimension greater than required will be rejected if the appearance or function of the structure is adversely affected, or if the larger dimensions interfere with other construction. Repair, or remove and replace rejected concrete as required to meet the construction conditions. When permitted, accomplish the removal of excessive material in a manner to maintain the strength of the section without affecting function and appearance.

### **PART 13 - STRENGTH OF CONCRETE STRUCTURES**

- A. The strength of the concrete structure in-place will be considered potentially deficient if it fails to comply with any of the requirements which control the strength of structure, including the following conditions.
  - 1. Failure to meet compressive strength tests requirements.
  - 2. Concrete which differs from the required dimensions or location in such a manner to reduce strength.
  - 3. Concrete subjected to damaging mechanical disturbances; particularly load stresses, heavy shock, and excessive vibration.
  - 4. Poor workmanship and quality control likely to result in deficient strength.
- B. When there is evidence that the strength of the concrete structure in-place does not meet specification requirements, the concrete testing service shall take cores drilled from hardened concrete for compressive strength determination, complying with ASTM C 42 and as follows:
  - 1. Take at least 3 representative cores from each member or area or suspect strength, from locations directed by the Architect.
  - 2. Test cores in a saturated-surface-dry condition per ACI 318 if the concrete will be wet during the use of the completed structure.
  - 3. Test cores in an air-dry condition per ACI 318 if the concrete will be dry at all times during use of the completed structure.
  - 4. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 85% and no single core is less than 75% of the 28-day required compressive strength.
  - 5. Report test results in writing to the Architect on the same day that tests are made. Include in test reports the project identification name and number, date, name of contractor, name of concrete testing service, location of test core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength and type of break (corrected for length-diameter ratio) direction of applied load to core with respect to horizontal plane of the concrete as placed, and the moisture condition of the core at time of testing.

6. Fill core holes solid with patching mortar, and finish to match adjacent concrete surfaces.
  7. Conduct static load test and evaluations complying with ACI 318 if the results of the core tests are unsatisfactory, or if core tests are impracticable to obtain, as directed by the Architect.
- C. Concrete work which does not conform to the specified requirements, including strength, tolerances, and finishes, shall be corrected at the Contractor's expense, without extension of time therefore. The Contractor shall also be responsible for the cost of corrections to any other work affected by or resulting from corrections to the concrete work.

#### **PART 14 - JOINT MATERIALS**

- A. Preformed Expansion Joint Fillers: Type I - Standard - highly resilient.
- B. Joint Sealing Compound: Polysulfide sealants, elastomeric caulk; Hornflex by Construction Products Division, W.R. Grace & Company or an approved equal.

#### **PART 15 - MOISTURE BARRIER**

- A. Provide moisture barrier cover over prepared base material where shown on drawings. Use only materials which are resistant to decay when tested in accordance with ASTM E 154, as follows:
  1. Polyethylene sheet not less than 10 mils thick.
  2. Water resistance barrier paper consisting of heavy Kraft paper laminated together with glass fiber reinforcement and overcoated with black polyethylene on each side.

#### **PART 16 - BONDING AGENT**

- A. Chemical Bonding Agent: Film-forming, freeze-thaw resistant compound suitable for brush or spray application complying with Mil B-19235.
- B. Provide concrete bonding agent as manufactured by one of the following or approved equal.
  1. Polyweld; Chem-Master Corp.
  2. Daraweld-PBA; W,R, Grace

#### **PART 17 - FLOOR FINISH MATERIALS**

- A. Chemical Floor Hardener (ChHd-Fn): Colorless, transparent, oil free moisture, sodium silicate or polyurethane seals, dust proofs, hardens interior concrete floors. Place on floor slab concrete and slab on grades, interior concrete floors only.

