

## **SECTION 03 30 00**

### **CONCRETE**

#### **PART 1 - GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Provide all labor, materials, equipment, and services, etc., required to furnish and install all plain and reinforced concrete work, as indicated on the Drawings, Specified herein, or otherwise required for a complete and proper job.
- B. The Work shall include, but shall not necessarily be limited to:
  - 1. Forms, shoring, reinforcing, reinforcing accessories, and form removal.
  - 2. The furnishing, placing, finishing, curing and protection of all plain and reinforced concrete above and below grade.
    - a. Provide non-architectural concrete as indicated on the Drawings and Specified herein.
  - 3. Concrete footings, foundations, walls, beams, piers, pilasters, pits, suspended slabs, slabs on grade, ramps, etc.
  - 4. Concrete stair platforms and treads.
  - 5. Concrete equipment bases and pads, including those required for all trades.
  - 6. Miscellaneous concrete fills and enclosures.
  - 7. Vapor retarders under interior slabs on grade.
  - 8. Installation of embedded items (pipe sleeves, duct sleeves, keys, chases, boxes, bolts, anchors, reglets, inserts, etc.) furnished by other trades.
  - 9. Non-shrink grout pads under base plates.
  - 10. Expansion joint filler and sealant at joints in and around concrete slabs.
  - 11. Sealing of concrete slabs to remain exposed.

##### **1.02 RELATED REQUIREMENTS**

- 1. SECTION 03 35 00: CONCRETE FINISHING
- 2. SECTION 05 12 00: STRUCTURAL STEEL FRAMING
- 3. SECTION 05 50 00: MISCELLANEOUS METAL WORK

##### **1.03 SUBMITTALS**

- A. The Contractor shall furnish mix designs with test records for each type of concrete to be used that demonstrates the mix design will meet the required average concrete strength as defined in ACI 318, section 5.3. Mix designs and supporting data shall be submitted not less than ten (10)

days prior to placement. NOTE: If concrete is to be pumped, separate mix design(s) shall be required.

- B. The Contractor shall furnish reinforcing steel placing drawings, and bar lists in accordance with "Manual of Standard Practice for Detailing Concrete Structures" (ACI Standard 315). Reproductions of structural drawings shall not be used as shop drawings.
- C. The Contractor shall submit manufacturers' technical data and application/installation instructions for all sealants, sealers, reinforced vapor retarders, control strips, waterstops, etc.

#### 1.04 TESTING

- A. Testing and inspection shall be performed as required by related building codes, the Contract Documents, the Program of Structural Tests and Inspections, or as otherwise directed by the Engineer. The Owner shall employ a testing laboratory for the purpose of testing concrete and submitting reports. The cost of testing shall be paid for by the Owner.
- B. The Contractor shall arrange and coordinate all testing and shall give the Owner, Engineer and testing agency a minimum of forty-eight (48) hours notice before each concrete pour.
- C. Concrete will be sampled and tested for quality control as follows:
  - 1. Sampling fresh concrete: ASTM C 172
  - 2. Compression test specimens: ASTM C 31
  - 3. Slump: ASTM C 143
  - 4. Air content: ASTM C 231
  - 5. Compressive strength: ASTM C 39
- D. All reinforcing shall be inspected by the testing agency for grade, size, spacing, position, cleanliness, cover and support.
- E. Compression tests shall consist of one (1) set of three (3) cylinders for each test made, cured and tested by the testing laboratory during the progress of the Work. In general, and unless otherwise recommended by the Engineer, *minimum* testing requirements shall include one set of cylinders per pour or one set of cylinders per fifty (50) cubic yards, *whichever is greater*.
- F. Accept as final, results of tests made by the qualified professional testing organization engaged by the Owner.
- G. Early (4-day) concrete cylinder breaks to facilitate the Contractors schedule and operations shall be paid for by the Contractor.

#### 1.05 PRECAUTIONS

- A. No aluminum of any kind (conduit, wire, reglet, inserts, etc.) shall be placed in concrete work, except where contact surfaces are coated with an epoxy asphalt paint, approved by the Engineer.
- B. Use no form release agents containing materials which may affect a satisfactory finish and/or adhesion of materials to be applied to concrete by other sections.
- C. Slab curing agents other than water may not be used, without prior written approval.
- D. No conduits, pipes, ducts or other non-structural components of any kind shall be placed in

concrete slabs, without the Engineer's prior written authorization.

