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**SECTION 03 30 00**  
**CAST-IN-PLACE CONCRETE****PART 1 GENERAL****1.1 DESCRIPTION**

- A. The Work of This Section Includes, but is not limited to:
  - 1. Concrete Reinforcement
  - 2. Concrete Formwork
  - 3. Cast-In-Place Concrete
  - 4. Concreting Accessories
- B. Related Work Specified Elsewhere:
  - 1. Section 03 60 00 - Grout

**1.2 REFERENCED STANDARDS AND SPECIFICATIONS**

- A. American Concrete Institute (ACI):
    - 1. 304 Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete
    - 2. 305R Hot Weather Concreting
    - 3. 306R Cold Weather Concreting
    - 4. 309 Recommended Practice for Consolidation of Concrete
    - 5. 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures
    - 6. 318 Building Code Requirements for Reinforced Concrete
    - 7. 347 Recommended Practice for Concrete Formwork
  - B. American Society for Testing and Materials (ASTM):
    - 1. A185 Specification for Welded Steel Wire Fabric for Concrete Reinforcement
    - 2. A615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
    - 3. A706 Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcements
    - 4. C31 Making and Curing Concrete Test Specimens in the Field
    - 5. C33 Specifications for Concrete Aggregate
    - 6. C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
    - 7. C88 Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
    - 8. C94 Specification for Ready-Mixed Concrete
    - 9. C143 Test for Slump of Portland Cement Concrete
    - 10. C150 Specification for Portland Cement
    - 11. C171 Specification for Sheet Materials for Curing Concrete
    - 12. C172 Sampling Fresh Concrete
    - 13. C173 Test for Air Content of Freshly Mixed Concrete by the Volumetric Method
    - 14. C231 Test for Air Content of Freshly Mixed Concrete by the Pressure Method
    - 15. C260 Specification for Air-Entraining Admixtures for Concrete
    - 16. C494 Specification for Chemical Admixtures for Concrete
    - 17. C535 Test for Resistance to Abrasion of Large Size Coarse Aggregate by the Use of the Los Angeles Machine
    - 18. D1752 Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Construction
  - C. American Welding Society (AWS):
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1. D12.1 Welding Reinforcing Steel Metal Inserts and Connections in Reinforced Concrete Construction

### **1.3 QUALITY ASSURANCE**

- A. Design Criteria:
  1. Design each required concrete group to meet the physical properties specified in Table I of this Section.
  2. In addition to structural strength and stability requirements, design and construct concrete in structures built with Concrete Groups D, E, F, and G to ensure:
    - a. Maximum density and impermeability - these qualities are achieved with low water cement ratios and a slow, moist cure.
    - b. Maximum resistance to reaction of chemicals, alternate wetting and drying, and exposure to the elements.
    - c. Well-formed and smooth surfaces to minimize resistance to flow.
- B. Testing Agency: Concrete testing for slump, compressive strength, and air content shall be performed by a testing laboratory engaged and paid by the Contractor and approved by the Architect. No concrete shall be poured unless the testing agency is on-site.
- C. Concrete Testing:
  1. Perform compressive strength, slump, and air content tests for each \_\_\_\_\_ cubic yards of concrete placed, or any portion thereof, for each structure. Cast at least 5 cylindrical strength test specimens for each batch. Test 2 cylinders at 7 days; test 2 cylinders at 28 days. Hold the remaining cylinder for testing in the event that any of the other cylinders are damaged prior to testing. Test concrete from Groups C and F of Table I at 3 days rather than at 7 days.
  2. Determine concrete strength from standard test specimens made and cured according to ASTM C31 and ASTM C172, and tested in accordance with ASTM C39. Perform core drilling and testing in accordance with ASTM C42. Compute and evaluate in accordance with ASTM C94.
  3. Determine air content in accordance with ASTM C231 or ASTM C173, as applicable.
  4. Determine slump in accordance with ASTM C143.
  5. Keep a slump cone and an air meter in close proximity to all concrete placements.

