

## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section includes:
  - 1. Cast-in-place concrete, including concrete over metal deck, footings, shear walls, link beams and drag beams.
  - 2. Floors and slabs on grade and on vapor barrier.
- B. Work installed but furnished in other Sections:
  - 1. Items to be embedded in concrete.
- C. Related work:
  - 1. Concrete reinforcement: Section 03200.
  - 2. Vapor barrier under slabs-on-grade: In compliance with Division 7.

##### 1.2 SUBMITTALS

- A. Procedure: In compliance with Division 1.
- B. Data: Manufacturers' brochures and technical data for all manufactured products.
- C. Certificates:
  - 1. Cement certification.
  - 2. Admixture certification: Include chloride ion content.
  - 3. Batch plant tickets.
- D. Concrete mix designs for approval: Certified concrete mix designs for initial and any subsequent changes in mix designs.

##### 1.3 QUALITY ASSURANCE

- A. Mock-up: Before beginning work, cast a sample panel of each type of finish at a location on the site agreed-upon with the Architect.
  - 1. Protect panel until its removal is authorized by the Architect. Make such modifications as necessary to achieve a panel satisfactory to the Architect.
  - 2. Approved panel shall serve as the standard for all remaining work. Remove panel only after completion and acceptance of work.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Portland cement: ASTM C 150, Type II low alkali, typical, Type V for all elements in contact with earth. Do not change source, brand or type of cement without Architect's written approval.
- B. Fly ash: ASTM C 618, Type F. Do not change source, brand or type of fly ash without Architect's written approval.
- C. Aggregates: Submit pit source and characteristics of each type aggregate to Architect prior to designing mixes.
  - 1. Hardrock aggregates: ASTM C 33 graded so that coarse aggregate nominal size is not larger than 1/5 of the narrowest dimension between form faces; nor 3/4 of the minimum clear spacing between individual reinforcing bars or bundles of bars, whichever is less, but never greater than 3/4 inch in any dimension for slabs 4 inches thick or less; 1-1/2 inches at all other locations.
  - 2. Lightweight structural concrete: Mixed of portland cement, sand, coarse lightweight aggregates, an air-entraining admixture and water. Testing laboratory shall design lightweight structural concrete in accordance with ACI 211.2 for 28-day compressive strengths required by Drawings or specified herein, with weight not exceeding 110 lbs. per cubic foot air dry. Trial batch strengths shall be as specified above. Lightweight structural concrete shall meet the drying shrinkage requirements specified.
- D. Admixtures:
  - 1. May be used only with the Architect and the Building Department approval.
  - 2. Submit manufacturer's data for products proposed for use to the Architect in compliance with the requirements of Section 01334.
- E. Water: Fresh, clean, and free of oil and other materials injurious to concrete.
- F. Structural adhesive: ASTM C 881, 2-component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements.
  - 1. Rezi-Weld 1000 by WR Meadows.
  - 2. Thiopoxy by WR Grace.
  - 3. Sikadur Hi-Mod by Sika Chemical Corp.
  - 4. Patch and Bond Epoxy by The Burke Co.
- G. Sealer: One of the following.
  - 1. Cure-Hard by WR Meadows (sodium silicate).
  - 2. Ashford Formula by Curecrete Chemical Co. (sodium silicate).
  - 3. Lapidolith by Sonneborn (magnesium or zinc fluosilicate).
  - 4. Chem Hard (magnesium fluosilicate), Fluohard (magnesium fluosilicate) or Seal Hard (siliconate/sodium silicate) by L&M Construction Chemicals, Inc.
  - 5. Saniseal 50 by Master Builders Co. (magnesium or zinc fluosilicate).

