

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish and install cast-in-place concrete work.

1.02 REFERENCES

- A. "Manual of Standard Practice" of the Concrete Reinforcing Steel Institute.
- B. ACI - American Concrete Institute.
- C. CRD-C621-83 - Specification for Non-Shrink Grout.
- D. ASTM A 82 - Steel wire, Plain, for Concrete Reinforcement.
- E. ASTM A 185-90a - Steel Welded Wire Fabric, Plain, For Concrete Reinforcement.
- F. ASTM A 615-90 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- G. ASTM C 31-90 - Making and Curing Concrete Test Specimens in the Field.
- H. ASTM C 33-90 - Concrete Aggregates.
- I. ASTM C 39 - Compressive Strength of Cylindrical concrete Specimens
- J. ASTM C 42-87 - Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- K. ASTM C 94-90 - Ready-Mixed Concrete.
- L. ASTM C 143-90 - Slump of Portland Cement Concrete.
- M. ASTM C 150-89 - Portland Cement.
- N. ASTM C 171 - Sheet Materials for Curing Concrete.
- O. ASTM C 172-90 - Sampling Freshly Mixed Concrete.
- P. ASTM C 173-78 - Air Content of Freshly Mixed Concrete by the Volumetric Method.
- Q. ASTM C 231-89 - Air Content of Freshly Mixed Concrete by the Pressure Method.
- R. ASTM C 260-86 - Air-Entraining Admixtures for Concrete.
- S. ASTM C 309-89 - Liquid Membrane-Forming Compounds for Curing Concrete.
- T. ASTM C 494-86 - Chemical Admixtures for Concrete.
- U. ASTM C 1064 - Temperature of Freshly Mixed Portland Cement Concrete.
- V. ASTM D 994-71 - Preformed Expansion Joint Filler for Concrete (Bituminous Type).

W. ASTM E 154 - Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls or as Ground Cover.

X. ASTM E 1155 - Determining F_F Floor Flatness and F_L Levelness Numbers.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Section 01300.

B. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, and others if requested by Architect.

C. Shop Drawings: Show 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.

D. Submit locations for construction and control joint layout for walls and slabs.

E. Laboratory test reports for concrete materials and mix design test.

F. ACI certified flatwork finisher certificate.

G. Submit for record, a written plan of the field procedures to be implemented for hot and cold weather protection.

H. Submit chart for application requirements of evaporation control.

1.04 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. American Concrete Institute (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: Conform to requirements of Section 01400 and this section. Field technician shall be ACI/MCTCB certified,

C. ACI Flatwork Certification: Prepare, place and finish all interior and exterior slabs in the presence of and under the direction of an ACI Certified Concrete Flatwork Finisher.

D. Pre-Concrete Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings" and the following:

1. At least 14 days prior to placing concrete, conduct a meeting to review detailed requirements for concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements of submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Agency responsible for concrete design mixes.
 - c. Agency responsible for field quality control.

- d. Ready-mix concrete producer.
 - e. Concrete subcontractor.
 - f. Architect.
- E. Pre-Concrete Slab Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings" and the following:
- 1. At least 7 days prior to placing concrete, conduct a meeting to review detailed requirements for concrete design mixes for slabs and exterior flatwork to determine procedures for satisfactory concrete placement, finishing and curing operations. Review requirements of submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with concrete slabs to attend conference, including, but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Agency responsible for concrete design mixes.
 - c. Agency responsible for field quality control.
 - d. Ready-mix concrete producer.
 - e. ACI Certified Concrete Flatwork Finisher, including field foreman.
 - f. Architect.
- F. Construct a mock-up at an approved location of the vapor barrier installation, including taping of seams, perimeter seal and attachment, and sealing of penetrations.

1.05 PROJECT CONDITIONS

- A. To prevent exterior concrete entrance slabs, pavement and walks from repeated freeze thaw cycles and de-icers before adequate curing to protect concrete has occurred, placement shall occur before October 1 or in the Spring after frost in the ground is gone and temperatures remain above freezing. No de-icers shall be used on the concrete during the project.
- B. Apply surface evaporation retardant to slab surface when water loss reaches .15 lbs of water loss per square foot (.6 kg per sm) per hour as determined in ACI 308.

