

## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. The extent of concrete work is shown on the drawings.

##### 1.2 QUALITY ASSURANCE

- A. Codes and Standards

Comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

ACI 212 "Specifications for Concrete Admixtures."

ACI 301 "Specifications for Structural Concrete for Buildings."

ACI 302 "Guide for Concrete Floor and Slab Construction."

ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete."

ACI 311 "Recommended Practice for Concrete Inspection."

ACI 347 "Recommended Practice for Concrete Formwork."

Concrete Reinforcing Steel Institute, "Manual of Standard Practice."

- B. Workmanship:

- (1) The Contractor is responsible for correction of concrete work which does not conform to the specified requirements, including strength, tolerances, and finishes. Correct deficient concrete utilizing materials specified herein as directed by the Engineer.
- (2) Concrete Testing Service: Employ, at contractor's expense, a testing laboratory acceptable to Engineer to perform material evaluation tests and to design or review concrete mixes.

- (3) Materials and installed work may require testing and retesting, as directed by the Engineer, at anytime during the progress of the work. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be done at the Owner's expense, including the retesting of rejected materials and installed work, shall be done at the contractor's expense.
- c. Tests for Concrete Materials:
- (1) Test aggregates by method of sampling and testing of ASTM C-33.
  - (2) For Portland cement, sample the cement and determine the properties by the methods of test of ASTM C-150.
  - (3) Submit written reports to the Engineer for each material sampled and tested prior to the start of work. Provide the project identification number, date of report, name of the contractor, name of concrete testing service, source of concrete aggregates, material manufacturer, and brand name for manufactured materials, values specified in the referenced specification for each material and test results. Indicate whether or not material is acceptable for intended use. Submit two (2) copies.
  - (4) Certificates of material properties and compliance with specified requirements may be submitted in lieu of testing, when acceptable to the Engineer. Certificates of compliance must be signed by the material producer and the contractor.

### 1.3 SUBMITTALS

- A. **Manufacturer's Data; Concrete Work:** Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dryshake finish materials and others as requested by the Engineer.
- B. **Shop Drawings; Concrete Reinforcement:** Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement" showing bar schedules, stirrup spacing diagrams of bent bars, arrangement of concrete reinforcement. Include special reinforcement required at openings through concrete structures.
- C. **Mix Design; Concrete Work:** Submit two (2) copies of mix design and supporting data for each strength and type concrete.

- D. Submit in accordance with Section 01300.

## PART 2 - PRODUCTS

### 2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Unless otherwise shown or specified, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood faced or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection.
- B. Forms for Unexposed Finish Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least two (2) edges and one side for tight fit.
- C. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces to be cured with water or curing compound.

### 2.2 REINFORCING MATERIALS

- A. Reinforcing Bar (Rebar): ASTM A-615, and as follows:  
  
Provide Grade 60, except where otherwise shown, for bars Nos. 3 to 18.
- B. Welded Wire Fabric (WWF): ASTM A-185, welded steel wire fabric.
- C. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Wood, brick, and other devices will not be acceptable.

For slabs-on-grade, use supports with sand plates or horizontal runners where wetted base material will not support chair legs.

For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected or stainless steel protected.

## 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C-150, Type 1, unless otherwise acceptable to Engineer.

Use only one brand of cement throughout the project, unless otherwise acceptable to Engineer.

- B. Normal Weight Aggregates: ASTM C-33, and as herein specified. Provide aggregates from a single source for all exposed concrete.
- C. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps, or other deleterious substances.

Dune sand, bank-run sand and manufactured sand are not acceptable.

- D. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:

- (1) Crushed stone, processed from natural rock or stone.
- (2) Washed gravel, either natural or crushed. Use of pit or bankrun gravel is not permitted.

- E. Maximum Aggregate Size: Not larger than one-fifth of the narrowest dimensions between sides of forms,  $\frac{1}{3}$  of the depth of slabs, nor  $\frac{3}{4}$  of the minimum clear spacing between individual reinforcing bars or bundles of bars.

These limitations may be waived if in the judgement of the Engineer workability and methods of consolidation are such that concrete can be placed without honeycomb or voids.

- F. Water: Clean, fresh, drinkable.

- G. Admixtures:

Water Reducing Admixture: "Eucon WR-75" by The Euclid Chemical Company, "Pozzolith 200N" by Master Builders, "Plastocrete 160" by Sika Chemical

Corporation or equal. The admixture shall conform to ASTM C-494, Type A and not contain more chloride ions than are present in municipal drinking water.