- H. Curing compound:
  - 1. Liquid membrane-forming compound complying with ASTM C 309, Type I (1D), Class B, guaranteed not to affect the appearance of the concrete surfaces, and the bond, adhesion, or effectiveness of finishes and surface treatment specified herein to be applied to concrete.
  - 2. Curing compound used on exposed concrete surfaces shall be non-discoloring, fast drying and shall be conclusively demonstrated not to darken or yellow with age.
  - 3. Curing compound for use on concrete floors to receive adhered covering shall be specially formulated for such use and shall be certified by the manufacturer not to inhibit the bonding qualities of flooring adhesives.
- I. Dry-pack and grout: One of the following:
  - 1. Masterflow 713 by Master Builders.
  - 2. Five Star Grout by US Grout Corp.
  - 3. Fondag Nonshrink Grout by Specrete Products, Ltd.
- J. Expansion joint materials:
  - 1. Joint filler: Use in combination with plastic joint cap made by Greenstreak, Quaker Plastic Corp., WR Meadows, or equal.
    - a. Homex Expansion Joint by Homasote Co., or equal non-bituminous product compatible with sealant specified in Section 07920.
    - b. Sealtight self-expanding cork by WR Meadows, or equal compatible with sealant specified in Section 07920.
  - 2. Joint sealant and back-up rod: As specified in Section 07920.
- K. Curing paper: Orange Label Sisalkraft by Fortifiber Corp., or equal.
- L. Water stop: One of the following.
  - 1. Waterstop-Rx by Cetco.
  - 2. Waterstop-Plus by Intercontinental Chemical and Equipment, Inc. (Waterstop-Plus is extruded from a cartridge sealant.)
  - 3. Bluestop by Vinyltex Corp.

## 2.2 SOURCE QUALITY CONTROL

- A. Employ a testing laboratory, acceptable to the Owner and Architect, to test the materials for conformance with these Specifications before concrete mixes are established and when source is changed, unless recent test results of materials to be used on the Project, performed by an acceptable testing laboratory, are accepted by the Architect.
- B. Testing coarse aggregates:
  - 1. Test aggregates before and after concrete mix is established and whenever the character source of material is changed, but not less than one test for each 500 cubic yards.

2. Perform a sieve analysis to determine conformity with limits of gradation. Perform sampling and testing according to ASTM C 33, and as follows:
  - a. Sampling of aggregates: ASTM D 75. Take samples of aggregates at source of supply, or if source of supply has been approved, from storage bunkers at ready-mixed concrete plant.
  - b. Testing of aggregates shall include:
    - 1) Sieve analysis: ASTM C 136.
    - 2) Organic impurities: ASTM C 40. Fine aggregate shall develop a color not darker than the referenced standard color.
    - 3) Soundness: ASTM C 88. Loss after 5 cycles not over 8% for coarse aggregate, nor 10% for fine aggregate.
    - 4) Abrasion: ASTM C 131. Weight loss not over 10-1/2% after 100 revolutions, nor 42% after 500 revolutions.
    - 5) Deleterious materials: ASTM C 33.
    - 6) Materials passing No. 200 sieve: ASTM C 117, not over 1% for gravel, 1.5% for crushed aggregate per ASTM C 33.
    - 7) Reactive materials: ASTM C 289. Aggregates shall indicate no potential deleterious reactivity.
    - 8) Definitions: ASTM C 125.
3. Cement test:
  - a. The cement mill laboratory will be acceptable as testing laboratory for this purpose when approved by the Building Department. Submit evidence to show that the cement mill laboratory is qualified to perform tests. The laboratory shall make tests for every 500 barrels or fraction thereof of cement used, in compliance with ASTM C 150.
  - b. Make tensile strength test at 7 days. Tag the cement for identification at the location of sampling. A representative of the Testing Agency shall certify that materials being used are taken from the lots sampled and tested for this report.

### 2.3 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
  1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
  2. Proportion lightweight structural concrete according to ACI 211.2 and ACI 301.

B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.

1. Requirements of Mix designer:

a. List design mixes required, stating where each applies, and identified as follows:

1) "(3-57 AR Col)" which interpreted means 3000 psi, Size 57 agg., air-entrained retarder used for columns.

b. Design concrete mixes subject to controls specified under Paragraph, "Proportioning", including adjustments for seasonality.

c. Verify adequacy of design mix for compressive strength in accordance with ACI 301, Method 1 or Method 2 as hereinafter modified.

1) Method 1: Make and test compressive test cylinders in accordance with appropriate ASTM procedures to substantiate an average compressive strength as specified in Paragraph, "Proportioning".