1. Apply to exposed concrete slabs not indicated or scheduled to receive subsequent finishes.
  2. Products offered by manufacturers to comply with the requirements for colorless liquid chemical floor hardener include the following:
    - a. Sonsothane - Sonneborn-Contech
    - b. Horn One-Kote - A.C. Horn/W. R. Grace & Co.
    - c. Lithoplate; Protex Industries
- B. Under no circumstances shall dry cement or mixture of cement and sand be used to absorb surface moisture or to stiffen surface to be finished. See manufacturer's recommendation for curing and sealant.
- C. Hard Steel Trowel Finish - After slab concrete has been placed, surface shall be brought to established grade, with straight-edge and bull floated to "smooth out" surface. When water sheen has disappeared, surface shall be floated with power and/or wood floats. After floating with power and no water appears when trowel is operated, surface shall be troweled until smooth hard surface is obtained free of pin holes and other imperfections. All hard trowel finishes shall be treated with a one component, oil free, polyurethane sealer and hardener applied in strict accordance with the manufacturer's recommendations, and specifications for structural concrete for buildings ACI 301-72, Chapter 11 - Slabs, Exposed.
- D. This Contractor shall take care to protect concrete work and finished concrete during construction. If work is damaged or finished surfaces marred by subsequent construction, this Contractor shall restore or rebuild concrete work to satisfaction of the Architect and remove damaged materials from site at this Contractor's expense.
- E. Work on slabs on grade shall begin only after earth subgrade has been thoroughly compacted as described under another Section of the Specifications, after pipes and drains to be located under slabs are placed, tested and approved.
- F. Work under this Section includes furnishing, placing and compacting of clean porous fill of washed gravel or crushed stone under slabs on grade. Porous fill shall be 6" thick and shall be compacted by rollers and by machine driven tampers or by mechanical vibration. Fill shall be free from protrusions which would puncture vapor barrier.
- G. At edge of interior slabs adjoining foundation walls and at all other places where floor slab is pierced, provide joint filler and sealer as specified herein.

## **PART 18 - CONTROL JOINTS**

- A. Form control joints in concrete wall where shown and as detailed on the Drawings.

## **PART 19 - CONCRETE CURING MATERIALS**

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd. and complying with AASHO M 182, Class 3.
- B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171:
  - Waterproof Paper
  - Polyethylene Film
  - White Burlap-Polyethylene Sheet
- C. Liquid Membrane-Forming Curing Compound: Liquid type membrane-forming curing compound complying with ASTM C 309, Type 1, unless other type acceptable to the Architect.
  - 1. Products offered by manufacturers to comply with the requirements for membrane-forming curing compounds include the following:
    - Masterseal; Master Builder's Co.
    - Clear Seal; A.C. Horn/W.R. Grace
    - Kure-N-Seal; Sonneborn-Contech
    - Polyclear; Upco Chemical/USM Corp.
    - Clear Cure; L&M Construction Chemicals
    - Klearseal; Castle Chemical Corp.
    - LR-151; Protect Industries

## **PART 20 - PREPARATION**

- A. Before placing concrete, inspect and complete the form work installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts involved in ample time to permit the installation of their work; cooperate with other trades in setting such work, as required.
- B. Forms shall be constructed of materials as indicated for use and purpose intended. See Architect's Drawings also.
- C. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

## **PART 21 - CONCRETE PLACEMENT**

- A. Place concrete in compliance with the practices and recommendations of ACI 304, and as herein specified.
- B. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practicable to its final location to avoid segregation due to handling or flowing. Do not subject concrete to any procedure which will cause segregation.
- C. Screed concrete which it is to receive other construction to the proper level to avoid excessive skimming or grouting.

- D. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use re-tempered concrete. Remove rejected concrete from the project site and dispose of in an acceptable location.
- E. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practicable by methods which will prevent segregation and loss of concrete mix materials.
- F. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice, and other deleterious materials.
- G. Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
- H. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.
- I. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the recommended practices of ACI 309, to suit the type of concrete and project conditions. Vibration of forms and reinforcing will not be permitted, unless otherwise accepted by the Architect.
- J. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
- K. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
- L. Bring slab surfaces to the correct level with a straight edge and strike off. Use bull flats or darbies to smooth the surface. Do not disturb the slab surfaces prior to beginning finishing operations.
- M. Maintain reinforcing steel in the proper position continuously during concrete placement operations.

## **PART 22 - BONDING**

- A. Roughen surfaces of set concrete at all joints, except where bonding is obtained by use of a concrete bonding agent, and clean surfaces of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in manner to expose bonded aggregate uniformly and not to levee laitance, loose particles of aggregate, or damaged concrete at the surface.