## 1.06 QUALITY ASSURANCE

### A. Codes and Standards:

1. In addition to complying with all other pertinent codes and regulations, comply with all applicable recommendations of ACI publications 301 - "Structural Concrete for Buildings", ACI 347 - "Recommended Practice for Concrete Formwork" and ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures". Refer to ACI 302 for concrete floor and slab construction, ACI 304 for concrete placement, ACI 305 for hot weather standards, and ACI 306 for cold weather standards, and ACI 318 "Building Code Requirements for Reinforced Concrete".
2. Concrete testing shall be in accordance with the requirements of ACI 318 and ACI 311 - "Recommended Practice for Concrete Inspection".

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Forms for Exposed Concrete: Shall be exterior grade plywood, equal to American Plywood Association B-B Plyform, in excellent condition, free of dents, scratches or surface deposits. Forms for architectural concrete shall be HDO (High Density Overlaid) Plyform, in "like-new" condition. Use appropriate thickness of Class I, II or Structural I Plyform as recommended by APA for specific installations.
- B. Forms for Concealed Concrete: May be Plyform, matched lumber or steel.
- C. Form Ties and Spreaders: Shall be ties which, following form removal, are "snapped" not less than one (1") inch from the concrete surface. Do not use wire ties and wood spreaders. Where concrete is to remain exposed to view or painted, ties shall have removable tapered plastic cones of one (1") inch outside diameter. Ties for walls below grade shall incorporate water seal washers.
- D. Steel Reinforcement: Shall be deformed bars complying with the requirements of ASTM A 615, Grade 60. Mesh reinforcement (welded wire fabric) shall conform to the requirements of ASTM A185. Provide mesh in flat sheets.
- E. Steel Reinforcement – Epoxy Coated: Reinforcing bars identified on the drawings as epoxy coated shall conform to the following standards:
  1. ASTM A615 deformed bars, Grade 60.
  2. ASTM A775 Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
  3. ASTM DD3963 Standard Specification for the Fabrication and Job Site Handling of Epoxy-Coated Reinforcing Steel Bars.
- F. Welded Wire Fabric: Welded wire fabric shall be provided in flat sheets and shall conform to ASTM A185, wire size and spacing to be as indicated on the drawings.
- G. Welded Wire Fabric – Epoxy Coated: Welded wire fabric identified on the drawings as being epoxy-coated shall be provided in flat sheets and shall conform to the following standards:

1. ASTM A185.
  2. ASTM A884 Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric.
- H. Reinforcement Accessories: Shall conform to Product Standard PS7-766, National Bureau of Standards, Department of Commerce, Class C. Reinforcement accessories shall include, but are not limited to: spacers, chairs, ties, slab bolsters, slips, chair bars, and other devices for reinforcement.
- I. Cement: Shall be Portland cement of domestic manufacture conforming to the requirements of ASTM C150, Type II. Only one brand of cement shall be used throughout the project.
- J. Concrete Aggregates: Shall conform to the following requirements:
1. Fine Aggregate: Shall consist of clean, hard, tough and preferably siliceous material (sand), free from mineral or other coatings, soft particles, clay, loam or other deleterious matter. Materials shall meet the requirements of ASTM C33.
  2. Coarse Aggregate (normal weight): Shall consist of crushed stone or gravel having clean, hard, durable, uncoated particles, free from deleterious matter. Materials shall meet the requirements of ASTM C33.
  3. Lightweight Aggregate: Shall consist of Expanded Shale, Clay, or Slate (ESCS) lightweight aggregate produced by the rotary kiln method shall meet ASTM C 330.
- K. Concrete Curing Membranes:
1. White polyethylene sheeting 4 mils thick, ASTM C171; or
  2. Waterproof paper, Sisalkraft Type, ASTM C171-69 as manufactured by Fortifiber Corp., Ludlow Papers, Glas-Kraft; or
  3. Liquid membrane curing compound of resin or latex bases liquid conforming to ASTM C309 Type I, Class A except for surfaces to be covered with other surfacing materials, the compound shall be compatible with the adhesives to be used.
- L. Curing Paper for Concrete Slabs: Shall be waterproof, reinforced paper, "Orange label Sisalkraft", as manufactured by Fortifiber Corporation; "Scuf-Champ" as manufactured by Ludlow Papers; "Flor-Cur W/S", as manufactured by Glas-Kraft, or approved equal.
- M. Curing Agent: ASTM C309.
- N. Admixtures: Shall be used in complete accordance with the manufacturer's directions. All admixtures shall be by the same manufacturer, who shall provide at no added cost to the Owner, the services of its representative at the job to ensure proper use of each particular admixture. Admixtures shall be certified by the manufacturer to comply with the following:
1. Air-entraining: ASTM C260.
  2. Water-reducing: ASTM C494. No admixtures containing calcium chloride (chloride ions) shall be placed in concrete work.
- O. Mixing Water: Shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.
- P. Form Oil: Shall be non-staining type.
- Q. Joint Sealant: (For joints in concrete slabs and walks) Shall be self-leveling, multi-component