2) Method 2: Appropriate field test data for concrete made with the same ingredients may be used. Thirty (30) or more consecutive strength test results of mixes with same materials and proportions used in similar construction and climatic conditions within past year shall be used to indicate performance in accordance with specification. Required average compressive strength shall be specified in Paragraph, "Proportioning".

d. Adjust mix designs that prove unsatisfactory in use, subject to Architects review. Concrete that does not consistently exhibit specified control characteristics shall be considered unsatisfactory. All work constructed with such concrete shall be removed and replace by Contractor.

2. Submit for Architects Review.

a. List of mixes.

b. Mix Proportions.

c. Proposed adjustments for seasonality.

d. Test results and/or mill certificates showing that mix proportions and materials comply with performance characteristics specified.

e. A concrete mix design submittal shall include the proposed mix components and quantities, material sources, aggregate gradations, manufacturer's data sheets for admixtures, etc. As well as actual strength and slump data for trial mix or historical data statistically summarized. Relative to semi-lightweight concrete also include splitting strength, modulus, shrinkage unit weight and other information as well as identify if the materials are vacuum saturated or not and the supplies description of their product. The mix sheet shall clearly indicate location of use, a pumped or place mix, and other conditions of proposed usage.

C. Proportioning:

1. Structural Concrete:

a. Water reducing (plasticizing) admixture required.

- b. Trial Mix: Determine average compression strength by ACI 301, Method 1 with minimum of 15% greater than specified  $f'_c$  or by Method 2 where average strength exceeds specified strength  $f'_c$  by at least:
  - c. 400 psi if standard deviation is less than 300 psi.
  - d. 530 psi if standard deviation is 300 psi to 400 psi.
  - e. 690 psi if standard deviation is less than 400 psi to 500 psi.
  - f. 898 psi if standard deviation is less than 500 psi to 600 psi.
  - g. 1131 psi if standard deviation is less than 600 psi to 700 psi.
- 2. Semi Lightweight Structural Concrete:
  - a. Dry Weight: 110 pounds per cubic foot
  - b. Splitting Tensile Strength: When tested in accordance with ASTM C496, minimum as follows for given compressive strength.
  - c. Modulus of Elasticity: Minimum 2,400,000 pounds per square inch (secant modulus at 0.3  $f'_c$ ).
  - d. Cement Factor and Water-Cement Ratio: Base on degree of saturation and absorption characteristics of lightweight aggregates stockpiled for use.
  - e. Shrinkage Compensated Cement: May be used to control drying shrinkage if acceptable to Architect.
  - f. Natural Sand: ASTM C33 Substitute for lightweight fines.
- 3. Pumped Concrete:
  - a. Aggregates:
    - 1) Maximum Size: One-third maximum opening in either pump or pipeline, whichever is smaller.
    - 2) Grading: As close as possible to middle of ASTM C33; for normal weight concrete and ASTM C330 for semi lightweight concrete grading range.
    - 3) Fine Aggregate Fineness Modulus (FM): 2.4 to 3.0 with 15 to 30 percent passing number 50 sieve and 5 to 10 percent passing number 100 sieve.
    - 4) Daily Variation in Fineness Modulus (FM): 0.20 from value used in selectin proportion.
    - 5) Lightweight Aggregate Moisture Content: At lease equal to 24-hou absorption percentage when tested in accordance with ASTM C127.
  - b. Admixtures:
    - 1) Pumping Aids: As required to produce pumpable mix with sufficient strength.
    - 2) Accelerators: Do not use with pumped concrete.

D. Concrete shrinkage test:

- 1. Before placing any concrete slabs or exposed concrete above grade, prepare a trial batch of the mix design, using the same aggregates, cement and admixtures (if any) proposed for use on the Project. Prepare at least 3 specimens for determining the "drying shrinkage" of each mix design including structural semi-lightweight concrete.