1.06 COORDINATION

- A. Coordinate sizes, locations and scheduling of bond outs, sleeves, inserts and other cast in items with the other subcontract trades. Obtain items furnished by other trades to be cast in to concrete.

1.07 FOUNDATION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly in writing.
- B. General: Engage an engineering surveyor to lay out the Work using accepted surveying practices.
 - 1. Work from establish benchmarks and control points to set lines and levels.
 - 2. Inform installers of lines and levels to which they must comply.
 - 3. Check the location, level and plumb, of every major element as the Work progresses.
 - 4. Notify Construction Manager and Architect when deviations from required lines and levels exceed allowable tolerances.
 - 5. Coordinate and locate anchor bolt layouts.
 - 6. Coordinate elevation and locations of openings, bondouts, sleeves and inserts required to be placed in the work.

PART 2 - PRODUCTS

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 practicable sizes to minimize number of joints.
 - 1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, 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 Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Architect's control sample. Provide solid backing and form supports to ensure stability of textured form liners.
- D. Forms for Cylindrical Columns and Supports: Metal or glass-fiber-reinforced plastic, that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.
- E. Carton Forms: Biodegradable paper surface, treated for moisture-resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- F. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 g/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.
- G. 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 (38 mm) to the plane of the exposed concrete surface.
 - 1. Provide ties that, when removed, will leave holes not larger than 1 inch (25 mm) in diameter in the concrete surface.

2.02 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- C. Welded Wire Fabric: ASTM A 185, 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 specifications.
 - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs. Type used shall not perforate vapor retarder.
 - 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).
 - 3. For slabs on metal deck, use bright basic (CRSI, Class 3) continuous mesh support or reinforcing bar chairs for type of reinforcing required.

2.03 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type II.

1. Use one brand of cement throughout Project.
- B. Concrete Aggregates: Shall conform to the requirements of ASTM C-33.
1. Fine Aggregate: Sand shall consist of hard, tough and preferably siliceous material, clean, free from mineral or other coatings, soft particles, clay, loam or other deleterious matter.

 2. Coarse Aggregate: Crushed stone or gravel, having clean, hard, durable, uncoated particles, free from deleterious matter. The 1-1/2"(38 mm) aggregate shall conform to gradation #467 and the 3/4"(19 mm) aggregate to size #67 in Table II of ASTM C-33. 3/4"(19 mm) aggregate shall be the minimum permissible size used, unless required for structural clearances between reinforcing bars or between bars and the forms require smaller aggregate size. Clearances requiring smaller aggregate size shall be submitted to the Architect for verification and approval.
- C. Water: Potable.
- D. Fiber Reinforcement: Polypropylene fibers, in a collated fibrillated form, engineered and designed for plastic shrinkage control of concrete slabs, complying with ASTM C 1116, Type III, not less than 3/4 inch (19 mm) long. Use in slabs on grade.
1. Products: Provide one of the following:
 - a. Fibermesh; Fibermesh Co., Div. Synthetic Industries, Inc.
 - b. Forta Econo-Net ; Forta Corporation.
 - c. Grace Fibers; W.R. Grace & Co.
- E. Admixtures, General: Provide concrete admixtures that contain not more than 0.01 percent chloride ions.
- F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- G. Mid-Range Water-Reducing Admixture: ASTM C 494, Type A.
- H. High-Range Water-Reducing Admixture: ASTM C 494, Type F or G.
- I. Accelerating Admixture: ASTM C 494, Type C.
- J. Retarding Admixture: ASTM C 494, Type D.

2.04 RELATED MATERIALS

- A. Reglets: Where sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.024-inch-thick (24-gage) stainless steel or eraydo zinc metal. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
1. Reglet #307; Hohmann & Banard, Inc.
- B. Isolation Joint: 2 pound minimum density closed cell polyethylene with 3/8"(9 mm) deep top strip off to allow installation of joint sealant; 3/8 inch (9 mm) thickness by full depth of slab; Isostrip by Century Floors, or approved equal.
1. Attach isolation joint with Vaporlock edge tape, preformed 3" wide two-sided adhesive.
- C. Dowels: 18 (400 mm) inch long square dowels with sawn ends (sheared bars not acceptable).
1. Dowel sleeve shall be Expando-Lok, 3/4 inch (19 mm) x 9 (229 mm) inch long, plastic sleeve with 3/16"(4 mm) thick polyethylene foam on vertical legs to allow for lateral slab movement.
 2. Dowel Aligner: Cast plastic dowel aligner with nailing flange.