### **1.4 SUBMITTALS**

- A. Shop Drawings: Submit detailed reinforcing drawings prepared in accordance with ACI 315, including bar schedule with bar marks and bends indicated.
- B. Design Mix:
  1. Prior to start of placing concrete, submit design mix for each group of concrete, indicating that the concrete ingredients and proportions will result in a concrete mix meeting the physical requirements for each concrete group specified in Table II of this Section.
  2. Do not vary the proportions of the ingredients or source of material of the approved mix without submitting corresponding test result documentation to the Architect for approval.
- C. Certificates:
  1. Submit a certification attesting that reinforcing steel meets the requirements of ASTM A615 including Supplementary Requirement S1, and that welded steel wire fabric meets the requirements of ASTM A185.

2. Submit, with the concrete mix design, laboratory test reports and manufacturer's certificates attesting the conformance of ingredients with these specifications (ASTM C94, paragraph 5.3.2).
  3. Submit a certification or delivery ticket from the concrete supplier for each batch delivered to the site (ASTM C94, Section 15). The delivery ticket shall list: name of ready-mix batch plant, serial number of ticket, date and truck number, name of contractor, specific designation of job, batch number, amount of concrete, time loaded or of first mixing of cement and aggregates, number of revolutions, water added by receiver of concrete and his initials, type and name of admixtures and amount of same, type and brand of cement, amount of cement, total water content by producer, maximum size of aggregate, weights of fine and coarse aggregate, and indication that ingredients are as previously certified or approved.
- D. Test Reports: Submit four copies of required slump tests, air content tests, and strength tests.
- E. Pour Schedules: Submit concurrently with the steel reinforcing drawings six copies of concrete pour schedules showing sequence of pours and all contraction, expansion and construction joints.

### **1.5 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Reinforcing Steel:
1. For reinforcing steel fabricated on-site, ship from the mill in bundles, limited to one size and length, tagged with a waterproof tag showing the name of the mill, heat number, grade and size of the bars, and identifying number.
  2. For reinforcing steel fabricated off-site, deliver in bundles identified as to structure and shop drawing number. Identify each individual bar with a waterproof tag showing the grade, size and bar mark from the approved bar schedule.
  3. Protect reinforcing steel and wire fabric from damage and from dirt, oil, grease, other foreign matter, and rust-causing conditions. Do not store reinforcement in direct contact with the ground.
- B. Concrete Ingredients: Handle, control and store concrete materials in accordance with ACI 304, Chapter 2.

## **PART 2 PRODUCTS**

### **2.1 READY-MIX CONCRETE**

- A. Shall conform to ASTM C94, except as noted otherwise.
- B. Materials:
1. Cement: ASTM C150, Types II, IIA, III, and IIIA as indicated in Table I.
  2. Fine Aggregate: ASTM C33, with the following additional requirements for Concrete Groups D, E, F, and G only:
    - a. Washed natural sand.
    - b. Weighted percentage of loss not more than 12 percent by weight when subjected to five cycles of the magnesium sulfate soundness test in accordance with ASTM C88.
    - c. Coarse Aggregate: ASTM C33, with the following additional requirements for Concrete Groups D, E, F, and G only.
      - 1) Percentage of wear not exceeding 45 percent when tested in accordance with ASTM C535.
      - 2) Weighted percentage of loss not more than 15 percent by weight when subjected to five cycles of the magnesium sulfate soundness test in accordance with ASTM C88.