2. The "drying shrinkage" specimens shall be 4" x 4" x 11" prisms, made, cured, dried and measured as specified in ASTM C 157. Measure and report separately for 7, 14, 21 and 28 days of drying, after 7 days of moist curing. The effective gauge length of the specimens shall be 10".
  3. The average "drying shrinkage" of the test specimens after 28 days of drying shall not exceed 0.050%.
- E. Submit reports showing results of sieve analysis, mix design and results of compression tests.
1. Make test specimens from not less than 3 batches of each design mix.
  2. The trial batch strength for each mix shall exceed indicated f'c by 25% or a lesser amount based on standard deviations of strength test records according to ACI 318.
  3. Do not start concrete production until mixes have been reviewed and are acceptable to the Architect.
- F. Concrete mixing:
1. Mixing and delivery shall comply with ASTM C 94, these Specifications, and Building Code requirements.
  2. The Owner's Testing Agency will perform check sieve analysis of the aggregates being used, check compliance with mix design and the cement being used against mix design; check that water has been removed from the drum before adding mix ingredients for the following load and shall witness the loading of mixing trucks. The Owner's Testing Agency will send a written report of each inspection to Architect indicating compliance with these Specifications.
  3. In addition to the requirements of ASTM C 94 section 16.1, provide the following information on delivery tickets signed by an authorized representative of the batching plant with each mixer truck of concrete delivered to the site.
    - a. Type and brand of cement.
    - b. Cement content per cu. yd. of concrete.
    - c. Maximum size of aggregate.
    - d. Total water content expressed as water/cement ratio.
    - e. Time batched.
  4. Deliver batch tickets to Inspector at the site when concrete is delivered.
  5. 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.
  6. Remove all materials, including water remaining in the ready-mix truck drum, completely before ingredients for the following loads are introduced in the drum.
  7. Do not use concrete that has not been placed 30 minutes after leaving the mixer, or concrete that is not placed within 60 minutes after water is introduced into the mix.

## 2.4 VAPOR BARRIER

- A. 6 mil thick clear polyethylene film. Type recommended for below grade application.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrate surfaces to receive cast in place concrete and associated work and conditions under which work will be installed. Do not proceed until satisfactory conditions have been corrected in a manner complying with the Contract Documents and acceptable to the Installer. Starting of the work within a particular area will be construed as Installer's acceptance of surface conditions.

### 3.2 GENERAL

- A. Applicable provisions of the following American Concrete Institute publications govern the work of this Section.
  - 1. ACI 301, Specifications for Structural Concrete for Buildings.
  - 2. ACI 302, Guide for Concrete Floor and Slab Construction.
  - 3. ACI 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
  - 4. ACI 304.2, Placing Concrete by Pumping Methods.
  - 5. ACI 305, Hot Weather Concreting.
  - 6. ACI 306, Cold Weather Concreting.
  - 7. ACI 308, Standard Practice for Curing Concrete.

### 3.3 PHASING

- A. Allow sufficient time in the construction schedule for appropriate slab drying, in accordance with the finish manufacturer's recommendations, for slabs to receive a deferred finish that is moisture sensitive.

### 3.4 PREPARATION

- A. Inspect excavations, subgrades and formwork, as applicable for each placing operation, for accuracy of lines, levels, elevations and dimensions.
- B. Inspect placement of reinforcement and accessories for proper position, sizes, clearances, fastenings, laps and splices.
- C. Moisten, do not saturate, earth subgrade and bearing surfaces. Do not place concrete on muddy subgrade.
- D. Wet wood forms thoroughly when they are not treated with form release agent. Wet other materials sufficiently to reduce suction and maintain concrete workability.
- E. Grade sand covering the vapor barrier to provide a layer of uniform thickness. Wet so that concrete is placed on damp sand.
- F. Verify that steel decking joints are sealed and that there are no openings or voids that will permit concrete leakage.