Water Reducing, Retarding Admixtures: "Eucon Retarder-75" by The Euclid Chemical Company, "Pozzolith 100XR" by Master Builders, "Plastiment" by Sika Chemical Corporation or equal. The admixture shall conform to ASTM C494, Type D, and not contain more chloride ions than are present in municipal drinking water.

Non-Corrosive, Non-Chloride Accelerator: "Accelguard 80" by The Euclid Chemical Company or approved equal. The admixture shall conform to ASTM C-494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long term non-corrosive test data.

Air Entraining Admixture: Conform to ASTM C-260.

Calcium Chloride: Calcium chloride or admixtures containing more than 0.1% chloride ions are not permitted.

Certification: Written conformance to above mentioned requirements and the chloride ion content of the admixture will be required from the admixture manufacturer prior to mix design review by the Engineer.

- H. Corrosion Resistant Cement: Where specified, special corrosion resistant concrete utilizing Type II Portland Cement (ASTM Standard) with Class F fly ash must be used. The latest version of ASTM C 618 classification must be followed for chemical requirements, physical properties (e.g., fineness, soundness, etc.), and for all other technical and non-technical specifications regarding fly ash. Sampling and testing for the verification of fly ash characteristics must be done according to the latest edition of ASTM C311. Contractor should make sure that the supplier of the fly ash should have a quality control program in conformance with ASTM C 618 that is technically and statistically sound.

## 2.4 RELATED MATERIALS

- A. Waterstops: Provide flat, dumbbell type or centerbulb type waterstops at construction joints and other joints as shown. Size to suit joints.

Provide polyvinyl chloride (PVC) waterstops: Corps of Engineers CRD-C572.

- B. Moisture Barrier: Provide moisture barrier cover over prepared base material where shown on drawings. Use only materials which are resistant to decay when tested in accordance with ASTM E-154, as follows:
- Polyethylene sheet not less than 6 mils thick.
- C. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHO M-182, Class 3.
- D. Moisture-Retaining Cover: One of the following complying with ASTM C-171.
- Waterproof paper  
Polyethylene film  
Polyethylene-coated burlap.
- E. Curing and Sealing Compound: The compound shall be a styrene butadiene type, conforming to Federal Specification TT-C-800A, 30% solids contents minimum, and have test data from an independent laboratory indicating a maximum moisture loss of 0.030 grams per sq. cm. when applied at a coverage rate of 300 sq. ft. per gallon. Compound shall be "Super Pliocure" by The Euclid Chemical Company, "Masterseal 66" by Master Builders or equal.
- F. Dissipating Curing Compound: The compound shall be a dissipating resin type compound, conforming to ASTM C-309, Type I, "Kurez DR" by The Euclid Chemical Company, or equal. The film must chemically break down in a two (2) to four (4) week period after application.
- G. Bonding Compound: The compound shall be a polyvinyl acetate, rewettable type. "Euco Weld" by The Euclid Chemical Company, "Weldcrete" by The Larsen Company or equal.
- H. Epoxy Adhesive: The compound shall be a two (2) component, 100% solids, 100% reactive compound suitable for use on dry or damp surfaces, "Euco Epoxy #463 or #615" by The Euclid Chemical Company, "Sikadur Hi-Mod" by Sika Chemical Corporation or equal.
- I. Non-Shrink Grout: The grout shall conform to CRD-C-621-80, "Corps of Engineers Specification for NonShrink Grout", "Firmix" (metallic) or "Euco NS" (nonmetallic) by The Euclid Chemical Company, "Embeco 153" (metallic) or "Masterflow 713" (non-metallic) by Master Builders or equal by U.S. Grout Corporation.

- J. Portland Cement Grout: Portland cement grout shall be prepared from materials specified in 2.3 and shall be proportioned to produce a minimum 28-day compressive strength of 4,000 psi.

