

**SECTION 03300
CAST-IN-PLACE CONCRETE**

PART 1 - GENERAL

- 1.01 DESCRIPTION:** This item specifies cast-in-place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.

Cast-in-place concrete (if shown on the Drawings) includes the following:

- A. Foundations, grade beams, footing and spread footings.
- B. Slabs-on-grade.
- C. Fill for steel deck.
- D. Foundation walls.
- E. Building frame members.
- F. Equipment pads and bases.
- G. Fill for steel pan stairs.
- H. Thrust blocking.

1.02 RELATED WORK

- A. 02300 Excavation and Backfill for Buildings

1.03 REFERENCES

- A. ACI 301 - Specifications for Structural Concrete for Buildings
- B. ACI 304.3R - Heavyweight Concrete: Measuring, Mixing, Transporting and Placing
- C. ACI 305.1 - Specification for Hot Weather Concreting
- D. ACI 306.1 - Standard Specification for Cold Weather Concreting
- E. ACI 309.1 - Report on Behavior of Fresh Concrete During Vibration
- F. ACI 315 - Details and Detailing of Concrete Reinforcement
- G. ACI 318 - Building Code Requirements for Structural Concrete and Commentary
- H. ACI 347 - Guide to Formwork for Concrete
- I. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
- J. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
- K. ASTM A615- Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- L. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field
- M. ASTM C33 - Standard Specification for Concrete Aggregates
- N. ASTM C39 - Standard Specification for Lightweight Aggregates for Structural Concrete
- O. ASTM C94 - Standard Specification for Ready-Mixed Concrete
- P. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
- Q. ASTM C150 - Standard Specification for Portland Cement
- R. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete
- S. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete
- T. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
- U. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete
- V. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- W. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete
- X. ASTM C416 - Standard Classification of Silica Refractory Brick
- Y. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete
- Z. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
- AA. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers
- BB. ASTM E1745 - Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

- CC.** Concrete Reinforcing Steel Institute - Manual of Standard Practice
- DD.** Concrete Reinforcing Steel Institute - Placing Reinforcing Bars

PART 2 - MATERIALS

2.01 FORM MATERIALS

- A. FORMS FOR EXPOSED FINISH CONCRETE:** Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practical sizes to minimize number of joints and to conform to joint system shown on drawings.
 - 1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class 1, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. FORMS FOR UNEXPOSED FINISH CONCRETE:** Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. FORMS FOR CYLINDRICAL COLUMNS AND SUPPORTS:** Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.
- D. FORM RELEASE AGENT:** Provide commercial formulation form release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- E. FORM TIES:** Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1 1/2 inches to the plane of the exposed concrete surface.
 - 1. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.

2.02 REINFORCING MATERIALS

- A. REINFORCING BARS:** ASTM A615, Grade 60, deformed.
- B. STEEL WIRE:** ASTM A82, plain, cold-drawn steel.
- C. WELDED WIRE FABRIC:** ASTM A185, welded steel wire fabric.
- D. SUPPORTS FOR REINFORCEMENT:** 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 "Placing Reinforcing Bars".
 - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

2.03 CONCRETE MATERIALS

- A. PORTLAND CEMENT:** ASTM C150, Type I.
 - 1. Use one brand of cement throughout Project unless approved by Engineer.
- B. FLY ASH:** Will be allowed with a 20% by weight maximum proportion.
- C. NORMAL-WEIGHT AGGREGATES:** ASTM C33 and as specified. Provide aggregates from a single source for exposed concrete.

1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
 2. Local aggregates not complying with ASTM C33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when approved by Engineer.
- D. LIGHTWEIGHT AGGREGATE:** If shown on Drawings, use ASTM C330.
- E. WATER:** Potable.
- F. ADMIXTURES**
1. **GENERAL:** Provide concrete admixtures that contain not more than 0.1 percent chloride ions.
 2. **AIR-ENTRAINING ADMIXTURE:** ASTM C260, certified by manufacturer to be compatible with other required admixtures.
 3. **WATER-REDUCING ADMIXTURE:** ASTM C494, Type A.
 4. **HIGH-RANGE WATER-REDUCING ADMIXTURE:** ASTM C494, Type F or Type G.
 5. **WATER-REDUCING, ACCELERATING ADMIXTURE:** ASTM C494, Type E.
 6. **WATER-REDUCING, RETARDING ADMIXTURE:** ASTM C494, Type D.
- G. CAPILLARY BARRIER:** Under all interior slabs on grade, use 4" layer of clean flume sand, whether shown on the drawings or not.
- H. VAPOR RETARDER:** Provide vapor retarder that is resistant to deterioration when tested according to ASTM E1745, as follows:
1. Plastic sheet not less than 10 mils thick.
- I. MOISTURE-RETAINING COVER:** One of the following, complying with ASTM C171.
1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.
- J. LIQUID MEMBRANE-FORMING CURING COMPOUND:** Liquid-type membrane-forming curing compound complying with ASTM C309, Type I, Class A. Moisture loss not more than 0.55 kg/sq. meter when applied at 200 sq. ft./gal. Use Type 1-D on exterior concrete pavements and walks.
1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/l.

PART 3 - EXECUTION

- 3.01 GENERAL:** Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.
- 3.02 SUBMITTALS:** Submit the following documents:
- A.** Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others if requested by Engineer.
 - B.** Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.