- G. Place items to be embedded in concrete, including but not limited to, conduits, sleeves, nailers, anchors and rough hardware, built into concrete as indicated or required.
  - 1. Do not embed piping and conduits unless approved by the Architect, and as indicated on the Drawings.
  - 2. Embed bolts, inserts and other items in the concrete. Secure accurately so that they are not displaced during concrete placing, compacting and finishing operations. Wire tie, nail or bolt embeds securely to forms.
  - 3. Set embedded bolts for materials and equipment attached to concrete to template, layouts and shop drawings. Verify size, length and location of electrical conduits with respect to equipment supports.
  - 4. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete in the voids.
  - 5. Install expansion joint fillers where indicated, and as required to isolate concrete slabs-on-grade from other building elements such as walls and equipment pads. Cover filler with plastic joint cap and leave in place until ready to receive sealant.
  - 6. Install the water stop in all construction joints below grade, and elsewhere as indicated.
    - a. Place water stop in a continuous ribbon on the exterior face of the outermost dowel line. Keep a concrete cover of 2 inches, minimum.
    - b. When using Waterstop-Rx, butt ends of water stop and nail to concrete to avoid displacement during concrete placing and consolidation.
- H. Do not proceed with placement of concrete until all conditions are satisfactory.
- I. Install vapor barrier where called for on the drawings under interior slabs on grade. Lap joints minimum 6 inches and seal. Do not disturb or damage vapor barrier while placing concrete. Repair damaged vapor barrier.

### 3.5 CONVEYING

- A. Rapid handling: Transport concrete from the mixer to location of placing as rapidly as practical to avoid separation or loss of ingredients.
- B. Transporting methods: Use pipes, cranes, carts, buggies or other approved means to deliver concrete to final locations. Do not use delivery systems (pipe, chutes, etc.) formed of aluminum for transporting concrete.
- C. Free fall:
  - 1. As dictated by job conditions at each location, but not more than 4 ft. where concrete will be exposed in the work and 6 ft. at all other locations.
  - 2. Avoid large concentration of concrete in one location that would produce unacceptable deflection in supporting formwork or steel decking.
- D. Concrete flow:
  - 1. Keep surface of concrete level during placing with a minimum of concrete allowed to flow from one position to another.
  - 2. Carry concrete up uniformly for the length of walls being placed to reduce lateral flow of concrete to 5 feet, maximum.
- E. Runways: Construct substantial runways and scaffolding to avoid movement and vibration in the forms and reinforcing steel as a result of transporting and placing concrete.

### 3.6 PLACING

- A. General: Comply with ACI 304. Do not place concrete in or under water.
- B. Consolidation: Thoroughly consolidate concrete and work it around reinforcement and embedded items and into corners and angles of forms, by spading, rodding and tamping to exclude rock pockets, air bubbles and "honeycombs" and to obtain required density and strength.
- C. Internal vibration:
  - 1. Use mechanical vibrators to consolidate each layer with that previously placed, to completely embed reinforcement and fixtures, and to bring fine materials to the faces and top surfaces to produce the proper finish.
  - 2. Assign at least one workman at each location where concrete is being placed to vibrate and consolidate the concrete in forms. Take care to avoid over-vibration causing separation of ingredients. Keep extra standby vibrator at the site.
  - 3. Do not use vibrator to move concrete.
- D. Flow of concrete:
  - 1. Keep surface of concrete level during placing, with a minimum of concrete allowed to flow from one position to another.
  - 2. Place concrete in a continuous operation until each section or panel has been completed.
- E. Record: Keep records showing location, date and time of placement and quantity of all concrete placed on the Project.
- F. Floor slabs: Shape slabs to the levels, slopes and elevations indicated and accurately pitch or grade to drainage fittings and fixtures installed in them. Where indicated, depress slabs to receive other finishes.
- G. Wall supported elements:
  - 1. Under normal weather conditions, wait at least 2 hours after depositing concrete in walls and columns before placing concrete in supported floors.
  - 2. Consider beams, girders, capitals and brackets as part of the floor systems.
- H. Temperature: Do not place concrete when the temperatures of the materials in contact with the concrete, the concrete temperature, and the ambient temperature exceed the ranges recommended in ACI 305 and 306, or if it is likely to exceed these temperature before the concrete has taken its initial set, unless special precautions recommended by ACI 305 and 306 are provided.
- I. Construction joints:
  - 1. Location: Locate joints to least impair the strength and appearance of the structure. Obtain the Architect's approval of all construction joint locations before casting concrete. In general construction joints shall be located as follows, unless otherwise indicated on the Drawings:
    - a. In walls locate at the underside of floors or slabs, and at the top of footings or floor slabs.
    - b. In slabs-on-grade locate joints where shown on the Drawings; offset not less than 5 feet, with a minimum of 2 offsets. Allow proper time lapse in placing of floor sections adjoining prior placings.