polyurethane. Use primer as recommended by the manufacturer. Sealant shall be THC-900 or THC-901 (low sag) as required by job conditions. Sealant shall be as manufactured by Tremco, or approved equal. Color shall be as selected by the Architect.

- R. Interior Concrete Sealer: Shall be "Kure-N-Seal WB" by Sonneborn or "A-H Clear Cure" by ANTI HYDRO COMPANY.
1. Exposed interior concrete slabs, shall have two (2) applications of sealer in accordance with manufacturer's directions. Slabs to receive finish flooring or painting shall not be treated with sealers or hardeners.
  2. Slabs to receive concrete hardener shall be sealed as specified in SECTION 03 35 00: CONCRETE FINISHING.
- S. Exterior Concrete Sealer (Sidewalks, patios, pads): Shall be Silpro "Silocks VOC", Conproco "Shield W20", or approved equal.
- T. Premolded Expansion Joint Filler Strips: Shall be 1/2" thick, unless otherwise noted, premolded, resilient, compressible, re-expanding, non-extruding bituminous and fiber material, made with cane fibers, uniformly saturated with not less than 35% and not more than 50% by weight of asphalt.
- U. Non-Shrink Grout: Shall be used under all base and bearing plates, and shall be Embeco #153 Pre-Mixed, as manufactured by Master Builders, Euco Hi-mod Grout as manufactured by The Euclid Chemical Company, or approved equal. Compressive strength of grout (2" cubes) shall be not less than 5,000 psi at 7 days and 7,500 psi at 28 days.
- V. Burlap for Concrete Slabs: Shall be approximately 9 oz. per sq. yd., complying with AASHTO M182, Class 3.
- W. Chemical Bonding Agent: Shall be film-forming, freeze-thaw resistant compound suitable for brush or spray application complying with Mil-B-19235 and shall be Daraweld-G by W.R. Grace Company, Euroweld by Euclid Chemical Company, or approved equal.
- X. Vapor Retarder: Shall be reinforced vapor retarders (not less than 0.010 inches thick), T-65 by the Griffolyn Company, "Moistop," by FortifiberCorp, Ply-Bar Plus II by Firstline Corp., or approved equal, as noted on the Drawings or Specified herein.) Tape for vapor retarders shall be 4" wide (minimum) pressure sensitive tape as recommended by the manufacturer. Sealant for vapor retarders shall be as recommended by the manufacturer.
- Y. Plastic Control Joints: Shall be "Zip Cap" type as manufactured by Greenstreak Inc., or approved equal. Depth shall be as required to penetrate 1/4 of the thickness of the slab.
- Z. Other Materials: All other materials not specifically described herein, but required for a complete and proper installation, shall be as selected by the Contractor and approved by the Architect.

## PART 3 - EXECUTION

### 3.01 PROPORTIONS

- A. All concrete shall be ready-mixed controlled concrete and proportioned according to ACI 211 for normal weight concrete.
- B. The nominal maximum size of the aggregate shall not be 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 distance between reinforcing bars or between bars and forms, whichever is least.

In general, 3/4" size will satisfy these requirements.