- C. Samples of materials as requested by Engineer, including names, sources, and descriptions, as follows.
- D. Laboratory test reports for concrete materials and mix design test.
- E. Material certificates in lieu of material laboratory test reports when permitted by Engineer. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

3.03 QUALITY ASSURANCE

- A. **CODES AND STANDARDS:** Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. ACI 301, "Specifications for Structural Concrete for Buildings."
 - 2. ACI 318, "Building Code Requirements for Reinforced Concrete."
 - 3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
- B. **CONCRETE TESTING SERVICE:** Engage a testing agency acceptable to Engineer to perform material evaluation tests and to design concrete mixes.

Materials and installed Work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at Contractor's expense.

3.04 PROPORTIONING AND DESIGNING MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.
 - 1. Do not use the same testing agency for field quality control testing.
- B. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 calendar days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Engineer.
- C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:
 - 1. Concrete for foundations and slabs-on-grade shall be 3500 psi, 28-day compressive strength normal weight. Water-cement ratio 0.50 maximum (non air-entrained), 0.45 maximum (air-entrained). Minimum cement factor = 520 lbs./c.y. Water reducing admixture is required.
 - 2. Concrete on steel decks and/or stair landings or steps shall be 4000 psi, 28-day compressive strength lightweight concrete. Water-cement ratio shall be as required by vendor. Water reducing admixture is required.
 - 3. If shown on Drawings, concrete grout for CMU pier, bond beam, and lintel fill shall be 2500-psi, 28-day compressive strength conforming to ASTM C 416 standard specification. Design mixture to be 1/2, 1/2, 1 1/2 (Portland cement, sand, pea gravel) with 9" design slump and 3/8" maximum size pea gravel.
 - 4. All other concrete shall be 3500 psi, 28-day compressive strength normal weight. Minimum cement factor = 520 lbs./c.y. (non air-entrained).
- D. **SLUMP LIMITS:** Proportion and design mixes to result in concrete slump at point of placement as follows:
 - 1. Ramps, slabs, and sloping surfaces: Not more than 4 inches.
 - 2. Concrete Footing Shafts: Slump range of 5 to 8 inches.

3. Grade Beams: Slump range 3 to 5 inches.
4. Slabs and Pavements on Grade: Maximum slump 5 inches.
5. Concrete grout for CMU pier, bond beam, and Lintel Fill-Slump range 7 to 9 inches.
6. Concrete containing high-range water-reducing admixture (super-plasticizer): Not more than 8 inches after adding admixture to site-verified 2-to-3-inch slump concrete.
7. Other concrete: Not more than 4 inches.

E. ADJUSTMENT TO CONCRETE MIXES: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in Work.

3.05 ADMIXTURES

- A.** Use water-reducing admixture in all 3500 psi concrete.
- B.** Use high-range water-reducing admixture (super-plasticizer) in concrete, as required, for placement and workability.
- C.** Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees F (10 degrees C).
- D.** Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content of 5% with a tolerance of plus or minus 1 1/2 percent.
- E.** Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

3.06 CONCRETE MIXING

- A. READY-MIXED CONCRETE:** Comply with requirements of ASTM C94, and as specified.
 1. When air temperature is between 85 degrees F (30 degrees C) and 90 degrees F (32 degrees C), reduce mixing and delivery time from 1 1/2 hours to 75 minutes, and when air temperature is above 90 degrees F (32 degrees C), reduce mixing and delivery time to 60 minutes.

3.07 FORMS

- A. GENERAL:** Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits.

1. Provide Class A tolerances for concrete surfaces exposed to view.
2. Provide Class C tolerances for other concrete surfaces.

- B. CONSTRUCTION:** Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. 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 for easy removal.

Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.

Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

- C. 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.
- D. CLEANING AND TIGHTENING:** Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.08 VAPOR RETARDER/BARRIER INSTALLATION

- A. GENERAL:** Place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour.
- B. JOINTS:** Lap joints 6 inches and seal with manufacturer's recommended mastic or pressure-sensitive tape.

3.09 PLACING REINFORCEMENT

- A. GENERAL:** Comply with CRSI "Placing Reinforcing Bars" for details and methods of reinforcement placement and supports and as specified.
 - 1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.
 - 2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
 - 3. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Engineer.
 - 4. Place reinforcement to maintain minimum coverage as indicated 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.
 - 5. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.10 JOINTS

- A. CONSTRUCTION JOINTS:** Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Engineer.
- B. KEYWAYS:** Provide keyways at least 1 1/2 inches deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.
- C. CONSTRUCTION JOINTS:** Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.

- D. **BONDING AGENT:** Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. **WATERSTOPS:** Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Support and protect exposed waterstops during progress of Work. Field fabricate joints in waterstops according to manufacturer's printed instructions.
- F. **ISOLATION JOINTS IN SLABS-ON-GRADE:** Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
- G. **CONTRACTION (CONTROL) JOINTS IN SLABS-ON-GRADE:** Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch wide by one-fourth of slab depth or inserts 1/4 inch wide by one-fourth of slab depth, unless otherwise indicated.
 - 1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab cured, remove inserts and clean groove of loose debris.
 - 2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
 - 3. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and locate to conform to bay spacing wherever possible (at column centerlines, at half bays, third bays).
 - 4. Joint fillers and sealants shall be as specified on plans.