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- d. Water: Potable
  - e. Admixtures:
    - 1) Air Entraining Admixture: ASTM C260.
    - 2) Admixtures containing calcium chloride or soluble chlorides shall not be used in concrete:
      - (a) containing aluminum,
      - (b) subject to alkali-aggregate reaction, and
      - (c) for Concrete Groups D, E, F, and G of Table I.
      - (d) Admixtures other than air entraining shall conform to ASTM C494.
      - (e) All admixtures are subject to the written approval of the Architect.
  - C. Mix Proportioning:
    - 1. Select proportions for concrete to obtain the quality requirements for each group of concrete as specified in Table I of this Section.
    - 2. Where Concrete Group A is specified, Group C may be used upon written approval of the Architect. Where Concrete Group D is specified, Group F may be used upon written approval of the Architect.
  - D. Failure to Meet Strength Requirements: Paragraph 17 of ASTM C94 shall not apply. Failure to meet strength requirements will be governed by the appropriate provisions of the General Conditions.

## **2.2 REINFORCEMENT**

- A. Reinforcing Steel Bars: ASTM A615 including Supplementary Requirement S1, Grade 60. For applications requiring welding of reinforcing steel bars, use ASTM A706, Grade 60, Low-Alloy Deformed Bars (except where smooth bars are indicated).
- B. Welded Steel Wire Fabric: ASTM A185

## **2.3 CONCRETING ACCESSORIES**

- A. Premolded Expansion Joint Filler: ASTM D1752
  - 1. Sponge Rubber: Type I
  - 2. Cork: Type II
  - 3. Self-Expanding Cork: Type III
- B. Waterstops at joints between new and old concrete or where indicated on the Contract Drawings:
  - 1. Specially formulated joint sealant comprised of bentonite/butyl rubber supplied in coil forms.
  - 2. Upon hydration the water stops shall swell to form a self-healing compression seal that completely locks out water and prevents water migration along the waterstop.
  - 3. Install a minimum of two inches from edge of wall joint. Install two parallel strips of waterstop at each wall joint. Install two parallel strips of waterstop at each wall joint.
  - 4. Installation shall be in strict conformance with manufacturer's requirements.
  - 5. Waterstops shall be Adeka ULTRA SEAL.
- C. Vapor Barrier: Vapor Barrier Basis of Design Manufacturer: Stego Industries; [www.stegoindustries.com](http://www.stegoindustries.com).
  - 1. Product: Stego Wrap Vapor Barrier - 15mil.
- D. Bond Breaker: Non-staining liquid product which imparts a waterproof film to prevent adhesion of concrete and will not leave a paint-impeding coating on the face of the concrete.
- E. Waterproof Sheet Material for Curing: ASTM C171.
- F. Spacers, Chairs, Bolsters, Ties and Other Devices:

1. Galvanized steel or non-corroding material conforming to the requirements of the Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice for Reinforced Concrete Construction".

### **PART 3 EXECUTION**

#### **3.1 GENERAL**

- A. Unless otherwise specified, conform to ACI 304, 305R, and 306R for concrete installation requirements such as preparation, mixing, conveying, depositing, curing, and cold and hot weather requirements. Consolidate concrete in accordance with ACI 309.
- B. Concrete not placed within 90 minutes or 300 revolutions, whichever occurs first, after the first mixing of the cement and aggregates will be rejected.

#### **3.2 COORDINATION**

- A. Examine the drawings and specifications for work of other sections or other contractors and coordinate such work with the requirements of this Section. Make provisions for installation of such items as sleeves, pipes, conduits, inserts and hangers in a manner that will not impair or weaken concrete construction.

#### **3.3 REINFORCEMENT**

- A. Cleaning and Bending:
  1. Clean metal reinforcement free of loose rust, mill scale, or other coatings that will destroy or reduce the bond.
  2. Perform cutting and bending in the shop. Bend and cut steel cold. Do not bend or straighten bars in a manner that will injure the material.
- B. Placement: Arrange and place reinforcement in accordance with the approved shop drawings. Secure in position with chairs, spacers, and ties. Concrete brick may be used to support reinforcement for slabs on grade when approved by the Architect.
- C. Splicing:
  1. Furnish reinforcing bars in full lengths as indicated on the Contract Drawings and approved shop drawings.
  2. Do not splice bars unless indicated on the Contract Drawings or approved by the Architect in writing.
  3. When authorized, make splices in accordance with ACI 318. Perform welding in accordance with AWS D12.1.
  4. Lap mesh reinforcement not less than one mesh space plus 2 inches, and tie.
- D. Concrete Cover:
  1. Provide clearance and spacing indicated on the Contract Drawings.
  2. Where no clearances are indicated, the thickness of concrete cover over reinforcement shall be:
    - a. 3 inches for concrete placed against ground without the use of forms
    - b. 2 inches for concrete placed in forms that will be exposed to ground or weather
    - c. 1-1/2 inches for formed concrete not exposed to ground or weather
    - d. 1 inch for slabs not exposed to ground or weather