- D. Plate Dowels: PNA Diamond Dowel system, consisting of saw cut steel plate and pocket former sleeve.
- E. Vapor Barrier : Stego Wrap manufactured by Stego Industries LLC. Extruded 15 mil polyolefin membrane. 15 foot wide roll. Material manufactured with ISO certified virgin resins.
1. Accessories:
 - a. Tape: High density polyethylene tape with pressure sensitive adhesive. Minimum 4 inch width.
 - b. Pipe Boot: Construct boots from vapor barrier material and high density polyethylene tape per manufacturer's instruction.
 - c. Wall Edge Tape: Preformed 3" wide two-sided bituminous adhesive tape.
 2. Reference Standards:
 - a. ASTM E-1745 Water Vapor Retarders Used in Contact with Earth under Concrete Slabs: Exceeds Class B.
 - b. ASTM E-96 Water Vapor Transmission Rate Result: 0.006 gr./ft²/hr.
 - c. ASTM E-96 Permeance Rating Result: 0.01 gr./ft²/hr.
 - d. GRI-GS-1-86 Puncture Resistance Rating: 204.0 lbs./sq. ft.
 - e. ASTM D1709 Puncture Resistance Result 1972.5 grams.
 - f. ASTM D 638 Tensile Strength Result: 54.2 lbs./ MD, 55.5 lbs./ CMD.
 - g. ASTM D 1790 Low Temperature Brittleness: Pass
- F. Moisture-Retaining Cover: One of the following as specified under concrete curing, sealers and protection, complying with ASTM C 171.
1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.
- G. Exterior Curing Compound: Euclid Kurez Vox.
- H. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
1. Eucobar; Euclid Chemical Co.
 2. E-Con; L&M Construction Chemicals, Inc.
 3. Confilm; Master Builders, Inc.
 4. Finisher's Friend; Century Floors.
- I. Interior Sealer: Ashford Formula manufactured by Curecrete Chemical Company.
- J. Non-Shrink Grout: "Euco N-S" by the Euclid Chemical Company; "Master-Flow 928" (non-metallic) by Master Builders, Five Star Grout, Dayton Superior Sure Grip Grout, or Sika Grout 212. The grout shall conform to CRD C-621, type b or d.
- K. Underlayment Compound (under floor covering): Free-flowing, self-leveling, pumpable, cement-based compound for applications from 1 inch (25 mm) thick to feathered edges. Apply primer as provided by manufacturer.
1. K-15 with P-51 primer, Ardex, Inc.
 2. Levellex with Levellex Primer, L&M Construction Chemicals, Inc.
 3. Silflo 200 with Silflo Primer; Silpro Masonry Systems, Inc.
 4. Thoro Underlayment Self-Leveling with Thoro Primer 800; Thoro System Products.
- L. Bonding Agent: Polyvinyl acetate or acrylic base.
1. Polyvinyl Acetate (Interior Only):
 - a. Superior Concrete Bonder, Dayton Superior Corp.
 - b. Euco Weld, Euclid Chemical Co.
 - c. Weld-Crete, Larsen Products Corp.
 - d. Everweld, L&M Construction Chemicals, Inc.

2. Acrylic or Styrene Butadiene:
 - a. Day-Chem Ad Bond, Dayton Superior Corp.
 - b. SBR Latex, Euclid Chemical Co.
 - c. Daraweld C, W.R. Grace & Co.
 - d. Hornweld, A.C. Horn, Inc.
 - e. Everbond, L&M Construction Chemicals, Inc.
 - f. Acryl-Set, Master Builders Inc.

- M. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.
 1. Euco Epoxy System #452 or #620, Euclid Chemical Co.
 2. Epoxitite Binder 2390, A.C. Horn, Inc.
 3. Epobond, L&M Construction Chemicals, Inc.
 4. Concesive Standard Liquid, Master Builders, Inc.
 5. Sikadur 32 Hi-Mod, Sika Corp.