3.11 INSTALLING EMBEDDED ITEMS

- A. **GENERAL:** Set and build into formwork 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 items to be attached.
- B. **FORMS FOR SLABS:** Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.12 PREPARING FORM SURFACES

- A. **GENERAL:** Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.
- B. **APPLICATION:** Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

3.13 CONCRETE PLACEMENT

- A. **INSPECTION:** Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. **GENERAL:** Comply with ACI 304.3R and as specified.
- C. **DEPOSIT OF CONCRETE:** Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

- D. PLACING CONCRETE IN FORMS:** Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.1.
 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
- E. PLACING CONCRETE SLABS:** Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
 2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 3. Maintain reinforcing in proper position on chairs during concrete placement.
- F. COLD-WEATHER PLACEMENT:** Comply with provisions of ACI 306.1 and as follows:
1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 2. When air temperature has fallen to or is expected to fall below 40 degrees F (4 degrees C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F (10 degrees C) and not more than 80 degrees F (27 degrees C) at point of placement.
 3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 4. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- G. HOT-WEATHER PLACEMENT:** When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305.1 and as specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 degrees F (32 degrees C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineer.

3.14 FINISHING FORMED SURFACES

- A. **ROUGH-FORMED FINISH:** Provide a rough- formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. **SMOOTH-FORMED FINISH:** Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. **RELATED UNFORMED SURFACES:** At tops of walls, horizontal offsets, and similar unformed surfaces 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 indicated.

3.15 MONOLITHIC SLAB FINISHES

- A. **SCRATCH FINISH:** Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.
 - 1. After placing slabs, finish surface to tolerances of F (F) 15 (floor flatness) and F (L) 13 (floor levelness) measured according to ASTM E1155. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.
- B. **FLOAT FINISH:** Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.
 - 1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, 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. Finish surfaces to tolerances of F (F) 18 (floor flatness) and F (L) 15 (floor levelness) measured according to ASTM E1155. 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:** Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.
 - 1. 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 finish surfaces to tolerances of F (F) 20 (floor flatness) and F (L) 17 (floor levelness) measured according to ASTM E1155. Grind smooth any surface defects that would telegraph through applied floor covering system.
- D. **TROWEL AND FINE BROOM FINISH:** Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.

- E. NONSLIP BROOM FINISH:** Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

3.16 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 specified to blend with in-place construction. 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 by 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 diagrams or templates of manufacturer furnishing machines and equipment.

3.17 CONCRETE CURING AND PROTECTION

- A. GENERAL:** Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. INITIAL CURING:** 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 7 days.
- C. CURING METHODS:** Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.
1. **MOISTURE CURING:** Provide moisture curing by the following methods:
 - a. Keep concrete surface continuously wet by covering with water.
 - b. Use continuous water-fog spray.
 - c. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.
 2. **MOISTURE-RETAINING CURING:** Provide moisture-retaining cover curing as follows:
 - a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed 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.
- D. CURING COMPOUND:** Apply curing compound on exposed interior slabs and exterior slabs, walks, and curbs as follows:
1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3

hours after initial application. Maintain continuity of coating and repair damage during curing period.

2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
- E. CURING FORMED SURFACES:** Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- F. CURING UNFORMED SURFACES:** Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.
1. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

3.18 REMOVING FORMS

- A. FORMWORK NOT SUPPORTING WEIGHT OF CONCRETE:** 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 degrees F (10 degrees C) 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:** Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. FORM-FACING MATERIAL:** Form-facing material may be removed 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.

3.19 REUSING FORMS

- A.** Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound 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.

3.20 CONCRETE SURFACE REPAIRS

- A. PATCHING DEFECTIVE AREAS:** Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Engineer.
- B. PATCHING PROCEDURE:** Mix dry-pack mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than one inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
 2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color.

Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

C. REPAIRING FORMED SURFACES: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.

D. REPAIRING UNFORMED SURFACES: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Engineer.
4. Repair defective areas, except random cracks and single holes not exceeding one inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

3.21 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. SAMPLING AND TESTING: Sampling and testing for quality control during concrete placement may include the following, as directed by Engineer.

1. **SAMPLING FRESH CONCRETE:** ASTM C172, except modified for slump to comply with ASTM C94.
 - a. Slump: ASTM C143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - b. Air Content: ASTM C173, volumetric method for lightweight or normal weight concrete; ASTM C231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
 - c. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 degrees F (4 degrees C) and below, when 80 degrees F (27 degrees C) and above, and one test for each set of compressive-strength specimens.

- d. Compression Test Specimen: ASTM C31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - e. Compressive-Strength Tests: ASTM C39; one set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
- 2. **FREQUENCY OF TESTING:** When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
 - 3. **COMPARISON BETWEEN FIELD-CURED CYLINDERS AND COMPANION LABORATORY-CURED CYLINDERS REQUIREMENT:** When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 - 4. **STRENGTH LEVEL REQUIREMENT:** Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- B. **SAMPLING TEST RESULTS:** Test results shall be reported in writing to Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
 - C. **NON-DESTRUCTIVE TESTING:** Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
 - D. **ADDITIONAL TESTS:** The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed.

PART 4 - MEASUREMENT AND PAYMENT

4.01 CAST-IN-PLACE CONCRETE MEASURED AS PART OF ANOTHER BID ITEM:

No measurement will be made for cast-in-place concrete; include this work in other items.