- C. Concrete for every part of the Work shall be of a homogeneous structure which, when cured, will have at least the strength required by design. The limiting values of concrete shown in Table A and the requirements hereinafter specified must be met.
- D. Proportions of concrete ingredients shall be determined in advance of concreting operations by the testing laboratory, and shall be such as to produce a concrete fulfilling every requirement of the Contract Documents. Advance specimen shall be tested as to compliance with this requirement by standard laboratory tests of concrete made with representative samples of the cement and aggregates, which the Contractor proposes to use for each specific portion of the Work. It shall be the Contractor's responsibility to provide the concrete strengths required and to pay the cost for a laboratory to make necessary trial mixes.
- E. The design strength of the concrete in this structure is based upon ultimate strength requirements of ACI 318. The minimum strength requirement stated is the strength of the concrete at 28 days when samples are cured and tested in accordance with the recommended standards of ACI 318.
- F. By the water-cement ratio is meant the total quantity of water entering the mixture, including the surface water carried by the aggregates, expressed in terms of the quantity of cement.
- G. All concrete shall be air-entrained concrete, typically 6%  $\pm$  1% by volume for 3/4" aggregate and 8%  $\pm$  1% for 3/8" aggregate, except as noted below for slabs. Maximum air-entrainment for exterior slabs shall be 6%  $\pm$  1%. Interior floor slabs on grade and framed floor slabs shall contain 3%  $\pm$  1% entrained air.
- H. The water-cement ratio shall be expressed in U.S. gallons per sack (94 lb net) of cement.

TABLE A

Minimum Allowable Compressive Strength @ 28 days (psi)	Maximum <sup>(1)</sup> Allowable Net Water Content (gals/sack)	Minimum <sup>(2)</sup> Permissible Cement Sacks per cu. yd.	Maximum Total Water (gals)
3000	6.0	5.5	33.0
4000	5.0	6.5	32.5

- 1) Decrease if possible. This represents the total water in the mix at the time of mixing, and includes free water on aggregates. Reduce net allowable water content by one gallon for air-entrained concrete.

- 2) Increase as necessary to meet other requirements.

- I. The method of measuring water and aggregates shall be such as to secure specified proportion in each batch, and in a manner that proportion of water to cement can be closely controlled and easily checked at any time.
- J. The proportions of aggregates to cement for concrete for any of this work shall be such as to produce concrete that will work readily into corners and angles of the forms and around the reinforcement without excessive puddling or spading and without permitting the materials to segregate or free water to collect on the surface.
- K. No change in source of materials or mix shall be made without the Engineer's authorization. Concrete mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional

cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results shall be submitted to and accepted by Engineer before using in the Work.

### 3.02 STRENGTH COMPLIANCE

- A. The following more clearly defines performance:
  - 1. To meet the requirements of this Specification and those of ACI 318, the average of any three consecutive strength tests of laboratory-cured specimens representing each class of concrete shall be equal to or greater than the specified strength ( $f'_c$ ), and not more than one out of ten strength tests shall have a value of less than the specified minimum strength. In addition to the above requirement, the allowed 10% of tests below the minimum required strength shall be equal to or greater than 90% of the minimum specified strength ( $f'_c$ ).
  - 2. Should the strengths shown by the test specimens fall below the specified design strengths, the Engineer shall have the right to require additional curing on those portions of the structure represented by those test specimens.
  - 3. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit, at the Contractor's expense, check tests for strengths to be made by means of Windsor Probes or typical cores drilled from the structure in accordance with ASTM C42 and C39. In cases of failure of the latter, the Engineer, in addition to other resources, may require, at the Contractor's expense, load tests on any members in which such concrete was used. Load tests need not be made until concrete has aged 60 days.

### 3.03 DESIGN OF FORMWORK

- A. The design, engineering and safety of formwork, as well as its construction shall be the exclusive responsibility of the Contractor.
- B. Exercise care in order to ensure that all formwork is properly designed, engineered and erected, and capable of safely supporting all loads and pressures. Forms shall be held to the dimensions indicated on the Drawings, with the tolerances established by Article 3.31 of ACI 347.78.
- C. Temporary openings shall be provided at the base of forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is deposited.
- D. Forms shall be sufficiently tight to prevent leakage of grout or cement paste.
- E. Properly set and secure all embedded items to be furnished by other trades.
- F. Properly set and secure all form applications for chamfers, reglets, rustication joints, etc., as indicated on the Drawings.