- N. Expandable Waterstops: 1" x 3/4"(25 x 19 mm) expandable bentonite.
 1. Superstop; Mameco/Paramount.
 2. Water Stop RX; Volclay Waterproofing Systems
 3. SwellStop; Greenstreak.

- O. Chemical Resistant Waterstop: Thermoplastic elastomeric rubber, TPER; Serrated with center bulb.
 1. Style 618; Westec Barrier Technologies; 800-793-7832."

2.05 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 Architect 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 Architect of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Architect. Mix design submittal shall be accompanied by field experience test data for the mix design or results of trial batch test for the design.

- C. Design Mixes to Provide Normal Weight Concrete with the Following Properties as Indicated on Drawings and Schedules:
 1. Exterior Slabs, Pads, Steps, Pole Bases and Walks: 4500-psi, 28-day compressive strength; water-cement ratio, 0.42 maximum, air-entrained, minimum 3/4 inch (19 mm) coarse aggregate.
 2. Interior Slabs : 3000-psi, 28-day compressive strength; water-cement ratio, 0.54 maximum, non-air-entrained, minimum 3/4 inch (19 mm) coarse aggregate; fiber reinforced for slabs on grade that do not contain reinforcing bars.
 3. Reinforced Wall, Footings, Utility Encasements, Bollard and Rail Post Encasement, Interior Pads: 3000-psi, 28-day compressive strength; water-cement ratio, 0.54 maximum (air-entrained).
 4. Where coarse aggregate size is not specified, the nominal maximum size coarse aggregate size shall be not larger than:
 - a. 1/5 the narrowest dimension between sides of forms, nor;
 - b. 1/3 the depth of slabs, nor;
 - c. 3/4 the minimum clear spacing between individual reinforcing bars or wires, bundles of bars, or prestressing tendons or ducts.

- D. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
 1. Ramps and sloping surfaces: 3 inches (75 mm) maximum.
 2. Slabs: 5 inches (125 mm) maximum.
 3. Reinforced foundation systems: 2 inch(50 mm) minimum and 5 inches (125 mm) maximum.

4. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site-verified 2-to-5-inch (50-to-125 mm) slump concrete. Plant-added high-range water-reducing admixture is subject to approval by Architect. Use of high-range water-reducing admixture is prohibited for slabs.
 5. Other concrete: 4 inches(100 mm) maximum.
- 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 Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in Work.
- F. Fiber Reinforcement: Add at manufacturer's recommended rate but not less than 1.5 lb per cu. yd. (1.0 lb per cu. Yd. for micro-fibers)

2.06 ADMIXTURES

- A. Use mid-range water-reducing admixture for all concrete. Add admixture at manufacturer's prescribed rate. Dosage shall not exceed 8 ounces per 100 pounds of cement.
- B. Accelerating admixture may be used in concrete slabs placed at ambient temperatures below 50°F (10°C).
- C. Retarding admixture may be used in concrete slabs placed at ambient temperatures above 80°F (27°C).
- D. High-range water-reducing admixture may be used for reinforced foundation systems. High-range water-reducing admixture is not permitted for use in slabs.
- E. The approved air-entraining admixture shall be used in concrete exposed to weather. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:
 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
 - a. 5.0 percent for 1-1/2-inch (38 mm) maximum aggregate.
 - b. 6.0 percent for 3/4-inch (19 mm) maximum aggregate.
 - c. 7.0 percent for 3/8-inch (9 mm) maximum aggregate.
- F. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

2.07 CONCRETE MIXING

- A. Job-Site Mixing: Mix concrete materials in appropriate drum-type batch machine mixer. For mixers of 1 cu. yd. or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than 1 cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd.
 1. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
 2. Mix the concrete in quantities required for immediate use, and any which has developed initial set, or which does not reach the forms within 1-1/2 hours after water has been added, shall not be used.
 3. Mix all concrete by machine, having a capacity of not less than "one bag batch" of concrete.
 4. Ready-mixed concrete shall be mixed and delivered by the means and standards set forth by ASTM C-94.
 5. When concrete is mixed in a truck mixer loaded to its maximum rated capacity, the number of revolutions of the drums or blades at mixing speed shall be not less than 70 nor more than 100.
 6. When a truck mixer or agitator is used for transportation, complete placement within 1-1/2 hours or

before the drum has revolved a total of 300 revolutions, whichever comes first, after the introduction of mixing water.