END OF SECTION 03300

**SECTION 03301
CONCRETE FOR GENERAL CONSTRUCTION**

PART 1 - GENERAL

- 1.01 DESCRIPTION:** This item specifies general (non-structural) concrete used in the project, except for special concrete which may be identified in the General Requirements. Unless otherwise noted in the General Requirements, in other sections of these specifications, or on the drawings, all concrete shall be Class A as hereinafter defined. Full cooperation shall be given other trades to install embedded items. Suitable templates or instructions will be provided for setting items not placed in the forms. Before placing concrete, embedded items shall have been inspected, and tests for concrete or other materials or for mechanical operations shall have been completed and approved. General concrete includes the following:

1. Incidental Paving
2. Minor Structures
3. Sidewalks
4. Streets
5. Curbs and Gutters
6. Thrust blocking

1.02 RELATED WORK

- 1.03 REFERENCES:** Generally, Portland cement concrete shall conform to the requirements of the Portland Cement Association's Specifications for Plain and Reinforced Concrete, latest revisions. Other publications (latest revisions), listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references:

A. American Association of State Highways Officials (AASHTO), Standard:

1. M 73 Cotton Mats for Curing Concrete.
2. M 148 Liquid Membrane Forming Compounds.

B. American Concrete Institute (ACI), Standards:

1. ACI 305.1 Specification for Hot Weather Concreting
2. ACI 306.1 Standard Specification for Cold Weather Concreting
3. ACI 315 Details and Detailing of Concrete Reinforcement
4. ACI 318 Building Code Requirements for Structural Concrete and Commentary
5. ACI 347 Guide to Formwork for Concrete

C. American Society for Testing and Materials (ASTM), Publications:

1. A 185 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
2. A 615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
3. A 996 Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
4. C 33 Standard Specification for Concrete Aggregates
5. C 78 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
6. C 94 Standard Specification for Ready-Mixed Concrete
7. C 143 Standard Test Method for Slump of Hydraulic-Cement Concrete
8. C 150 Standard Specification for Portland Cement
9. C 171 Standard Specification for Sheet Materials for Curing Concrete
10. C 173 Standard Test Method for Air Content of Concrete by Volume Method
11. C 192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

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| 12. | C 330 | Standard Specification for Lightweight Aggregates for Structural Concrete |
| 13. | C 231 | Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| 14. | C 260 | Standard Specification for Air-Entraining Admixtures for Concrete |
| 15. | C 330 | Standard Specification for Lightweight Aggregates for Structural Concrete |
| 16. | C 464 | Standard Specification for Chemical Admixtures for Concrete |
| 17. | C 595 | Standard Practice for Blended Concrete Cements |
| 18. | D 98 | Standard Specification for Calcium Chloride |
| 19. | E 11 | Standard Specification for Wire-Cloth and Sieves for Testing Purposes |

PART 2 - MATERIALS

- 2.01 ABRASIVE AGGREGATE:** shall consist of not less than 55 percent aluminum oxide or silicon-carbide abrasive ceramically bonded together to form a homogenous material sufficiently porous to provide a good bond with Portland Cement paste or shall be crushed, factory-graded emery aggregate, cubical or polyhedral in form, consisting of not less than 25 percent ferric oxide. The aggregate shall not be affected by freezing, moisture, or cleaning compounds. The aggregate shall be well graded in size from particles retained on the No. 30 sieve to particles passing the No. 8 sieve designated by ASTM E 11.
- 2.02 ADMIXTURES:** Provide concrete admixtures that contain not more than 0.1 percent chloride ions.
- A. AIR-ENTRAINING ADMIXTURE:** ASTM C-260
 - B. ACCELERATING AGENT:** Calcium chloride conforming to ASTM D 98, Type 1 or Type 2. Use and amount shall be subject to approval.
 - C. OTHER ADMIXTURE:** Admixture other than air-entraining agent and accelerating agent shall conform to ASTM C 494 and shall be compatible with the mix at job temperatures. Other admixture may be used in establishing the design mix. Other admixture may be used on written approval when required by the concrete placing and finishing conditions; however, reduction of the cement content will not be permitted.
 - D. WATER-REDUCING ADMIXTURE:** ASTM C494, Type A.
 - E. HIGH-RANGE WATER-REDUCING ADMIXTURE:** ASTM C494, Type F or Type G.
 - F. WATER-REDUCING, ACCELERATING ADMIXTURE:** ASTM C494, Type E.
 - G. WATER-REDUCING, RETARDING ADMIXTURE:** ASTM C494, Type D.
- 2.03 AGGREGATES:** ASTM C 33. Coarse aggregate shall be well graded from fine to coarse within the prescribed limits. Maximum nominal coarse aggregate size shall be 1 1/2 inches for concrete work 5 inches or more in thickness and 1 inch for concrete work 4 inches thick, or less, except that aggregates shall not be larger than three-fourths the minimum clear spacing between reinforcing steel, or between reinforcing steel and forms.
- A.** Provide aggregates from a single source for exposed concrete.
 - B.** For exposed exterior surfaces, fine or coarse aggregates shall not contain substances that cause spalling.
 - C.** Local aggregates not complying with ASTM C33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Engineer.
- 2.04 FLY ASH:** Will be allowed with a 20% by weight maximum proportion.
- 2.05 CAPILLARY BARRIER:** Under all interior slabs on grade, use 4" layer of clean flume sand, whether shown on the drawings or not.