### 3.04 PREPARATION OF FORM SURFACES

- A. Plywood and other wood surfaces not subject to shrinkage shall be sealed against absorption of moisture from the concrete by either: (1) a field applied approved form oil or sealer; or, (2) a factory applied non-absorbent liner. All shall be subject to review for finish appearance.
- B. When forms are coated to prevent bond with concrete, it shall be done prior to placing of reinforcing steel. Excess coating material shall not be allowed to stand in puddles in the forms

nor allowed to come in contact with concrete against which fresh concrete will be placed.

- C. Where architectural (as-cast) finishes are required, materials, which will impart a stain to the concrete, shall not be applied to the form surfaces. Where the finished surface is required to be painted or treated, the material applied to the form surface shall be compatible with the type of paint to be used.
- D. All forms shall be thoroughly cleaned before reuse.
- E. All necessary chamfer strips and related architectural detail strips shall be provided for as indicated on the Drawings.
- F. The Contractor shall thoroughly review all Drawings for special formwork required at openings such as windows, doors, etc.

### 3.05 CONCRETE REINFORCEMENT

- A. Reinforcing bars to be embedded in concrete shall be free of oil, dirt, loose mill scale and loose rust. Reinforcing bars with rust, mill scale, or a combination of both will be acceptable as being satisfactory with cleaning or brushing, provided that upon wire brushing, the dimensions including height of deformations and weights of a cleaned sample shall not be less than the applicable ASTM specification requirements.
- B. The placement of bars shall conform to "Placing Reinforcing Bars," as published by the Concrete Reinforcing Steel Institute. Maintain adequate space for proper concrete cover.
- C. Place no concrete before installation of reinforcement has been reviewed by the Owner's Representative and/or independent testing agency.
- D. In event of displacement of any reinforcement, same shall be corrected and retied as necessary and in a satisfactory manner.
- E. All splicing of bars, concrete cover, and bar spacing shall conform to "Building Code Requirements for Reinforced Concrete" (ACI 318) as published by the American Concrete Institute, and to recommended practices in "Splicing Reinforcing Bars" by the Concrete Reinforcing Steel Institute, or as hereinafter specified.
  - 1. When necessary to splice reinforcement, bars shall be lapped at least 48 bar diameters, unless noted otherwise, placed in contact and wired. Laps shall be avoided at points of maximum stress. All rods shall be securely wired together at all intersections. No permanent device for fastening reinforcement shall be left in contact with the face of forms at exposed surfaces.
- F. The welding of reinforcing bars shall be performed in accordance with "Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections for Reinforced Concrete Construction" (AWS D12.1), as published by the American Welding Society. Welders shall be qualified by tests as prescribed in the "Standard Qualification Procedures" (AWS B3.0), as published by the American Welding Society.
- G. Tack welding of reinforcing steel shall not be permitted.
- H. Heat bending of reinforcing steel shall not be permitted.
- I. All splicing of wire fabric shall be made with fabric lapped at least 2 meshes wide and tied at 3'-0" o.c.
- J. Steel stair pans and landings shall be reinforced with 2" x 2" x 16/16 gauge welded wire mesh



tack welded in place.

### 3.06 MIXING

- A. Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set for it in ASTM C94 and ACI 614.
- B. Transit-mixed concrete shall be delivered in high-lift trucks to enable it to be easily deposited in the forms.
- C. The mixing shall be continuous after the water has been added to the mix in the drum, but no concrete shall be placed in the forms more than 90 minutes after the water has been added.

### 3.07 CONSISTENCY

- A. The consistency of the concrete is mainly dependent upon the thoroughness of the mixing and the quantity of water contained in the mix. In general, the maximum slump and minimum strengths shall be as follows:

TABLE B

Type of Construction	Compressive Strength Required (psi)	Maximum Slump (Inches)
All Exterior slabs	4000	3
Footings	3000	3
Foundation Walls, piers	3000	3
Interior Slabs	3000	3
Miscellaneous Concrete	3000	4