### **PART 23 - EXTERIOR AND INTERIOR WALLS**

- A. Grout air holes with mortar. Remove excess grout. Patches shall be ground to produce uniform surfaces, free of blemished and fins to the satisfaction of the Architect. Patches shall be kept continuously moist for a period minimum of six days.
- B. Fill tie holes after form oil have evaporated sufficiently for good bond as specified for patching operation above. Exposed walls shall receive a rubbed finish.
- C. At completion, concrete shall be of uniform texture and finish.

### **PART 24 - COLD WEATHER PLACING**

- A. Protect all concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.
- B. When the air temperature has fallen to or is expected to fall below 40 degrees F., provide adequate means to maintain the temperature in the area where concrete is being placed at either 70 degrees F for 3 days or 50 degrees F for 5 days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Keep protections in place and intact at least 24 hours after artificial heat is discontinued. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
- C. When air temperature has fallen to or is expected to fall below 40 degrees F. uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 50 degrees F. and not more than 80 degree F. at point of placement.
- D. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcing steel, and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.
- E. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators.

### **PART 25 - HOT WEATHER PLACING**

- A. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

- B. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing water.
- C. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
- D. Wet forms thoroughly before placing concrete.
- E. Use set-control admixtures when required and accepted in mix designs.

## **PART 26 - CONSTRUCTION JOINTS**

- A. Locate and install construction joints, which are not shown on the drawings, so as not to impair strength and appearance of the structure, as acceptable to the Architect. Locate construction joints, if required but not shown as follows:
  - 1. In slabs on ground, so as to divide the slab into areas not in excess of 1200 sq.ft., unless otherwise accepted by the Architect. Conform to slab placement diagrams or pattern layout for placement, where shown.
- B. Provide keyways at least 1½” deep in all construction joints in walls, slabs, and between walls and footings.
- C. Place construction joints perpendicular to the main reinforcement. Continue all reinforcement across construction joints.

## **PART 27 - ISOLATION JOINTS IN SLABS ON GROUND**

- A. Provide isolation joints in slabs on ground at all points of contact between slabs on ground and vertical surfaces, such as foundation walls, grade beams, and elsewhere as indicated.
- B. Provide control joints in slabs on ground to form panels or patterns as shown. Use inserts ⅛” wide x 1¼” deep below the slab surface, after the concrete has cured for at least 7 days.

## **PART 28 - FINISH OR FORMED SURFACES**

- A. Provide as-cast rough form finish to formed concrete surfaces that are to be concealed in the finish work or by other construction, unless otherwise indicated.
- B. Standard form finish shall be the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched and all fins and other projections exceeding 1/4" in height rubbed down or chipped off.
- C. Provide smooth rubbed (SmRbd-Fn) to front exterior exposed concrete surfaces, which have received smooth form finish treatment, not later than the day after form removal.



- D. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.
- E. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently to permit the operation of a power-driven float, or both. Consolidate the surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level the surface plane to a tolerance not exceeding 1/4" in 10' when tested with a 10' straightedge placed on the surface at not less than 2 different angles. Cut down high spots and fill all low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform smooth, granular texture.

#### **PART 29 - CHEMICAL-HARDENER FINISH: INTERIOR FLOOR TOPPING CONCRETE**

- A. Apply chemical-hardener finish to dry interior concrete floors where shown on the drawings or in schedules. Apply liquid chemical-hardener after complete curing and drying of the concrete surface. Dilute the liquid hardener with water, and apply in 3 coats; 2/3 strength. Evenly apply each coat, and allow 24 hours for drying between coats.
- B. Apply proprietary chemical hardeners in accordance with the manufacturer's printed directions.
- C. After the final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

#### **PART 30 - CONCRETE CURING AND PROTECTION**

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper period of time necessary for hydration of the cement and proper handling of the concrete.
- B. Start initial curing as soon as free moisture has disappeared from the concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 72 hours.
- C. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures. Avoid rapid drying at the end of the final curing period.

#### **PART 31 - CURING METHODS**

- A. Perform curing of concrete by moist curing, by moisture-retaining cover curing, by membrane curing, or by combinations thereof, as herein specified, optional to the Contractor with approval from the Architect.