## 2.5 PROPORTIONING AND DESIGN OF MIXES

- A. Mix Design: All mix designs shall be proportioned in accordance with Section 3.8.2 (field experience or trial batches) of ACI 301. Submit mix designs on each class of concrete for review. If trial batches are used, the testing facility shall not be the same as used for field quality control testing unless otherwise acceptable to the Engineer.
- B. Submit written reports to the Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been approved by the Engineer.
- C. If mix is not designed by a. above, design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:
  - 4,000 psi 28-day compressive strength; 560 lbs. cement per cu. yd. minimum; W/C ratio 0.44 maximum for non- air-entrained concrete or 0.35 for air entrained concrete.
  - 3,000 psi 28-day compressive strength; 480 lbs. cement per cu. yd. minimum; W/C ratio 0.58 maximum for non air-entrained concrete or 0.46 for air entrained concrete.

All poured in place concrete shall have a minimum compressive strength of 4,000 psi in 28 days except walks or grade which shall be 3000 psi.
- D. The mix designer shall submit with the mix design a maximum amount of water that may be added to the concrete on site and still maintain the specified strength, along with supporting information and calculations. In no case shall this amount be more than 1 gallon of water per cubic yard of concrete.
- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the Owner and as accepted by the Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the Engineer before using the mix.

- F. Admixture Usage: Use air entraining admixture in all concrete structures and slabs at a rate to result in concrete at the point of placement having an air content within the following limits:

4% to 5% for maximum 2" aggregate  
4.5% to 5.5% for maximum 1½" aggregate  
4.5% to 6% for maximum 1" aggregate  
5% to 6% for maximum ¾" aggregate  
5.5% to 7% for maximum ½" aggregate  
6% to 7.5% for maximum ⅜" aggregate

Other admixtures may be used to obtain a concrete mix which has strength, slump and all other parameters specified.

Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.

- G. Slump: Proportion and design mixes to result in concrete slump at the point of placement as indicated below:

- (1) Ramps, slabs and sloping surfaces: Not more than 3 inches.
- (2) Reinforced foundation systems: Not less than 2 inches nor more than 4 inches.
- (3) All other concrete: Not less than 2 inches nor more than 5 inches.

The slump of the concrete shall be measured after it arrives at the job site. If low, the slump can be increased up to the range specified above by adding water so long as the amount of water added does not exceed that established by the mix designer. If water is added on site, the slump shall be checked again before placement to verify it does not exceed the limits specified above. If at any time the slump of the concrete exceeds the limits specified above, it shall be rejected. After the final desired slump has been attained, the compressive strength samples may be prepared.

## 2.6 CONCRETE MIXING

- A. Job-Site Mixing: Mix materials for concrete in an acceptable drum type batch machine mixer. For mixers of one cu. yd., or smaller capacity, continue mixing at least 1½ minutes, but not more than 5 minutes after all ingredients are in the mixer, before any part of the batch is released. For mixers of capacity larger than

one cu. yd., increase the minimum 1½ minutes of mixing time by 15 seconds for each additional cu. yd. or fraction thereof.

Provide a batch ticket for each batch discharged and used in the work, indicating the project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

- B. Ready-Mix Concrete: Comply with the requirements of ASTM C-94, and as herein specified.

During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C-94 may be required.

When the air temperature is between 85°F and 90°F, reduce the mixing and delivery time from 1½ hours to 75 minutes, and when the air temperature is above 90°F, reduce the mixing and delivery time to 60 minutes.

When temperature or humidity conditions dictate, the specified water reducing, retarding admixture may be used.

### PART 3 - EXECUTION

#### 3.1 FORMS

- A. Design, erect, support, brace, and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. Construct formwork so concrete members and structures are of correct size, shape alignment, elevation, and position.
- B. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms complying with ACI-347 to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades levels, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustifications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, and inserts and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

- D. Fabricate forms for easy removal without hammering or prying against the concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only, Kerf wood inserts for forming keyways, reglets, recesses, and the like to prevent swelling and for easy removal.
- E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- F. Provide 3/4-inch chamfer on all exposed top edges. Provide 3/4-inch chamfer on exposed corner edges shown on the plans or as directed by the Engineer. Use wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- G. Form Ties: Factory-fabricated, adjustable-length removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

Unless otherwise shown, provide ties so portion remaining within concrete after removal is at least 1½ inches inside concrete.

Unless otherwise shown, provide form ties which will not leave holes larger than 1 inch diameter in concrete surface.

- H. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove clips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms after concrete placement is required to eliminate mortar leaks.

### 3.2 PLACING REINFORCEMENT

- A. Comply with the specified codes and standards and Concrete Reinforced Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports as herein specified.

- B. Clean reinforcement of loose rust and mill scale, earth, oil, ice, and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers as required.
- D. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete not toward exposed concrete surfaces.