#### **3.4 FORMWORK**

- A. Responsibility:

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1. The design and construction of formwork are the sole responsibility of the Contractor.
  2. The Contractor shall remove and replace forms which no longer have smooth surfaces and/or are weak resulting in intrusions or extrusions in the concrete face.
- B. Design Criteria:
1. Design formwork system which is adequately braced and has strength and stability to insure finished concrete within the tolerances specified in ACI 347.
  2. Provide formwork sufficiently tight to prevent leakage of mortar.
  3. Chamfer external and exposed corners 1 inch.
- C. Coating Forms:
1. Coat forms with bond breaker prior to the placement of reinforcing steel.
  2. Do not allow excess form coating material to stand in puddles in the forms or to come in contact with concrete against which fresh concrete is to be placed.
  3. Clean reinforcing steel that has become contaminated with bond breaker to the satisfaction of the Architect prior to placing concrete.
- D. Embedded Items:
1. Clean items to be embedded in concrete free from oil or foreign matter that would weaken the bond of the concrete to these items.
  2. Install in the formwork requisite inserts, anchors, sleeves, and other items specified under other sections of these specifications. Close ends of conduits, piping, and sleeves embedded in concrete with caps or plugs.
- E. Joints:
1. Make contraction, expansion, and construction joints where indicated on the Contract Drawings. Additional construction joints are subject to prior approval of the Architect. Locate additional construction joints to least impair the strength of the structure.
  2. Form keyways and joints as indicated on the Contract Drawings.
  3. Continue reinforcing steel and wire fabric across construction joints.
  4. Install premolded joint filler at locations indicated. Extend filler from bottom of concrete. Seal as indicated on the Contract Drawings. Make splices in premolded filler in manner to preclude penetration of concrete between joint faces.

### **3.5 PREPARATION OF EQUIPMENT AND PLACE OF DEPOSIT**

- A. Before placement, clean equipment for mixing and transporting the concrete. Remove debris and ice from the places to be occupied by the concrete. Clean reinforcement of dirt, loose rust, and mill scale, or other coatings.
- B. Remove water from place of deposit before concrete is placed. Remove laitance and unsound material from hardened concrete before additional concrete is added.

### **3.6 MIXING**

- A. Mix and deliver ready-mixed concrete in accordance with ASTM C94.
- B. Do not over-mix. Do not use concrete which is retained in mixers so long as to require additional water in excess of design mix water to permit satisfactory placing.
- C. Use preparation methods capable of producing concrete with a temperature not more than 85 degrees Fahrenheit, and not less than 55 degrees Fahrenheit, at the time of placement.
- D. Do not heat concrete ingredients to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, within the specified temperatures.

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- E. Do not heat water in excess of 140 degrees Fahrenheit.

### **3.7 CONVEYING**

- A. Convey concrete from the mixer to the final deposit by methods that will prevent segregation or loss of materials.