7. Measurements:
 - a. By Weight: Only weighing equipment approved by the Architect shall be allowed. The equipment shall be platform-operated, and the weighing beam or dial shall be in full view of the operator. The equipment shall be capable of measurement within + 1% for the cement and water, + 2% for the aggregates, and + 3% for the admixtures. The cement and aggregates must be weighed by the weight.
 - b. By Volume: The admixtures shall be measured by volume. Water may be measured by weight or volume.
 - c. All Methods: The methods of measuring concrete materials shall be such that the proportion of water to cement can be accurately controlled during the progress of the work and easily checked at any time.

- B. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.
 1. 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.

- C. When air temperature has fallen to or is expected to fall between 40°F (4°C) and 30°F (-1°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 60°F (16°C) and not more than 80°F (27°C) at point of mixing, and 55°F at point of placement.. When air temperature has fallen to or is expected to fall below 30°F (-1°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 65°F (18°C) and not more than 80°F (27°C) at point of mixing, and 55°F at point of placement.
 1. Do not use frozen materials or materials containing ice or snow.
 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents.

- D. When Hot Weather Conditions Cause Concrete Temperatures to Exceed 90°F (32°C) Perform the Following Procedures:
 1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90°F (32°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. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

PART 3 - EXECUTION

3.01 GENERAL

- A. Coordinate the installation of vapor retarder/barrier, joint materials, and other related materials with earthwork, placement of forms and reinforcing steel.

3.02 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 ACI 347 limits and as follows:
 1. Surfaces exposed to view: Class A tolerance, checked with 5 foot template, except gradual

- irregularities not to exceed 1/4 inch (6 mm) and abrupt surface irregularities not to exceed 1/8 inch (3 mm).
2. Other concrete surfaces: Provide Class C tolerances checked with 5 foot (1525 mm) template, with gradual irregularities not to exceed 1/2 inch (12 mm) and abrupt surface irregularities not to exceed 1/4 inch (6 mm).
 3. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet (12 mm in 6 m), nor 3/4 inch in 40 feet (19 mm in 12 m) or more.
 4. Variation of Cross-Sectional Dimension (thickness): 12 inch (305 mm) dimension or less, do not exceed 3/8 inch (10 mm) greater nor 1/4 inch (6 mm) less than indicated. 12 inch (305 mm) dimension but not over 3 foot (915 mm) dimension, do not exceed 1/2 inch (12 mm) greater nor 3/8 inch (10 mm) less than indicated.
- B. 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.
- C. 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.
- D. 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.
- E. Chamfer exposed corners and edges of beams, columns and partitions 1" unless otherwise noted, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- F. 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.
1. Project sleeves through elevated slabs, 4 inches above top of slab.
 2. Correct mis-alignment and mis-located penetrations immediately upon discovery.
- G. 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.

3.03 VAPOR BARRIER INSTALLATION

- A. Install vapor barrier per manufacturer's instructions.
1. Granular base shall be level and properly rolled or tamped, ready to receive vapor barrier.
 2. Place vapor barrier with the longest dimension parallel with the direction of the pour.
 3. Lap vapor barrier over footings and seal to foundation walls with bituminous edge tape.
 4. Lap joints 6 inches and seal with polyethylene tape.
 5. Seal pipe penetrations with pipe boot made from vapor barrier and tape.
 6. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all four sides with polyethylene tape.

3.04 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "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.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect.
- D. Place reinforcement to maintain minimum coverages 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.
- E. 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. Support welded wire fabric with continuous mesh supports, spaced to hold welded wire fabric in proper position.
- F. Reinforce stair pans with strips of 3" x 6" (76 mm x 152 mm) #10 wire mesh or two layers 6" x 6" (152 mm x 152 mm) #10 mesh overlapped, full width and depth of pan.