Do not place reinforcing bars more than 2 inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.
- F. Where splices in reinforcing are necessary, reinforcing shall be lapped 36 diameters, but not less than 1' 6".
- G. Reinforcing in all concrete walls and footings shall be continuous around corners. Where footings step, reinforcing shall be continuous in step.

### 3.3 JOINTS

- A. Construction Joints: Locate and install construction joints as required and approved by the Engineer.
- B. Provide keyways, at least 1½ inches deep in all construction joints in walls, slabs, and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.
- C. Place construction joints perpendicular to main reinforcement. Continue all reinforcement across construction joints of structural members.
- D. Waterstops: Provide waterstops in construction joints at hydraulic structures. Install waterstops to form a continuous diaphragm in each joint. Make provisions to support and protect waterstops during the progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions. Protect waterstop material from damage where it protrudes from any point.

- E. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs on ground at all points of contact between slabs on ground and vertical surfaces which originate below the slab, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

### 3.4 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of the items to be attached thereto.
- B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain the required elevations and contours in the finished slab surface. Provide and secure units sufficiently strong to support the types of screed strips by the use of strike-off templates or accepted compacting type screeds.

### 3.5 PREPARATION OF FORM SURFACES

- A. Coat the contact surfaces of forms with a form-coating compound before placement of reinforcement.
- B. Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of the form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in the forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- C. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

### 3.6 CONCRETE PLACEMENT

- A. Preplacement Inspection: The Engineer must be notified 24 hours prior to concrete placement in order to inspect the areas to receive concrete. Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit the installation of their work; cooperate with other trades in setting such work, as required. Thoroughly wet wood forms immediately before placing concrete, as required where form coatings are not used.

Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

- B. General: Comply with ACI-304 and as herein specified. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing.
- C. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined layer surface. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints. In vertical walls containing waterstop, the first 6 inches of concrete placed shall be Portland cement grout.
- D. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidations of concrete in accordance with the recommended practices of ACI-309 to suit the type of concrete and project conditions. Lower amplitude vibrators shall be used with "flowing" concrete.
- E. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the placed layer of concrete and at least 6" into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
- F. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation within the limits of construction joints until the placing of a panel or section is completed.

Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

Bring slab surfaces to the correct level with a straightedge and strikeoff. Use bull floats or darbies to smooth the surface, leaving it free of lumps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

Maintain reinforcing in the proper position during concrete placement operations.

Where slabs are poured on the ground, the soil should be thoroughly wet prior to placing the concrete.

- G. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures in compliance with ACI-306 and as herein specified.

When air temperature has fallen to or is expected to fall below 40°F. within 24 hours after placement, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 50°F, and not more than 80°F at point of placement.

Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

When the mean daily temperature is expected to drop below 40°F, provisions shall be made to protect the concrete from freezing until the concrete has sufficiently cured. This protection can be by insulated blankets or forms or other acceptable methods.

Use only the specified non-corrosive, non-chloride accelerator. Calcium chloride or admixtures containing more than 0.1% chloride ions are not permitted.

- H. Hot Weather Placing: When hot weather conditions exist that would seriously impair the quality and strength of concrete as defined in ACI-305, place concrete in compliance with ACI-305 and as herein specified.

Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F. Mixing water may be chilled or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing.

Cover reinforcing steel with water-soaked burlap if it becomes too hot so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

Wet subgrade or forms thoroughly before placing concrete.

Measures to erect windbreaks or sunshades or to minimize evaporation or other measures may be necessary to protect the concrete until it has properly cured.

Use only the specified water reducing retarding admixture.

- I. Fill all concrete unit masonry cells with concrete from top of footing to finish first floor elevation.

### 3.7 FINISH OF FORMED SURFACES

- A. **Rough Form Finish (RfFm-Fn):** For formed concrete surfaces not exposed to view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding ¼-inch in height rubbed down or chipped off.
- B. **Smooth Form Finish (SmFm-Fn):** For formed concrete surfaces exposed to view, or that are to be covered with a coating or covering material applied directly to the concrete, such as wall covering, or a coating material bonded to the concrete, such as waterproofing, dampproofing, painting, concrete coating or other similar system. This is the as-cast concrete surface as obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with all fins or other projections completely removed and smoothed.
- C. **Grout Cleaned Finish (GrtCl-Fin):** Provide grout cleaned finish to surfaces which have received smooth form finish treatment and which will not be covered with a covering material.