### **3.8 CONCRETE PLACEMENT**

- A. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not use vibrators to move concrete horizontally with the forms.
- B. Do not use retempered concrete or concrete contaminated by foreign material.
- C. Plan and conduct concrete placement to insure that the concrete is kept plastic and that the concrete is free of cold joints.
- D. Where there is a time delay greater than 45 minutes between adjacent concrete placement, a bulkhead construction joint, complete with waterstops where required, must be installed.
- E. Remove temporary spreaders in forms when concrete has reached an elevation rendering their service unnecessary.
- F. Do not commence placing when the sun, heat, wind or limitations of facilities provided prevent proper finishing or curing.
- G. Discontinue concreting when the descending natural air temperature falls lower than 40 degrees Fahrenheit unless preparations are made and in place to heat or insulate concrete in accordance with the cold weather concreting requirements of this specification.

### **3.9 CONSOLIDATION**

- A. Consolidate concrete thoroughly as it is placed in order to secure a dense mass. Work concrete well around the reinforcement and embedded items and into the corners of the forms.
- B. Use internal vibrators inserted vertically over the entire area of the placement.
- C. Vibrate until voids are eliminated, coarse aggregate is suspended in mortar, and entrapped air bubbles begin to rise to the surface. Concrete shall move back into the space vacated by the vibrator.
- D. Space vibrator insertions such that the area visibly affected by the vibrator overlaps the adjacent just-vibrated area by a few inches.
- E. Penetrate at least 6 inches into previously placed layers in order to bond between layers and avoid cold joints.
- F. Form vibrators may not be used.
- G. Take care not to over-vibrate air entrained concrete. Place vibrator to eliminate honeycombing but avoid excess vibrating that bleeds all entrapped air from the mix.
- H. Do not use vibrators to transport concrete.

### **3.10 JOINTS AND KEYWAYS**

- A. Construct expansion, control, and isolation joints and keyways where indicated on the Contract Drawings and at additional locations approved by the Architect.
- B. Where the placing of concrete is discontinued, clean off laitance and other objectionable material to a sufficient depth to expose sound concrete as soon as concrete is firm enough to retain its form. Smooth the top surface of concrete adjacent to the forms with a trowel to minimize visible joints on exposed faces.

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- C. Immediately after the work of placing concrete is halted, remove accumulations splashed upon the reinforcement and the surfaces of the forms. Perform this removal before concrete takes its initial set. Clean reinforcing steel carefully to prevent damage to the concrete steel bond.
  - D. Do not halt work within 18 inches of the top of any face.
  - E. For bonded horizontal joint construction, roughen the surface and expose the aggregate. Clean the surface thoroughly by wet sandblasting, by cutting with high-pressure water jet or by other approved methods. Perform cleaning after the concrete has hardened to prevent raveling of the surface below the desired depth.
  - F. Before bonding concrete is placed, clean the surface of loose or soft particles or other objectionable materials and keep wet for a minimum period of 12 hours.
  - G. Cover the cleaned and saturated surface with a coating of neat cement grout and deposit new concrete before the grout has attained its initial set.

### **3.11 CONCRETE PROTECTION**

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperature and mechanical injury. Maintain with minimum moisture loss and relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete.
- B. After the concrete has hardened, loosen forms as soon as possible without damage to the concrete, and run curing water continuously down inside the form.

### **3.12 REMOVAL OF FORMS**

- A. Do not remove forms until members have acquired sufficient strength to support their own weight and imposed loads safely.
- B. In cold weather, all forms must remain in place for 5 days except those in Concrete Groups C and F of Table I where the requirement is 3 days.
- C. Notify the Architect before forms are removed in order that an examination of the newly-stripped surfaces may be made prior to patching.

### **3.13 REPAIR OF TIE HOLES AND MINOR DEFECTS**

- A. Repair immediately after form removal.
  - B. Honeycombs and Small Defective Areas:
    - 1. Remove to sound concrete.
    - 2. Wet the affected area.
    - 3. Brush on bonding grout - 1 part cement, 1 part fine sand and water to produce a consistency of thick cream.
    - 4. Apply patching mortar - 1 part cement, 2-1/2 parts sand and enough water to produce a stiff consistency.
    - 5. Consolidate patching mortar and strike off to leave the patch slightly higher than the surrounding surface.
    - 6. Finish the repaired area flush with the surrounding area after the mortar has been in place for one hour.
  - C. Tie Holes:
    - 1. Thoroughly clean and dampen.
    - 2. Fill solid with patching mortar.
  - D. Perform patching before curing compound is applied.
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- E. Cure patched areas in the same way as adjacent concrete.
- F. Make repairs uniform in color and finish with surrounding concrete.