- c. In all cases make construction joints perpendicular to the main reinforcement. Continue reinforcement across joints, unless otherwise indicated.
  2. Provide keyways at least 1 ½ inches deep in construction joints in slabs, and between walls and footings etc. without exception; use prefabricated bulkheads for slabs.
  3. Keep exposed face of construction joints continuously moist from time of initial set until subsequent placing of concrete against them, but not to exceed the curing period. When not damp, wet (do not saturate) the contact surface of joints for a minimum of 24 hours before placing adjoining concrete.
    - a. Before placing adjoining concrete, clean contact surfaces to remove all laitance, loosened particles of aggregate or damaged concrete, and expose sound, coarse aggregates solidly embedded in the matrix.
    - b. To achieve the above, the contact surface may be washed with clean water under pressure (jet blast), may be sandblasted, or in areas which will be concealed from view when the building is completed an approved structural adhesive may be used on clean, structurally sound concrete. Remove wash water entirely from surface.
    - c. If a contact surface becomes coated with foreign materials of any nature after being cleaned, clean again to suitable condition.
- J. Tolerances: In compliance with ACI 117 with the following clarifications and as specified by the Architect for exposed concrete surfaces.
  1. Paragraph 4.5.4, Class A (1/8 in.) for offset in formwork.
  2. Paragraph 4.5.7, "Flat" 3/16 in. in 10 ft. for slabs.
  3. Unless more stringent requirements are specified for architecturally exposed surfaces provide concrete placement and finish as required to achieve tolerances as follows:
    - a. Slab on grade: FF=35, FL=25, with minimum local values FF=20, FL=15
    - b. Slab on metal deck: 3/16in. in 10ft.

### 3.7 FINISHING

- A. Formed concrete surfaces:
  1. General:
    - a. Remove fins, laitance and loose materials from concrete surfaces when forms are removed.
    - b. Repair honeycombs, rock pockets, sand runs, spalls and other damaged surfaces by removing the damaged or unsatisfactory area to sound concrete, with slightly undercut edges, and filling-in with the same mix as the adjacent concrete minus the coarse aggregate. All proposed repair procedures shall be mocked up and approved by the Architect prior to field application.
    - c. Fill-in tie holes with the same mix as the adjacent concrete minus the coarse aggregate.
    - d. Tamp and float, or trowel patches flush with adjacent surface and to match adjacent concrete texture.
  2. Exposed walls: Patch as specified above, rub with carborundum stones, fill imperfections with a cement paste, then sack and rub to produce uniformly smooth surfaces.
  3. Related unformed surfaces: Strike top of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, after concrete is placed, and float to a texture reasonably consistent with that of adjacent formed surfaces. Continue final treatment on formed surfaces uniformly across unformed surfaces.

- B. Top of grade beams, footings and pile caps: Screed to elevations indicated.
- C. Slabs:
  - 1. Protection:
    - a. Protect work of other trades from damage by covering it with heavy kraft paper securely taped in place. Leave protection in place as long as its need exists.
    - b. Control the use of water and other contaminants within the building so that no damage to previously installed work or existing structure and finish occurs.
  - 2. Compacting and floating:
    - a. Bring slabs to proper elevations and strike off with a straightedge. Remove excess water and laitance.
      - 1) Compact and consolidate to embed coarse aggregates.
      - 2) Float and test surfaces with a 10 ft. straightedge and eliminate high and low spots to comply with tolerances specified.
      - 3) From this point, use the methods and tools necessary to produce surface tolerances and finishes specified.
    - b. Use screeds of type and spacing required to produce specified slab tolerances.
- D. Screeding: At concrete for floors to be placed over steel deck.
  - 1. The steel angle closure at metal deck edges is not intended to serve as a screed.
  - 2. Use adjustable screeds at all screeded points and adjust to compensate for existing deflection and for deflection of deck and beams occurring during concreting operations.
  - 3. Continuously monitor screeds and floors during concrete placement and finishing and adjust concrete floor thickness as required to obtain level floors.
- E. Moisture control: In addition to other finishing requirements, use a water fog spray to reduce plastic shrinkage cracks during flatwork finishing operations when conditions of low humidity and/or high temperature exist.
  - 1. Immediately after concrete has been brought to a flat surface and the shiny film of moisture disappears, restore it and maintain until final troweling by applying a light film of moisture with an atomizing type fog sprayer.
  - 2. Use frequent light applications of moisture rather than excessive amounts at any one time. Adjust the amount and frequency of fog spray as required by variable conditions of weather, wind, temperature and humidity.
- F. General requirements:
  - 1. Finish surfaces to produce a uniform appearance throughout area involved and throughout adjacent areas with the same treatment.
  - 2. Where concrete finishing occurs adjacent to finished metal and similar surfaces, particularly where serrated or indented surfaces occur, remove all traces of cement film before allowing to harden.