3.05 JOINTS

- A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Architect. Apply bond breaking compound to the vertical face of slab edge prior to adjacent concrete placement.
 1. At exposed interior slabs (not covered by floor covering), after concrete of adjacent pour has hardened, saw cut along construction joint for installation of joint sealant.
- B. Provide keyways at least 1-1/2 inches (38 mm) deep in construction joints in walls and between walls and footings.
- C. 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. For foundations, use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. 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, masonry walls and other locations, as indicated. Install isolation joint material full depth of slab edges, between slab and abutting surfaces. Attach with edge tape. Remove top strip of isolation joint and fill with sealant.
 1. Joint fillers and sealants are specified in Section 07900 - Joint Sealants.
- F. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as specified and shown on approved joint layout submittal. Use saw cuts 1/8 inch (3 mm) wide by 3/4 inch (19 mm) , or depth equal to the largest coarse aggregate size, which ever is greater.
 1. Saw control joints, with Sof-Cut (800-776-3328) Model GS-1000 or larger saw, immediately after final troweling with cutting completed within 2 hours after final pass of trowel. Remove saw cut concrete spoils from floor surface immediately behind the saw cutting operations.
 2. Contraction joints shall be placed in accordance with approved Shop Drawings, with a maximum panel area as specified below. The panel shall be as nearly square as possible. If panel cannot be square, do not exceed panel length to panel width ratio of 1 to 1-1/2. Conform to bay spacing wherever possible (at column centerlines, half bays, third bays, one quarter bays, or equal division

- to meet the specified spacing requirements).
3. Saw cut non-reinforced slabs on grade in accordance with the following maximum spacing:
 - a. 4 inch thick: 8 feet
 - b. 5 to 6 inches thick: 10 feet.
 - c. 6 1/4 to 7 inches thick: 12 feet.
 - d. 7 1/4 to 8 inches thick: 14 feet.
 4. Joint fillers and sealants are specified in Section 07900 - Joint Sealants.
- G. Joints in Sidewalks and Exterior Flatwork: Groove control joints in concrete to detailed layout. Groover tool shall be Goldblatt Trowel No. 84389 06125 or equal, with 1 inch (25 mm) deep groove and 1/4 inch (6 mm) radius edge. Radius edges of walk with 1/4 inch (6 mm) radius edge tool.
- H. Chemical Resistant Waterstop: Provide waterstops in construction joints as indicated for tank room. 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. Allow proper clearances and properly secure to prevent displacement. Thoroughly and systematically vibrate concrete around waterstop to obtain impervious, void-free concrete in vicinity of joint and to maximize intimate contact between concrete and waterstop.
- I. Expandable Waterstop:
1. Install expandable waterstop, on the wet side (backfill side) of Chemical resistant waterstops.
 2. Clean surfaces where waterstop is to be applied, free of excessive dust, debris and water. Irregular and honeycombed surfaces shall be made reasonably smooth.
 3. Apply waterstop in a continuous strip on the water side of steel.”

3.06 INSTALLING EMBEDDED ITEMS

- A. Locate and set anchor bolts for structural steel. Tolerance allowances shall be in accordance with AISC Code of Standard Practice for Buildings and Bridges, Installation of Bolts and Embedded Items.
- B. 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.
- C. Space dowels 24inches (608 mm) on center, with proper projection to facilitate full coverage of dowel by the dowel sleeve. Dowels shall be level and square to the slab edge with the center line of the dowel at the center line of the slab thickness.
- D. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
- E. Install dovetail anchor slots in concrete structures as indicated on drawings.
- F. 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.
 1. Where slabs are thickened, the subgrade shall be sloped no greater than 1 to 20, thickness change to slope length ratio.

3.07 PREPARING FORM SURFACES

- A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.
- B. 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.

1. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.08 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, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- C. 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.
 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 (152 mm) 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 and highway straightedge 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. Placing Exterior Concrete Walks and Flatwork: Place concrete, screed and wood float surfaces to a smooth and uniform finish, free of open texturing and exposed aggregate. Avoid working mortar to surface.
1. Bull float directly behind screed before bleedwater appears.
 2. Immediately behind bullfloat, drag broom across surface for a medium broom finish. If bleedwater appears before application of broom finish, allow surface water to evaporate before brooming.
- G. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
- H. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.
1. 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.
 2. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.

3.09 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 ties removed and holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch (6 mm) 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. Smooth-Rubbed Finish: Provide smooth-rubbed finish on scheduled concrete surfaces that have received smooth-formed finish treatment not later than 1 day after form removal.
 - 1. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. 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.