### 3.08 CONCRETE PLACEMENT

- A. Prior to placing concrete, clean all equipment used for mixing and transporting the concrete. Remove all debris from the place to be occupied by the concrete, and check forms for dimensions, position and adequacy.
- B. Water shall be removed from excavations before any concrete is deposited. Any flow of water into an excavation shall be diverted through proper side drains to a sump, or shall be removed by other approved methods that will avoid washing the freshly deposited concrete. No pumping shall be done while the concrete is being placed.
- C. Convey concrete from the mixer to the place of final deposit by rapid methods, which will prevent the separation or loss of the materials. Equipment for placing concrete shall be of such size and design as to ensure delivery without segregation of the materials. All shall be in accordance with ACI 614.
- D. Concrete shall not be placed by means of open chutes, the combined length of which exceeds 30 feet, and shall not be allowed to drop freely through distances exceeding 6 feet or through loosely spaced reinforcing bars, conduits, etc., which will tend to segregate materials.

- E. Deposit concrete as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. No concrete that has partially hardened or been contaminated by foreign material shall be deposited on the Work.
- F. Once concreting is started, it shall be carried on as a continuous operation until the placing of the panel, section, or individual foundation is completed, so as not to cause formation of seams and planes of weakness within the section. If a section cannot be placed continuously, construction joints as specified and as detailed on the Drawings shall be provided. The top surface shall be generally level. When construction joints are necessary, they shall be made in accordance with the item on construction joints.
- G. Place concrete in layers not over 12" deep, and thoroughly compact by means of vibrators, hand tamping and spading. During the operation of placing, thoroughly work the concrete around reinforcement, embedded fixtures, pipes, and conduits, and into the corners of the forms so as to prevent interior voids, honeycomb, and the patching of concrete surfaces after forms are removed. Internal vibrators should be used to aid in the compaction of the concrete. Extreme care shall be used on thin sections and exposed concrete.

### 3.09 WEATHER PROTECTION

- A. Unless adequate protection is provided and/or approval is obtained, concrete shall not be placed during rain, sleet, snow, or freezing weather. Rainwater shall not be allowed to increase the mixing water or to damage the surface finish.
- B. Cold Weather Concreting:
  - 1. Winter concreting shall be done in accordance with the recommendations of ACI 306 and as herein specified.
  - 2. Concrete forms and steelwork shall be heated within the forms to a temperature of 50 degrees F. before placing of the concrete.
  - 3. The area outside the forms shall have a temperature of 50 degrees F. for seven (7) days during and after concrete is placed unless rising temperatures are indicated, then time can be reduced to five (5) days.
  - 4. The temperature of the concrete placed in the forms shall not be below 55 degrees F. when outside temperature is or falls below 40 degrees F. When temperature is below 30 degrees F., concrete placed in forms shall not be less than 65 degrees F.
  - 5. All heat around concrete forms shall be reduced slowly for three days to prevent concrete temperature cracks.
  - 6. Concrete footings, slabs and pads etc., which are placed above the frost line and which are intended to be protected from frost by the heated building when complete, shall be provided with suitable temporary heat until such time as the building is permanently enclosed and heated.
- C. Hot Weather Concreting:
  - 1. Hot weather concreting shall be done in accordance with the recommendations of ACI 305.
  - 2. Concrete deposited in hot weather shall have a placing temperature that will not cause difficulty from loss of slump, flash set, or cold joints (usually somewhat less than 90 degrees F.).

3. In hot weather, be adequately prepared to protect the concrete from the adverse influence of heat before the placement of any concrete. Take special precautions to avoid cracking of the concrete from rapid drying during placement of concrete when air temperature exceeds 70 degrees F., particularly when the work is exposed to direct sunlight.
  - a. Cool forms by fog sprayed with water or by protecting them from the direct rays of the sun.
  - b. If requested by the Contractor, deemed advisable by the Testing Engineer, and approved by the Engineer, a retardant may be used to delay the initial set of the mix.

### 3.10 CONSTRUCTION AND EXPANSION JOINTS

- A. Construction joints shall be located so as to least impair the strength and watertightness of the structure. All joints shall be keyed.
- B. All construction joint locations are shown on the structural drawings. Changes to the recommended joint pattern shall be subject to the notification of and acceptance by the Architect and Engineer, prior to placement.
- C. Reinforcement shall be continuous through the construction joints and additional reinforcing placed as required. Except where otherwise specified, the surfaces of construction joints shall be prepared in a manner that will ensure bonding with concrete or grout later placed on them. Wherever practical, construction joint surfaces shall be kept continuously moist until new concrete or grout is placed.
- D. Expansion joints shall be provided wherever new concrete abuts existing concrete foundation walls, at junctions of exterior concrete slabs and foundation walls and as otherwise noted, specified or detailed.
- E. Construction joints and expansion joints in foundation walls shall coincide with control joint locations in brick veneer and/or masonry walls wherever possible.