G. Schedule of finishes:

1. Scratch (or raked) finish:
  - a. Apply to monolithic slabs to receive adhered and bonded concrete floor topping, mortar setting beds for tile and stone paving, and other cementitious finish flooring material.
  - b. After placing slabs, plane the surface to a tolerance not exceeding 1/4 in. in 2 ft. when tested with a 2 ft. straightedge. Slope surfaces uniformly to drains where required. After leveling, roughen the surface before the final set with stiff brushes, brooms or rakes.
2. Float all other monolithic slab surfaces unless otherwise specified.
  - a. After placing concrete slabs, do not work the surface further until ready for floating.
  - b. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently to permit the operation of power-driven float, or both.
  - c. Consolidate the surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units.
  - d. Float surfaces to receive roofing and bituminous waterproofing to produce a uniform texture and finish throughout acceptable to the roofing and waterproofing subcontractors.
3. Steel trowel surfaces to receive elastomeric coating, ceramic tile, carpeting, resilient flooring, other thin floor coverings, and concrete slabs which have no other specified finish, to a hard, dense, burnished surface.
  - a. Consolidate the concrete surface by final hand troweling operation, free of trowel marks, uniform in texture and appearance, and with surface plane tolerance specified. Grind smooth surface defects that would telegraph through applied floor covering system.
  - b. After steel troweling, texture surfaces to be tiled and slabs to receive elastomeric coating with a fiber broom to provide a mechanical bond with the mortar, or omit the burnishing. These slabs must be approved by the subcontractors installing the tiles and the elastomeric coatings as satisfactory to receive their work.
4. Finish walk slabs with a medium broom finish, with tooled edges, as approved by the Architect on a 4 ft. square sample panel to be provided by the Contractor where directed at the site. Draw broom against a straightedge at right angle to the direction of traffic.

H. Markings:

1. At expansion joints and elsewhere as indicated, mark slabs with a 1/4 in. radiused edging or marking tool. In textured work edge and mark slabs, after texturing, with a combination edging/smoothing tool approximately 1-1/2 in. wide.
2. Where saw cutting is indicated, time this operation so that it is performed as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by the saw, but before shrinkage stresses have developed sufficiently to produce cracking.
3. Make marking lines straight, or curved as indicated, equally spaced and parallel to adjacent lines and/or walls, edges and other construction, and of uniform depth and cross section, with intersections accurately formed.

- I. Curbs: Immediately after removing forms, finish faces and top with a steel trowel.

### 3.8 CURING

#### A. Formed concrete:

1. Wet the tops and exposed portions of formed concrete and keep moist until forms are removed.
2. If forms are removed before 14 days after concrete is cast, coat concrete with curing compound as specified for flatwork below.

#### B. Concrete flatwork:

1. After finishing, spray the specified curing compound uniformly in a minimum of 2 coats at 90 deg. to each other at 3 times the minimum coverage rates recommended by the manufacturer.
  - a. Inspect treated surfaces daily for 14 days for evidence of drying.
  - b. Re-wet the surfaces and apply a new application of curing compound, if premature drying occurs, as soon as can be done after finishing without marring the surfaces.
2. All interior floors not scheduled to receive a deferred finish shall receive the sealer applied in compliance with its manufacturer's printed instructions. Remove sealer residue after curing period is completed.
3. Concrete for the fountain and waterfall structure should be only water cured.