- 2.06 VAPOR RETARDER:** Provide vapor retarder that is resistant to deterioration when tested according to ASTM E1745, as follows:
- A.** Plastic sheet not less than 10 mils thick.
- 2.07 CEMENT:** Only one brand of any one type of cement shall be used for exposed concrete surfaces of any individual structure. In determining the approved mix, Portland Cement or Portland-pozzolan cement may be used with Portland cement as a blend. The proportions of natural cement in the blend shall not exceed by 25 percent by volume of the total cement used in the mixture. The proportion of Portland-pozzolan cement in the blend shall produce a percentage of pozzolan not exceeding 20 percent by absolute volume of the total combined volumes of Portland cement and pozzolan.
- A. PORTLAND CEMENT:** ASTM C 150, Type I, unless otherwise specified
 - B. HIGH-EARLY-STRENGTH PORTLAND CEMENT:** ASTM C 150
 - C. PORTLAND-POZZOLAN CEMENT:** ASTM C 340
- 2.08 CURING MATERIALS:** Liquid membrane forming compounds shall conform to AASHTO M 148 and shall be listed on the LaDOTD list of approved products. Compound shall be Type 2 white pigmented.
- 2.09 REINFORCEMENT:**
- A. BARS:** Deformed, conforming to one of the following: ASTM A 615, grade 60,
 - B. WELDED WIRE FABRIC:** ASTM A185, welded steel wire fabric.
 - C. TIE BARS:** Deformed steel bars conforming to ASTM A 615, grade 60.
- 2.10 SUPPORTS FOR REINFORCEMENT:** 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 "Placing Reinforcing Bars".
- 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).
- 2.11 WATER:** shall be potable.
- 2.12 STORAGE OF MATERIALS:** Cement and aggregates shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter. Liquid admixtures shall be protected from freezing and from settling out of solution. Any deteriorated or damaged materials shall not be used for concrete.
- 2.13 FORM MATERIALS**
- A. FORMS FOR EXPOSED FINISH CONCRETE:** 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.

Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class 1, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
 - B. FORMS FOR UNEXPOSED FINISH CONCRETE:** Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

- C. FORMS FOR CYLINDRICAL COLUMNS AND SUPPORTS:** Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.
 - D. FORM RELEASE AGENT:** Provide commercial formulation form release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - E. FORM TIES:** Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1 1/2 inches to the plane of the exposed concrete surface. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.
- 2.14 MOISTURE-RETAINING COVER:** One of the following, complying with ASTM C171.
- A.** Waterproof paper.
 - B.** Polyethylene film.
 - C.** Polyethylene-coated burlap.
- 2.15 LIQUID MEMBRANE-FORMING CURING COMPOUND:** Liquid-type membrane-forming curing compound complying with ASTM C309, Type I, Class A. Moisture loss not more than 0.55 kg/sq. meter when applied at 200 sq. ft./gal. Use Type 1-D on exterior concrete pavements and walks.
- Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/l.

PART 3 - EXECUTION

- 3.01 GENERAL:** Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel. Cement and aggregates shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter. Liquid admixtures shall be protected from freezing and from settling out of solution. Any deteriorated or damaged materials shall not be used for concrete.
- 3.02 ESTABLISHED DESIGN-MIX PROPORTIONS:** Prior to commencing operations, the Contractor shall furnish a statement giving the mix proportions of all ingredients, maximum nominal coarse-aggregate size, that will be used in the manufacture of the class of concrete proposed for use. Proportions shall indicate weight of dry cement and weights of aggregates in saturated surface-dry condition. The statement shall be accompanied by test reports and all test results from an independent commercial testing laboratory, attesting that the proportions thus selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory.
- 3.03 ADMIXTURES**
- A.** Use water-reducing admixture in all 3000 psi concrete.
 - B.** Use high-range water-reducing admixture (super-plasticizer) in concrete, as required, for placement and workability.
 - C.** Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees F (10 degrees C).
 - D.** Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content of 5% with a tolerance of plus or minus 1 1/2 percent.
 - E.** Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

- 3.04 READY-MIXED CONCRETE:** Comply with requirements of ASTM C94, and as specified. When air temperature is between 85°F (30° C) and 90° F (32° C), reduce mixing and delivery time from 1 1/2 hours to 75 minutes, and when air temperature is above 90° F (32° C), reduce mixing and delivery time to 60 minutes.
- 3.05 PROPORTIONING OF CONCRETE MIXES:** Trial design batches and testing to meet requirements of the class of concrete specified shall be the responsibility of the Contractor. The design mix shall contain aggregates representative of those proposed for use in the work and shall be of consistencies specified herein. Tests for slump, unit weight, and air content shall be performed in the field, witnessed by the Engineer or his representative.
- 3.06 CONCRETE FIELD TESTS:** All materials to be tested and equipment necessary for taking samples shall be provided by the Contractor. Five 6 inch by 12 inch concrete cylinders shall be molded for each lot. A lot shall be defined as 50 cubic yards or each day's pour if less than 50 cubic yards. After 24 hours, the cylinders will be delivered to the testing laboratory for curing and testing. Two of the cylinders shall be tested at 7 days and three at 28 days. For acceptance and payment purposes, the compressive strength of the lot shall be the average compressive strength of the three specimens tested at 28 days. When the compressive strength of any individual specimen in a set of three is more than 15 percent above or below the average strength for a set, that specimen shall be considered an outlier and discarded and the strengths of the remaining cylinders shall be averaged to determine the strength of the set.
- If the compressive strength of the lot is below the required compressive strength, the concrete in the lot shall be removed and replaced at the contractor's expense.
- 3.07 REINFORCEMENT:** shall be fabricated to shapes and dimensions shown and shall be placed where indicated. Reinforcement shall be free of loose or flaky rust and mill scale, or coating, including ice, and any other substance that would reduce or destroy the bond. Reinforcing steel reduced in section shall not be used. After any substantial delay in the work previously placed reinforcing steel left for future bonding shall be inspected and cleaned. Reinforcing steel shall not be bent or straightened in a manner injurious to the steel or concrete. Bars with kinks or bends not shown on drawings shall not be placed. The use of heat to bend or straighten reinforcing steel will be permitted only if the entire operation is approved. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, the resulting arrangement of bars including additional bars necessary to meet structural requirements shall be approved by the Engineer before concrete is placed. Reinforcing steel shall not be spliced at points of maximum stress unless otherwise indicated. Laps or splices shall be made in conformance with ACI 318. Exposed reinforcement bars, inserts, and plates intended for bonding with future extensions shall be protected from corrosion.
- 3.08 REINFORCEMENT DETAILING AND PLACEMENT, INCLUDING CONCRETE PROTECTION FOR STEEL REINFORCEMENT:** unless otherwise indicated, shall conform to ACI 315 and 318.
- 3.09 TIE BARS:** shall be accurately aligned parallel to the finished surface, and shall be rigidly held in place and supported during placing of the concrete.
- 3.10 CLASSES OF CONCRETE, AND USAGE:** Concrete of the various classes and composition shall be in accordance with the following table, unless otherwise stated on the plans or in the General Requirements.