Combine one part Portland cement to 1½ parts fine sand by volume, and the bonding mixture "SBR Latex" by The Euclid Chemical Company to produce a grout the consistency of thick paint. Blend standard Portland cement and white Portland cement, amounts determined by trial patches, so that final color of dry grout will closely match adjacent surfaces.

Thoroughly wet concrete surfaces and apply grout immediately to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

- D. **Related Unformed Surfaces:** At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise shown.

### 3.8 MONOLITHIC SLAB FINISHES

- A. Scratch Finish (Scr-Fn): Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazo, and other bonded applied cementitious finish flooring material and as otherwise shown on drawings.

After placing slabs, plane surface to a tolerance so that depressions between high spots do not exceed ½-inch under a 10 foot straightedge. Slope surfaces uniformly to drains where required. After leveling, roughen surfaces before final set with stiff brushes, brooms or rakes.

- B. Float Finish (Flt-Fn): Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified.

After screeding and consolidating concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance so that depressions between high spots do not exceed 5/16-inch under a 10 foot straightedge. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

- C. Trowel Finish (Tr-Fn): Apply trowel finish to interior monolithic slab surfaces that are to be exposed to view, unless otherwise shown or specified, and slab surfaces that are to be covered with resilient flooring, paint, or thin film coating system.

After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance so that depressions between high spots do not exceed 3/16-inch under a 10 foot straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.

- D. Non-Slip Broom Finish (NSBrm-Fn): Apply non-slip broom finish to exterior concrete platforms or slabs, steps and ramps, all wet locations whether interior or exterior and elsewhere as shown on drawings or in schedules.

Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle brooms perpendicular to main traffic route. Coordinate required final finish with the Engineer before application.

- E. Sealer/Dustproof Finish: Apply a second coat of the specified clear, styrene butadiene type curing and sealing compound to interior concrete floors where indicated on the drawings. The compound shall be applied in strict accordance with the directions of the manufacturer and just prior to completion of construction.
- F. Slope all slabs in wet areas to drain to floor drains, channels or open tanks.

### 3.9 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly place concrete from premature drying and excessive cold or hot temperatures, and maintain without drying at a relatively constant temperature for a period of time necessary for hydration of cement and proper hardening.

Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 72 hours.

Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least seven (7) days in accordance with ACI-301 procedures. Avoid rapid drying at end of final curing period.

- B. Curing Methods: Perform curing of concrete by moist curing, by moisture-retaining cover curing, by specified curing compounds, or by combinations thereof, as herein specified.

- (1) Provide moisture curing by following methods:

Keep concrete surface continuously wet by covering with water, continuous water-fog spray, or by covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges with 4 inch lap over adjacent absorptive covers.

- (2) Provide Moisture-cover curing as follows:

Cover concrete surfaces with moisture-retaining cover for curing concrete, place in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any

holes or tears during curing period using cover material and waterproof tape.

- (3) Provide membrane curing as follows:

Apply specified curing compounds to concrete surfaces as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's directions. Recoat areas which are subjected to heavy rainfall within three (3) hours after initial application. Maintain continuity of coating and repair damage during curing period.

- C. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- D. Curing Unformed Surfaces: Cure unformed surfaces such as floor topping and other flat surfaces by application of the appropriate curing compound.

All interior slabs to be covered with resilient tile or carpet shall be cured with the specified clear curing and sealing compound. All other interior trowel finished slabs shall be cured with the specified dissipating resin type curing compound. The curing compounds must be applied immediately after final finishing.

Cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

### 3.10 SHORES AND SUPPORTS

- A. Comply with ACI-347 for shoring and reshoring multistory construction, and as herein specified.
- B. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support the work with excessive stress or deflection.

Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required until the concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

### 3.11 REMOVAL OF FORMS

- A. Formwork not supporting weight of concrete such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete such as beam soffits, joints, elevated slabs, and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum 28-day compressive strength. Determine compressive strength of in-place concrete by testing field-cured specimens representative of concrete location of members.

Form facing material may be removed four (4) days after placement only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

- C. No structural load may be placed on any unsupported concrete member (beams, walls, columns, elevated slabs, etc.) until compressive strength of field-cured specimens has reached design minimum 28-day compressive strength. Dead load may be applied after curing not less than 24 hours at not less than 50°F if the concrete is properly supported. No torsional load may be applied until compressive strength of field-cured cylinders has reached design minimum 28-day compressive strength.