1. For curing, use only water that is free of impurities which could etch or discolor exposed, natural concrete surfaces.
2. Keeping the surface of the concrete continuously wet by covering with water.
3. Continuous water-fog spray.
4. Covering the concrete surface with the specified absorptive cover, thoroughly saturating the cover with water, and keeping the absorptive continuously wet. Place absorptive cover so as to provide coverage of the concrete surfaces and edges, with a 4" lap over adjacent absorptive covers.
5. Cover the concrete surfaces with the specified moisture-retaining cover for curing concrete, placed in the 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 the curing period using cover material and waterproof tape.
6. Apply the specified membrane-forming curing compound to damp concrete surfaces as soon as the water film has disappeared. Apply uniformly in a 2-coat continuous operation by power spray equipment in accordance with the manufacturer's directions. Recoat areas which are subjected to heavy rainfall within 3 hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period.
7. Do not use membrane curing compounds on surfaces which are to be covered with a coating material applied directly to the concrete or with a covering material bonded to the concrete, such as other concrete, liquid floor hardener, waterproofing, damp proofing, membrane roofing, flooring, painting and other coatings and finish materials, unless otherwise acceptable to the Architect.

#### **PART 32 - CURING FORMED SURFACES**

- A. Cure formed concrete surfaces, including the undersides of girders, joist, beams, supported slabs and other similar surfaces by moist curing with the forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

#### **PART 33 - CURING UNFORMED SURFACES**

- A. Initially cure unformed surfaces, such as slabs and other flat surfaces by moist curing, whenever possible.
- B. Final cure unformed surfaces, unless otherwise specified, by any of the methods specified above, as applicable.
- C. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise acceptable to the Architect.

## **PART 34 - FINAL CURING OF CONCRETE**

- A. During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished surfaces from damage by subsequent construction operations.

## **PART 35 - MISCELLANEOUS CONCRETE ITEMS**

- A. Provide concrete grout for reinforced masonry lintels door jambs and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.
- B. Fill-in holes and opening left in concrete structures for the passage of work by other trades, unless otherwise shown or directed, after the work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the work.
- C. Place dove tail slots in all concrete surfaces where concrete and masonry walls connect.
- D. The concrete in each integral unit of the structure shall be placed continuously, and the Contractor shall not begin work without sufficient approved material on hand nor without sufficient forces and equipment to complete that unit without interruption in placing the concrete.
- E. Reinforce all walls, unless otherwise specified or shown on the drawings, with number five (5) bars at 12 inches on centers horizontal and vertical.
- F. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- G. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on the drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of the manufacturer furnishing the machines and equipment.

## **PART 36 - CONCRETE SURFACE REPAIRS**

- A. Repair and patch defective areas with cement mortar immediately after removal of forms, but only when directed by the Architect.
- B. Cut out honeycomb, rock pockets, voids over 1/2" diameter, and holes left by tie rods and bolts, down to solid concrete but, in no case, to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water, and brush-coat the area to be patched with neat cement grout. Proprietary patching compounds may be used when acceptable to the Architect.

- C. For exposed-to-view-surfaces, blend white portland cement and standard portland cement so that, when dry, the patching mortar will match the color of the surrounding concrete. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.
- D. Fill holes extending through concrete by means of a plunger-type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure complete filling.
- E. Repair of Unformed Surfaces: Test unformed surfaces, such as slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.
- F. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.
- G. Repair finished unformed surfaces that contain defects which adversely affect the durability of the concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectional conditions.
- H. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
- I. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to the Architect.
- J. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4" clearance all around. Dampen all concrete surfaces in contact with patching concrete and brush with a neat cement grout coating, or use concrete bonding agent. Place patching concrete before grout takes its initial set. Mix patching concrete of the same type or class as the original adjacent concrete. Place, compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
- K. Repair isolated random cracks and single holes not over 1" in diameter by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete and clean out dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with a neat cement grout coating. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part portland cement to 2½ parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.
- L. Repair methods not specified above may be used, subject to the acceptance of the Architect.

End of Section

## SECTION 03371 - GROUT

### PART 1 - GENERAL

- A. The general provision of the Contract, including General and Supplementary Conditions and Requirements, apply to the work specified in this section.

### PART 2 - RELATED WORK SPECIFIED ELSEWHERE

- A. Structural steel base plates, anchoring devices and leveling shims: Section 5A.