<u>CLASS</u>	AVERAGE COMPRESSIVE STRENGTH @ 28 DAYS psi	MINIMUM CEMENT CONTENT/C.Y. lbs.	MAXIMUM WATER CONTENT/BAG CEMENT Gallons
AA	4,000	564	6.0
A	3,500	520	6.5
B	3,000	470	6.5
C	2,500	423	7.0
D	2,000	376	8.0

The compositions shown in the table are for non-air entrained concrete. When air-entrainment is required, composition shall be adjusted accordingly, in accordance with the recommendations of the Portland Cement Association publication (latest revision) "Design and Control of Concrete Mixtures", subject to the approval of the Engineer.

The compositions shown are generally based on one (1") inch size (maximum) coarse aggregate. When required by the plans, other sections of the specifications, the General Requirements, or to meet the requirements of this section, the maximum size of coarse aggregate permissible may result in appropriate changes to the limits shown. Any such changes will be made without additional compensation to the Contractor.

The class of concrete required shall be Class A unless otherwise indicated.

3.11 SULFATE-RESISTANT CONCRETE: Not required for this project.

3.12 ENTRAINED-AIR CONTENT: When air-entrained concrete is required, air entrainment shall be produced by either adding an air-entraining agent at the mixer or by use of mill-produced air-entraining cement. When necessary to increase the air content to within the specified range, additional air-entraining admixture compatible with that already in the mixture shall be added at the mixer. Air content shall be based on measurements made in concrete mixtures at point of discharge at the job site.

Air content by total volume of concrete shall be:

4% to 6% for 1 1/2" maximum size coarse aggregate

5% to 7% for 3/4" to 1" maximum size coarse aggregate

6 1/2% to 8 1/2% for 3/8" to 1/2" maximum size coarse aggregate

Air content shall be determined in accordance with ASTM C 173 or C 231.

3.13 CORRECTIVE ADDITIONS: to remedy deficiencies in aggregate gradations shall be used only on written approval from the Engineer.

3.14 PLACING REINFORCEMENT

A. GENERAL: Comply with CRSI "Placing Reinforcing Bars" for details and methods of reinforcement placement and supports and as specified.

1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
3. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Engineer.

4. Place reinforcement to maintain minimum coverage as indicated 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.
5. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.15 JOINTS

- A. **CONSTRUCTION JOINTS:** Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Engineer.
- B. **KEYWAYS:** Provide keyways at least 1 1/2 inches deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.
- C. **CONSTRUCTION JOINTS:** Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.
- D. **BONDING AGENT:** Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. **WATERSTOPS:** Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's printed instructions.
- F. **ISOLATION JOINTS IN SLABS-ON-GRADE:** Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
- G. **CONTRACTION (CONTROL) JOINTS IN SLABS-ON-GRADE:** Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch wide by one-fourth of slab depth or inserts 1/4 inch wide by one-fourth of slab depth, unless otherwise indicated.
 1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab cured, remove inserts and clean groove of loose debris.
 2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
 3. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and locate to conform to bay spacing wherever possible (at column centerlines, at half bays, third bays).
 4. Joint fillers and sealants shall be as specified on plans.

- 3.16 **SLUMP:** shall be determined in conformance with ASTM C 143, and shall be within the following limits, provided the required strength is obtained:

Slump Range (inches)		
<u>Class of Concrete</u>	<u>Non-Vibrated</u>	<u>Vibrated</u>
AA	2-5	2-4
A	2-5	2-4
B	2-5	2-4

C	2-5	2-4
D	2-5	1-3

3.17 PREPARATION FOR PLACING: Water shall be removed from excavation before placing concrete. Any flow of water shall be diverted through proper side drains and shall be removed without washing over freshly deposited concrete. Hardened concrete, debris, and foreign materials shall be removed from interior of forms and from inner surfaces of mixing and conveying equipment. Reinforcement shall be secured in position, and shall be inspected, and approved by the Engineer, or his authorized representative, before placing concrete. Runways shall be provided for wheeled concrete-handling equipment; such equipment shall not be wheeled over reinforcement, nor shall runways be supported on reinforcement.

3.18 INSTALLING EMBEDDED ITEMS

- A. GENERAL:** Set and build into formwork 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 items to be attached.
- B. FORMS FOR SLABS:** Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.19 PREPARING FORM SURFACES

- A. GENERAL:** Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.
- B. APPLICATION:** Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

3.20 VAPOR RETARDER/BARRIER INSTALLATION

- A. GENERAL:** Place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour.
- B. JOINTS:** Lap joints 6 inches and seal with manufacturer's recommended mastic or pressure-sensitive tape.