### 3.12 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable. Apply new form surfaces as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Engineer.

### 3.13 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix place and cure concrete as herein specified, to blend with in-place construction. Fill-in openings in watertight structures with non-shrink

grout. Provide other miscellaneous concrete filling shown or required to complete work.

- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of the manufacturer furnishing machines and equipment.
- D. Non-Shrink Grout: All column base plates, equipment bases and other locations noted on the structural drawings shall be grouted with the specified non-shrink grout. All exposed grout shall be the specified non-metallic type.
- E. Reinforced Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

### 3.14 CONCRETE REPAIRS

- A. Patching Defective Areas: Patch defective areas with cement mortar immediately after removal of forms, but only when acceptable to Engineer. Hydraulic structure shall be repaired using hydraulic cement.

Cut out honeycomb, rock pockets, voids over ¼-inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Before placing cement mortar or hydraulic cement, thoroughly clean, dampen with water and brush coat the area to be patched with the specified bonding compound. New concrete shall be placed after the bonding compound has dried.

For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

- B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles,

honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning.

Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.

Repair concealed formed surfaces, where possible, that contain defects that adversely affect the durability of the concrete. If defects cannot be repaired, remove and replace the concrete.

- C. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having required slope.

Repair finished unformed surfaces that contain defects which adversely affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01-inch wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.

Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations, by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Engineer.

- D. Repair defective areas, except random cracks and single holes not exceeding 1 inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least  $\frac{3}{4}$ -inch clearance all around. Dampen concrete surfaces in contact with patching concrete and brush with concrete bonding agent. Mix patching concrete of same materials to provide concrete of the same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
- E. Repair isolated random cracks and single holes not over 1 inch in diameter by dry- pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and brush with concrete bonding agent. Mix drypack, consisting of one part Portland cement to  $2\frac{1}{2}$  parts fine aggregate passing a No. 16 mesh sieve, using only

enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

- F. With prior approval of the Engineer as to method and procedure, all structural repairs shall be made using the specified epoxy adhesive and/or epoxy mortar. Where epoxy injection procedures must be used, an approved low viscosity epoxy made by the manufacturers specified previously shall be used.
- G. Repair methods not specified above may be used subject to acceptance of Engineer.

### 3.15 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. The contractor will employ a testing laboratory to perform all tests and to submit test reports. Sampling and testing for quality control during the placement of concrete shall include the following:
  - (1) Slump: ASTM C-143; one test for each concrete load at point of discharge; and one test for each set of compressive strength test specimens.
  - (2) Air Content: ASTM C-231 pressure for normal weight concrete; one for each set of compressive strength test specimens.
  - (3) Concrete Temperature: Test hourly when air temperature is 40°F and below, and when 80°F and above; and each time a set of compression test specimens are made.
  - (4) Compression Test Specimen: ASTM C-31; one set of six (6) standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
  - (5) Compressive Strength Tests: ASTM C-39; one set for each 100 cu. yds. or fraction thereof, of each concrete class placed in any one day or for each 5,000 sq. ft. of surface area placed, minimum one set for each day; two (2) specimens tested at seven (7) days, 3 specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

When frequency of testing will provide less than five (5) strength tests for a given class of concrete, conduct testing from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.

When the total quantity of a given class of concrete is less than 50 cu. yds., the strength test may be waived by the Engineer if, in his judgement, adequate evidence of satisfactory strength is provided.

When the strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

The strength level shall be considered satisfactory so long as the average of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the specified strength by more than 500 psi.

- B. Tests results will be reported in writing to the Engineer and the contractor on the same day that tests are made. Reports of compressive strength test shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests. Contractor shall pay for all testing conducted as required by this section. No additional payment will be made to the Contractor by the Owner for testing services.
- C. Additional Tests: The testing service will make additional tests, of in-place concrete when test results indicate the required strength level has not been achieved and other characteristics have not been attained in the structure, as directed by the Engineer. The testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C-42, or by other methods as directed. Contractor shall pay for such tests conducted, and any additional testing as may be required, when unacceptable concrete is verified.

### 3.16 MANUFACTURER'S INSTRUCTIONS

All admixtures, compounds or other related materials shall be installed in strict accordance with the manufacturer's printed instructions.

END OF SECTION 03300.