### PART 3 - DELIVERY AND STORAGE

- A. Prevent damage to or contamination of non-shrink grouting materials during delivery, handling and storage.
- B. Store all non-shrink grouting materials in undamaged condition with seals and labels intact as packaged by the manufacturer.
- C. Non-shrink grout - SonogROUT - Sonneborn - Contech by Sonneborn Building Products Division or approved equal to be used under bearing plates or for grouting rebar dowels into existing walls.

### PART 4 - MATERIALS

- A. Non-shrink grout conforming to the following requirements:
  - 1. Manufactured under rigid quality control specifically for grout used in transferring heavy loads.
  - 2. Contain metallic and non-metallic aggregates especially graded to minimize bleeding.
  - 3. Contain metallic aggregate that is ductile and capable of withstanding impact without fracturing.
  - 4. Have an initial setting time of approximately one hour at 70 degrees F.
  - 5. Produce no settlement or drying shrinkage at 3 days or thereafter.
  - 6. Have higher strength at all ages than plain cement grout of the same flowability.
  - 7. Resist attack by oil and water and have lower absorption than plain cement grout of the same flowability.
- B. Portland Cement: ASTM C 150-72, Type 1.
- C. Sand: ASTM C 33-71a, Fine Aggregate.
- D. Pea Gravel: ASTM C 33-71a. Coarse aggregate, graded so that at least 90 percent passes 3/8-inch sieve and 90 percent is retained by a number 4 sieve.

## **PART 5 - MIXES**

- A. For less than 2-inch clearance, or where size or shape of space makes grouting difficult, grout mix shall consist of grout material and water.
- B. For greater than 2-inch clearances where coarse aggregate will not obstruct free passage of the grout, extend grout by adding 50 pounds of pea gravel per 100 pounds of grout material.
- C. Use the minimum amount of water necessary to produce a flowable grout without causing either segregation or bleeding.
- D. Portland cement mortar for raked-out edges of non-shrink grout: 1 part Portland cement, 2 parts sand and 0.50 parts water by weight.

## **PART 6 - MIXING**

- A. Mix non-shrink grouting materials and water in a mechanical mixer for no less than 3 minutes.
- B. Mix grout as close to the work areas as possible and transport the mixture quickly and in a manner that does not permit segregation of materials.
- C. After the grout has been mixed, do not add more water for any reason.

## **PART 7 - PROCEDURES**

- A. Installation methods and procedures shall be approved by the Engineer's representative before work is begun.

## **PART 8 - SURFACE PREPARATION**

- A. Remove all defective concrete, laitance, dirt, oil, grease, and other foreign material from concrete surfaces by bush-hammering, chipping, or other similar means, until a sound, clean concrete surface is achieved.
- B. Lightly roughen the concrete, but not enough to interfere with the proper placement of grout.
- C. Cover concrete area with waterproof membrane until ready to grout.
- D. Remove foreign materials from all steel surfaces in contact with grout.
- E. Align, level, and maintain final positioning of all components to be grouted.
- F. Take special precautions during extreme weather conditions according to the manufacturer's written instructions.

- G. Immediately before grouting, remove waterproof membranes and clean any contaminated surfaces.
- H. Saturate all concrete surfaces with clean water; remove excess water and leave none standing.

## **PART 9 - PLACING**

- A. Place non-shrink grouting material quickly and continuously by the most practical means permissible; pouring, pumping, or under gravity pressure.
- B. Do not use either pneumatic-pressure or dry packing methods without written permission of the Architect.
- C. Apply grout from one side only to avoid entrapping air.
- D. Final installation shall be thoroughly compacted and free from air pockets.
- E. Do not vibrate the placed grout mixture, or allow it to be placed if the area is being vibrated by nearby equipment.
- F. Do not remove leveling shims for at least 48 hours after grout has been placed.
- G. After shims have been removed, fill voids with plain cement-sand grout.
- H. After the non-shrink grout has reached initial set, rake out all exposed edges approximately 1-inch into the grouted area and point with portland cement mortar.

## **PART 10 - CURING**

- A. Cure grout for 3 days after placing by keeping wet and covering with curing paper or by another approved method.

End of Section