3.21 PLACING CONCRETE: Concrete shall be handled from mixer to transport vehicle to place of final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredient until the approved unit of operation is completed. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper finishing and curing of the concrete. Concrete shall be placed in the forms, as close as possible in final position, in uniform approximately horizontal layers not over 12 inches deep. Forms splashed with concrete and reinforcement splashed with concrete or form coating shall be cleaned in advance of placing subsequent lifts. Concrete shall not be allowed to drop freely more than 5 feet in unexposed work nor more than 3 feet in exposed work; where greater drops are required, a tremie or other approved means shall be employed. The discharge of the tremies shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 12 inches thick, and the spacing of the tremies shall be such that segregation does not occur. Concrete to receive other construction shall be screeded to proper level to avoid excessive shimming or grouting. Conduits and pipes shall not be embedded in concrete unless specifically indicated.

- A. TIME INTERVAL BETWEEN MIXING AND PLACING:** Concrete mixed in stationary mixers and transported by non-agitating equipment shall be placed in forms within 45 minutes from the time ingredients are charged into the mixing drum. Concrete that is truck mixed or transported in truck mixers or truck agitators shall be delivered to the site

of the work and discharge completed in the forms within 60 minutes, except that when the concrete temperature exceeds 85 degrees F., the time shall be reduced to 45 minutes. Transit-mixed concrete that is completely mixed at the site of concrete placement or batched cement and aggregates transported to mixers shall be placed in the forms within 1 1/2 hours after cement has been added. Concrete shall be placed in the forms within 15 minutes after discharge.

- B. COLD-WEATHER REQUIREMENTS:** Concrete shall not be placed when, without special protection, the concrete is likely to be subjected to freezing temperature before the expiration of the specified curing period. If necessary to place concrete under conditions of low temperature, placement shall be approved by the Engineer, or his authorized representative. The temperature of the concrete when placed shall be not less than 50 degrees F. Heating of the mixing water and/or aggregates will be required as necessary to maintain the minimum concrete temperature of 50 degrees F., and all methods and equipment for heating shall be subject to approval. Materials entering the mixer shall be free from ice, snow, frost, and frozen lumps. Suitable covering and other means that will not stain concrete, as approved, shall be provided for maintaining the concrete at the temperatures and periods specified in paragraph CURING. Salt, chemicals, or other materials shall not be mixed with the concrete to prevent freezing, except that calcium chloride may be used as an accelerating agent, after written approval from the Engineer's representative, when the weather is cold enough to require protection of the concrete from freezing. The amount of calcium chloride shall not exceed 2 percent by weight of the cement being used. The use of calcium chloride in concrete shall not, in any way, relieve the Contractor of responsibility for compliance with the requirements of these specifications governing protection and curing of the concrete. Any concrete damaged by inadequate protection or procedure shall be removed and replaced at no additional cost to the Owner.
- C. HOT-WEATHER PLACEMENT:** When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305.1 and as specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 degrees F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineer.
- D. CONVEYING CONCRETE BY CHUTE, CONVEYOR, OR PUMP:** Concrete may be conveyed by chute, conveyor, or pump if approved in writing. In requesting approval, the Contractor shall submit his entire plan of operation from time of discharge of concrete from the mixer to final placement in the forms, and the steps to be taken to prevent the formation of cold joints in the event the transporting of concrete by chute, conveyor, or pump is disrupted. Aluminum chutes and pipelines shall not be used for placing concrete. Conveyors and pumps shall be capable of expeditiously placing concrete at the rate most advantageous to good workmanship. Approvals will not be given for chutes or conveyors requiring changes in the concrete materials or design mix for efficient operation.

- E. VIBRATION:** Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.1. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
- F. PLACING CONCRETE SLABS:** Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
 2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 3. Maintain reinforcing in proper position on chairs during concrete placement.
- 3.22 COMPACTION:** Immediately after placing, each layer of concrete shall be compacted by internal concrete vibrators supplemented by hand spading, rodding, and tamping. Tapping or other external vibration of forms will not be permitted. Vibrators shall not be used to transport concrete inside forms. Internal vibrators submerged in concrete shall maintain a speed of not less than 7,000 impulses per minute. The vibrating equipment shall at all times be adequate in number of units and power to properly consolidate all concrete. Spare units shall be on hand as necessary to insure such adequacy. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing objectionable segregation. The vibrator shall not be inserted into lower courses that have begun to set. Vibrators shall be applied at uniformly spaced points not farther apart than the visible effectiveness of the machine.
- 3.23 BONDING:** Before depositing new concrete on or against concrete that has set, the surfaces of the set concrete shall be thoroughly cleaned so as to expose the coarse aggregate and be free of laitance, coatings, foreign matter, and loose particles. Forms shall be retightened. The cleaned surfaces may be moist but shall be without free water when concrete is placed.
- 3.24 FINISHES OF CONCRETE:** Within 12 hours after forms are removed, surface defects shall be remedied as specified herein. Temperature of the concrete, ambient air, and mortar during remedial work including curing shall be above 50 degrees F. Fins and loose material shall be removed. Honeycomb, aggregate pockets, voids over 1/2 inch in diameter, and holes left by the rods or bolts shall be cut out to solid concrete, reamed, wetted, brush-coated with neat cement grout, and filled with mortar. Mortar shall be a stiff mix of 1 part Portland cement to not more than 2 parts fine aggregate passing the No. 16 mesh sieve, and minimum amount of water using white Portland cement for all or part of the cement so that when dry, the color of the mortar shall match the adjoining concrete color. Mortar shall be thoroughly compacted in place. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. Holes that do not pass entirely through the wall shall be packed full. Patchwork shall finish flush and in the same place as adjacent surfaces. Exposed patchwork shall be finished to match adjoining surfaces in texture and color. Patchwork shall be damp-cured for 72 hours. Protruding portions of bar supports shall be ground flush with concrete surfaces that will be exposed, painted, or plastered directly. Unless otherwise provided in the General Requirements, all exposed edges or corners of formed structural concrete shall be chamfered 3/4". The absence of a chamfered corner or edge on a drawing does not relieve the Contractor of including the chamfer.