### **3.14 CURING**

- A. Keep concrete moist for at least 7 curing days after placement. Concrete Groups C and F of Table I must be kept moist for only 3 curing days.
- B. A curing day is defined as 24-hour day when the concrete surfaces are kept moist and the uniform temperature of the concrete mass is between 55 degrees Fahrenheit and 75 degrees Fahrenheit.
- C. Water curing is the preferred method of protection. Cover exposed surfaces with a saturated material (burlap or cotton mats) and keep wet continuously with a soil soaker hose for 7 days. Leave covering in place, without wetting, for an additional 3 days.

### **3.15 HOT WEATHER REQUIREMENTS**

- A. Hot weather conditions are deemed to exist when the temperature in the forms is 75 degrees Fahrenheit or above, or a combination of high air temperature, low relative humidity and wind velocity impairs the quality of fresh or hardened concrete. Take protective measures for mixing, transporting and placing concrete in accordance with ACI 305R.
- B. The temperature of the concrete at the place of discharge may not exceed 85 degrees Fahrenheit.
  - 1. If ice is used to lower temperature, place crushed, shaved or chipped ice directly into the mixer as part or all of the mixing water. Mix until ice is completely melted.
  - 2. Record the concrete temperature at the time of discharge.
- C. Do not add water that will cause the proportions to exceed the maximum water-cement ratio shown in Table I.
  - 1. Notify the resident project representative before adding any water to the concrete mix.
  - 2. Record the amount of water added to the concrete at the jobsite.
- D. Discharge concrete within 90 minutes or 300 revolutions, whichever occurs first, after the first mixing of cement and aggregates.
- E. Placing and Curing:
  - 1. Place concrete promptly upon arrival.
  - 2. Provide at least one standby vibrator for each 3 vibrators in use.
  - 3. Protect concrete from direct sunlight. Keep forms covered and moist by means of water sprinkling or the application of continuously wetted burlap or cotton mats for a minimum of 24 hours.
  - 4. When forms are removed, provide wet cover to the newly exposed surfaces to avoid exposure to hot sun and wind.
  - 5. Continue specified water curing methods for 10 days. Leave covering in place 4 additional days. Do not permit alternate wetting and drying cycles.

### **3.16 COLD WEATHER REQUIREMENTS**

- A. Cold weather is defined any time when the daily temperature is 40 degrees F or lower during placement and the protection period.
- B. Protect concrete surfaces from freezing for at least 24 hours after placement.
- C. All surfaces in contact with newly-placed concrete including formwork, reinforcement and subgrade must be above 35 degrees Fahrenheit.