### 3.11 CONTROL JOINTS IN SLABS

- A. Provide control joints in all slabs-on-grade. All joints shall be straight and square to facilitate alignment of finish flooring movement joints where applicable.
- B. Layout of control joints in slabs on grade are shown on the structural drawings.
- C. The maximum distance between joints in any direction shall not exceed 28 feet.
- D. Joints to be sawed shall be done as soon as the surface is firm enough so that it will not be torn or damaged by the blade, usually within 4 to 12 hours after the concrete hardens and depth to be 1/4 of the slab.
  1. Any exposed sawed joints shall be filled with a joint filler approved by the Architect.
- E. At the Contractor's option, concrete slabs to be covered by other finish flooring materials may utilize plastic control joints.
- F. Control joints shall not be cut in slab haunches when joint is parallel to haunch. Joints perpendicular to slab haunches may pass through the haunch.

### 3.12 REMOVAL OF FORMS

- A. Formwork not supporting the weight of concrete, such as sides of beams, walls, and similar parts of the work, may be removed 48 hours after placing the concrete, provided the concrete is sufficiently hard to not be damaged by the form removal operations, and provided that curing and protection operations are maintained.
- B. Removal of forms shall be in a manner to ensure safety of structure and prevent damage to concrete surfaces. Particular care shall be taken in the removal of forms for concrete surfaces to remain exposed.
- C. Whenever the formwork is removed during the curing period, the exposed concrete shall be cured by one of the methods specified.

### 3.13 SLAB ON GRADE

- A. Slabs shall be of thickness indicated, placed on fill specified, or identified on the Drawings. Concrete shall be full thickness of slab and troweled out as specified below. Carefully review the Drawings in order to coordinate and provide all slab recesses, depressions, and pitches required for equipment or finishes to be furnished and installed by other trades, or for proper drainage.
- B. Thicken and reinforce slabs on grade under non-bearing masonry partitions.
- C. Gravel or crushed stone shall have water applied just prior to the concrete placement so as to be wet (unless vapor retarder is provided).

### 3.14 FINISH OF NON-ARCHITECTURAL CONCRETE SURFACES (other than slabs, ramps, stairs and walks.)

- A. Immediately upon removal of forms, point all form tie holes and other defects flush with surface, or as otherwise directed by the Architect.
- B. Remove all fins, and fill all honeycomb, holes and depressions with 1:2 mortar on all exposed interior and exterior concrete surfaces. Before patching, thoroughly wet surrounding concrete and keep wet for several hours. Brush into the surface to be patched a grout of cement and water mixed to the consistency of paint. Carefully damp cure these patches.
- C. For non-architectural exterior or interior surfaces *to remain unfinished and exposed to view*, the surfaces, while concrete is "green", shall be wet, and rubbed with carborundum brick or other approved abrasive. Remove all fins, burrs, joint marks, and other projections, until uniform color and texture are produced. Any excess paste shall be removed. No cement grout or slush shall be used other than the cement paste drawn from the "green" concrete by the rubbing process. Wet rubbing shall not be required in storage and similar utilitarian spaces.
- D. Exterior or interior surfaces to receive paint or special coatings shall be finished as above, except uniform color and texture shall not be required.
- E. Concrete surfaces to receive waterproofing shall be cleaned and patched as above, remove all fins and fill all voids. Wet rubbing shall not be required on surfaces to receive waterproofing.
- F. Seal entire slab perimeters and all penetrations with joint sealer as specified elsewhere herein.