3.25 TYPE OF FINISH: Unless otherwise required by another section of the specifications, the plans, or General Requirements, all exposed surfaces, except floors, shall receive a "rubbed" finish and all unexposed surfaces shall have an "ordinary" finish, as described below. All floors shall receive a standard floor finish.

- A. RUBBED FINISH:** After concrete has set sufficiently to permit, the exposed surfaces shall be thoroughly wetted and rubbed with a carborundum or other abrasive of equal quality to bring the surface to a smooth texture and remove all form marks. The paste formed by the rubbing as above described may be spread uniformly over the surface and allowed to take a reset, after which it shall be finished by floating with a canvas, carpet-faced or cork float or rubbed down with dry burlap.
- B. ORDINARY FINISH:** An "Ordinary Finish" is defined as the surface left by the removal of the forms with all holes left by form ties filled and all defects repaired. The surface shall be true and even, free from stone pockets, depressions or projections beyond the surface. All surfaces which cannot be repaired to the satisfaction of the Engineer shall be given a "rubbed" finish.
- C. CONCRETE FLOOR FINISH:** After concrete has been placed, properly consolidated by vibration, and screeded to proper grade, the concrete surface shall be lightly tamped to force large aggregate slightly below the surface and then floated. Floating by power-driven floats or by hand floats shall begin when surface water has disappeared and/or concrete has stiffened sufficiently.

Power troweling shall begin as soon as little or no cement paste clings to blades. Troweling shall be continued until surface is dense, smooth, and free of all minor blemishes, such as trowel marks. Final hand troweling shall be continued until ringing sound is heard as trowel passes over surface.

Surface of concrete shall be checked for level to a tolerance not exceeding 1/8" in 10 feet when tested with a 10 ft. straightedge placed on surface at not less than two different angles. High spots shall be cut down and low spots filled. Surfaces shall be uniformly sloped to drains. Immediately after leveling, surface shall be re-floated to a smooth uniform texture. If variations greater than this exist, the Engineer may direct the Contractor to grind the floor to bring surface within requirements. Patching of low spots shall not be permitted. Grinding shall be done as soon as possible, preferably within 3 days, but not until concrete is sufficiently strong to prevent dislodging coarse aggregate particles.

3.26 CURING AND PROTECTION: Immediately after completion of finishing operations and as soon as marring of concrete will not occur, all exposed concrete surfaces shall be cured by covering with a white pigmented curing compound. Concrete shall not be left exposed for more than 1/2 hour during the curing period. Curing shall be maintained continuously for 72 hours.

- A. CURING:** Concrete surfaces shall be uniformly sprayed with white pigmented curing compound immediately after completion of surface finishing and as soon as surface water evaporates. Curing compound shall not be applied during rainfall.

Curing compound shall be applied under pressure by mechanical sprayers at the rate recommended by the manufacturer, but in no case less than 1 gallon per 100 square feet of surface area. Spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At time of use, the compound shall be thoroughly mixed. During application, the compound shall be stirred continuously by mechanical methods. Hand spraying of irregular widths or shapes and on surfaces exposed by form removal will be permitted provided curing compound has been thoroughly agitated prior to placing in the sprayer. Curing compound shall not be applied to inside faces of joints to be sealed. In split slab construction, curing compound shall be applied in such manner as to prevent spraying exposed tie bars.

When the side forms are removed before the end of the 72-hour curing period, the

exposed sides of concrete shall be immediately protected by applying a curing compound equal to that provided for the surface.

B. RAIN PROTECTION: Prior to beginning daily concrete placement operations, the contractor shall have available at the jobsite sufficient polyethylene sheeting materials to properly protect the last 1 hour's operation against the effects of rain. The surfaces and sides shall be covered with polyethylene sheeting, when required. Units shall be lapped at least 18 inches. Sheeting shall be placed and weighted down so that it will remain in contact with the surface. Sheeting shall be large enough to extend beyond concrete edges at least twelve inches. Visible surface damages by rainfall shall be ground to a smooth texture as specified above or otherwise repaired by the Contractor to the satisfaction of the Engineer.

C. TEMPERATURE: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

3.27 COLD WEATHER PROTECTION: When concrete is being placed and the air temperature is expected to drop below 35 degrees Fahrenheit, a sufficient supply of straw, hay, grass, or other approved blanketing material shall be available at the jobsite. When the temperature is expected to reach the freezing point during the day or night, the protective material shall be spread over the concrete to a sufficient depth to prevent freezing. Concrete damaged by freezing shall be removed and replaced at no direct pay.

3.28 CONCRETE SURFACE REPAIRS

A. PATCHING DEFECTIVE AREAS: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Engineer.

B. PATCHING PROCEDURE: Mix dry-pack mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.

1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than one inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

C. REPAIRING FORMED SURFACES: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.

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 specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

D. REPAIRING UNFORMED SURFACES: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Engineer.
4. Repair defective areas, except random cracks and single holes not exceeding one inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

3.29 QUALITY ASSURANCE: Testing except as otherwise specified herein shall be performed by an approved testing laboratory and at no cost to the Contractor.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT: No measurement will be made for cast-in-place concrete as a separate item, but shall be included in other items as specified.

END OF SECTION 03301