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- D. Place concrete at a temperature of not less than 55 degrees Fahrenheit. Mix concrete at a temperature between:
    - 1. 60 degrees Fahrenheit and 70 degrees Fahrenheit when outside air temperature is above 30 degrees Fahrenheit.
    - 2. 65 degrees Fahrenheit and 75 degrees Fahrenheit when outside air temperature is between 0 degrees Fahrenheit and 30 degrees Fahrenheit.
    - 3. 70 degrees Fahrenheit and 80 degrees Fahrenheit when outside air temperature is below 0 degrees Fahrenheit.
  - E. Follow concrete placement with tarpaulins or other readily movable coverings, so only a few feet of concrete is exposed to the outside air at any time.
  - F. Maintain the temperature and moisture conditions specified in all parts of the newly-placed concrete by covering, insulating, housing or heating. Arrange for protection methods in advance of placement.
  - G. Maintain concrete at a temperature of not less than 50 degrees Fahrenheit nor more than 70 degrees Fahrenheit for a period of 3 days after placement. Only 2 days are required for Concrete Groups C and F of Table I.
  - H. Do not remove forms during the initial protection period.
  - I. Protect insulation against wetting that will impair its insulating value using moisture-proof cover material. Keep insulation in close contact with concrete.
  - J. Construct enclosure to withstand wind and snow loads and be reasonably air-tight. Provide sufficient space between the concrete and enclosure to permit free circulation of heated air.
  - K. Use vented heaters. Do not permit heaters to heat or dry concrete locally.
  - L. Maintain relative humidity above 40 percent within heated enclosures before construction supports are removed.
  - M. Monitor temperature to insure concrete is kept within specified limits recording time and concrete temperature every 8 hours.
  - N. Assure concrete has developed necessary strength before removing forms. Provide additional test cylinders with the same protection as the structure they represent to verify concrete strength before construction supports are removed.
  - O. If water curing is used, terminate at least 12 hours before end of temperature protection period. Permit concrete to dry.
  - P. After the required protection period, gradually reduce the concrete temperature within an enclosure or insulation at a rate not to exceed 20 degrees Fahrenheit per day until the outside temperature has been reached.
  - Q. Apply membrane-forming curing compound to concrete surfaces during the first period of above-freezing temperatures after forms are stripped and before air temperature rises to 50 degrees F. Apply membrane-forming curing compound to slabs as soon as finishing operations are completed, except where live steam curing is used.

**SEE ATTACHED TABLES**

**TABLE 1****PROPERTIES OF CEMENT CONCRETE**

Concrete Group	REQD 7 Day Strength (psi)	REQD 28 Day Strength (psi)	Reinf. Steel Grade	Water / Cement Ratio	Max. % Air Content	Min. / Max. Slump (In.)	Max. C3A (%)	Cement Type	Max. Aggregate Size (In.)
A	2,100	3,000	60	0.51	5 +/- 1	2-4	-----	I or IA	1-1/2
B	2,100	3,000	60	0.51	6 +/- 1	2-4	----- -	I or IA	1
C	2,100*	3,000	60	0.57	5 +/- 1	2-4	----- -	III or IIA	1-1/2
D	2,800	4,000	60	0.45	5 +/- 1	2-4	----- -	I or IA	1-1/2
E	2,800	4,000	60	0.45	5 +/- 1	2-4	8	II or IIA	1-1/2
F	2,800*	4,000	60	0.46	5 +/- 1	2-4	----- -	III or IIIA	1-1/2
G	3,150	4,500	60	0.42	5 +/- 1-1/2	2-4	8	II or IIA	1-1/2
H	2,800	4,000	60	0.45	1.5 +/- 0.5	2-4	----- -	I	1
I	1,500	2,000	60	0.67	5 +/- 1	2-6	----- -	I or IA	1-1/2

\*Compressive Strength at 3 Days

**TABLE II**

**CONCRETE FINISH SCHEDULE**

LOCATION	CONCRETE GROUP	FINISH	REMARKS
Tanks	G	Grout Cleaned Finish	Exposed Exterior Faces of Walls to 1 Foot Below Grade
		Smooth Rubbed Finish	Interior Faces of Walls and Underside of Elevated Slabs / Beams
		Smooth Form Float Finish	Buried Exterior Faces of Walls Top of Tank Base Slab
Slabs on Grade and Elevated Floors on Metal Deck	H	Steel Troweled	Top of Slabs, Coordinate with Floor Finish Schedule
Sidewalks, Entrance Pads, Equipment Pads, Exterior Concrete Stairs or Interior Stairs With No Finishes	G	Non-Slip Broom Finish	
Frostwalls, Piers	G	Smooth Rubbed Finish	Exposed Exterior Faces of Walls to 1 Foot Below Grade
		Rough Form	Buried Faces of Walls
Footings	B	Rough Form	

**END OF SECTION 03 30 00**