### 3.9 MISCELLANEOUS CONCRETE WORK

#### A. Provide all other concrete work indicated or required to complete the Work, even though not specifically specified, including the following.

#### B. Grouting and dry-packing: Comply with the grout manufacturer printed instructions and the following.

1. Mix material with sufficient water so it flows under its own weight for grout, and to just moisten and bind the material together for dry-pack.
2. Place dry-pack by forcing and rodding to fill all voids and provide complete bearing under plates. Place fluid grout from one side only and puddle to completely fill voids; do not remove dams or forms until grout attains initial set. Finish exposed surfaces smooth and damp cure at least 3 days.

#### C. Equipment bases and foundations:

1. Provide machine, and equipment bases and foundations where indicated on Drawings.
2. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates of the manufacturer furnishing the machines and equipment.

#### D. Pits, trenches, curbs, integrally-cast equipment pads and other miscellaneous concrete work: Construct to the profiles and dimensions indicated.

#### E. Waterproof membranes:

1. Perform work over waterproof membranes to prevent damage to the membranes.
2. Schedule this work to reduce to a practical minimum the period when the installed membrane is left without protection.
3. Prior to placing concrete, inspect the membrane and repair damage that may have occurred.

### 3.10 PROTECTING/CLEANING

- A. Take suitable precautions in compliance with applicable ACI requirements to secure satisfactory concrete in either hot or cold weather.
- B. Restrict construction vehicular traffic on slabs-on-grade to prevent damage and staining.
- C. Protect concrete to prevent damage and staining.
- D. Protect work of other trades from damage by work of this Section with heavy kraft paper securely taped in place.
- E. Upon completion, wash and clean exposed concrete and leave free of oil, paint, plaster and foreign substances, ready to receive applied finishes or to be left exposed.

### 3.11 DEFECTIVE CONCRETE

- A. Concrete which does not meet the requirements of the Contract Documents will be deemed defective.
- B. Remove defective concrete as directed by Architect and replace with concrete meeting the requirements of the Contract Documents, at no additional cost to the Owner.

### 3.12 FIELD QUALITY CONTROL

- A. Concrete quality control: The following will be performed by the Owner's Testing Agency.
  - 1. Samples will be taken during progress of the work to determine slump, compression strength, aggregate sieve analysis, and grout-mix tests, with assistance furnished by the Contractor.
  - 2. 4 cylinders will be made for each day's pour or for each 100 cu. yds. or once for each 4,000 sq. ft. of surface area, whichever is less, for each type of concrete being cast.
  - 3. 1 cylinder will be tested at 7 days, and 2 cylinders at 28 days. The remaining cylinder will be kept in reserve in case tests are unsatisfactory.
  - 4. Samples will be made in compliance with ASTM C 172.
  - 5. Specimens will be made and laboratory cured in compliance with ASTM C 31.
  - 6. The 28-day values will be the criteria for acceptance of concrete regarding strength only.
    - a. 7-day tests may be regarded as indicative of compliance or non-compliance with the 28-day strength requirements, and the Contractor should be guided accordingly in matter of adjusting proportions, if necessary, and notify the Architect.
    - b. 7-day tests shall also be a guide to the Contractor regarding time for form removal.
  - 7. Slump tests will be made for each set of tests cylinders in compliance with ASTM C 143.
- B. Tests evaluation:
  - 1. Concrete cylinder test will be evaluated in compliance with ACI 214 and 318.
  - 2. If 28-day test results indicate that concrete strength is not as specified, core concrete as directed by the Architect in compliance with ASTM C 42.

3. In the event that additional core tests do not show strength required, or as determined by load tests made in compliance with ACI 318, the defective concrete shall be removed and replaced, or shall be reinforced as directed by the Architect, at the Contractor's expense.
4. If core tests results fall below design strength specified, adjust the concrete mix or water content for future batches, at no additional cost to the Owner.

END OF SECTION