### 3.15 FINISH OF ARCHITECTURAL CONCRETE SURFACES

- A. Concrete as listed below and as otherwise noted on the Drawings shall be poured-in-place architectural concrete.
- B. Concrete forms, mix designs, conveying, placing, consolidating, finishing, and all other work related to architectural concrete shall be provided as required to produce a suitable concrete finish in its natural state, without cutting, patching, rubbing or coating. NOTE: It shall be the Contractor's responsibility to establish mix designs and provide materials as required to satisfy all structural and aesthetic requirements related to architectural concrete. General concrete requirements specified elsewhere herein may be modified as necessary to meet design intent, subject to recommendations of the Contractor and the Architect's prior written approval.
- C. A suitable architectural finish shall be defined as one that produces:
  - 1. Form joints, rustication marks, chamfers, tie holes, and all other cast-in-place features as identified in the Contract Documents and on the Shop Drawings.
  - 2. Minimal surface defects.
  - 3. Consistent color and texture in conformance with approved samples. NOTE: Form sealer and release agents to be used on architectural concrete shall be clear, non-coloring and non-staining.

### 3.16 FINISH OF CONCRETE SLABS

- A. Concrete slabs shall have wood or metal screeds spaced not over 10' o.c. and set at the elevations shown on the Drawings. NOTE: Contractor may, at his option, use wet screeds *provided* that wet pads are established at not more than 10' o.c. both ways, with elevations established by use of laser equipment.
- B. Concrete shall be struck to the specified level using a wooden strike-off bar.
  - 1. Immediately following the strike-off, concrete shall be further leveled and consolidated with a wood bull float or wood darby. This shall be completed before free moisture rises to the surface so as to avoid bleeding.
  - 2. The surface finish shall be thoroughly compacted using power driven mechanical floor machines.
  - 3. Begin power floating adjacent to columns, forms, and walls where concrete is most likely to stiffen first.
  - 4. After power floating, the compacting shall be followed by not less than three (3) troweling operations, and if necessary, additional trowelings as required to bring the finish to a smooth, hard, dense surface, and to the following tolerances:
    - a. In any ten feet 1/4"
    - b. In any six feet 1/8"
    - c. In any three feet 1/16"
  - 5. The first power troweling, after power floating, shall produce a smooth surface relatively free of defects, but which may still contain some trowel marks.
  - 6. Final troweling shall be done when a ringing sound is produced as the trowel is

moved over the surface.

7. Finished surface shall be free of any trowel marks, uniform in texture and appearance, and shall be to the tolerance specified.
- C. Floor sealer/hardener shall be applied to exposed floors, as scheduled. .
- D. Within twenty-four (24) hours after final troweling, the finish surface shall be covered for not less than seven (7) days, with burlap or curing paper and cured as specified in the article on curing.
- E. Slabs to receive ceramic tile or quarry tile shall be finished as noted above, except that finish surface shall be textured as recommended by the tile manufacturer to ensure proper bonding of tile setting materials. Coordinate with the Work of Sections 09 30 00 and 09 40 00, as applicable.

### 3.17 FINISH OF CONCRETE WALKS, RAMPS AND STAIRS

- A. Concrete walks, ramps, and stairs shall be properly struck-off floated and finished with a fine broom finish or as otherwise noted. All joints and edges shall be tooled.
- B. A sample area (10 sq. ft. minimum) shall be finished and approved by the Architect prior to proceeding with the Work.
- C. All surfaces shall be properly damp cured.

### 3.18 CURING

- A. Protect newly placed concrete against low and high temperature effects and against rapid loss of moisture. Most cure all concrete for at least seven days at a temperature of at least 50 degrees F.
- B. Vertical or near vertical surfaces may be cured by maintaining wood forms continuously wet during curing period, by wrapping with continuous .006" polyethylene with taped joints or as approved by the Engineer.
- C. Floor surfaces, after hardening sufficiently to prevent damage, and normally within several hours after final troweling, shall be covered with reinforced waterproof kraft paper with taped lapped seams. . Paper shall be weighted to prevent displacement, and holes or tears shall be immediately repaired.
- D. Formed Surfaces: Keep steel forms which are heated by the sun, and all wood forms in contact with the concrete, wet during the curing period.
- E. Protection From Mechanical Injury: During the curing period, protect concrete from damaging mechanical disturbances, particularly load stresses and excessive vibration. Protect all finished concrete surfaces from damage caused by construction equipment, materials, or methods and running water. Do not overload self-supporting concrete structures. Foundation walls shall not be backfilled or driven over by vehicles during the curing period.

**END OF SECTION**