3.10 MONOLITHIC SLAB FINISHES

- A. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish .
 - 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, and when concrete has stiffened sufficiently to permit operation of power-driven floats. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. If pan floats are used, the first floating shall be done by power trowel with conventional float blades. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured according to ASTM E 1155. Cut down high spots and fill low spots, using a highway straightedge as required to meet the floor flatness and levelness tolerances. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- B. 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 troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances of F(F) 30 (floor flatness) and F(L) 20 (floor levelness) measured according to ASTM E 1155. Grind smooth any surface defects that would telegraph through applied floor covering system.
- C. Nonslip Trowel Finish: Apply a nonslip trowel finish to monolithic slab surfaces exposed to view at locations scheduled and where required for slip resistance by the Owner. Verify amount of texture with the Architect in advance of the pour.
 - 1. After floating, begin first trowel-finish operation using a power-driven trowel. Consolidate concrete surface by final troweling operation, 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 E 1155.

- D. 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 Architect before application.

3.11 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.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and trowel-finish concrete surfaces.
 - 1. Cure interior stair treads with curing methods as specified below for interior slabs.
- E. Non-Shrink Grout: Grout steel billet bearing plates, column base plates, equipment bases, and other locations noted in the Structural Drawings with non-shrink grout.

3.12 CONCRETE CURING, SEALERS 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. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Keep continuously moist for not less than 7 days.
- C. Provide Moisture-retaining Cover Curing as Follows: 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. Weight down and maintain in intimate contact with the slab for the duration of the curing period.
 - 1. Cure exposed interior slabs with waterproof curing paper or white polyethylene placed over slab that has been misted with water.
- D. Apply Curing Compound on Exterior Slabs, Walks, Pads, and Curbs as Follows:
 - 1. Apply curing compound to exterior 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.
- E. The Contractor shall protect completed concrete work from damage by construction operations. Upon completion of the project, surfaces shall be cleaned of dirt and stains, including exterior flatwork, walks

and pads.

- F. Interior Sealer: Apply sealer compound to interior concrete floors left exposed and sealed before dirtied by construction operations.
1. Surface shall be dry and clean, free of dirt, dust, and stains. Clean and dry slab that has become dirty using mechanical scrubbers with squeegee wetvac attachment.
 2. Spray the product with a low pressure sprayer to the entire surface as soon as the surface is firm enough to walk on.
 3. Keep the entire surface wet for 30 minutes by brooming excess product onto the dry spots or re-spraying the dry spots immediately.
 4. As the product begins to dry into the surface and becomes slippery underfoot, lightly sprinkle the surface with water to aid penetration and to bring alkali to the surface.
 5. As the product again begins to dry into the surface and becomes slippery underfoot, flush the surface with water and squeegee the surface totally dry, removing all excess product and alkali or other impurities brought to the surface.

3.13 SHORES AND SUPPORTS

- A. General: Comply with ACI 347 for shoring and reshoring in multistory construction, and as specified.
- B. Extend shoring from ground to roof for structures four stories or less, unless otherwise permitted.
- C. Extend shoring at least three floors under floor or roof being placed for structures over four stories. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores. Space shoring in stories below this level in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimums to ensure proper distribution of loads throughout structure.
- D. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to support work without excessive stress or deflection.
- E. Keep reshores in place a minimum of 15 days after placing upper tier, or longer, if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

3.14 REMOVING FORMS

- A. General: 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 (10°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, 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 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, and provided curing and protection operations are maintained.

3.15 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.

3.16 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.
- B. Mix dry-pack mortar, consisting of one part portland cement to 2-1/2 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 (6 mm) in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 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 Architect. 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 (.25 mm) 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 Architect.
 - 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch (25 mm) 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 (19 mm) 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.
- E. Repair isolated random cracks and single holes 1 inch (25 mm) or less in diameter in accordance with methods recommended by the International Concrete Repair Institute (ICRI). Saw cut cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Place and finish repair material to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- F. Perform structural repairs with prior approval of Architect for method and procedure, using specified

epoxy adhesive and mortar.

- G. Repair methods for conditions not specified above may be used, subject to acceptance of Architect.

3.17 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: The Owner will employ a testing agency to perform tests and to submit test reports.
- B. Sampling and testing for quality control during concrete placement may include the following, as directed by Architect.
1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; one test for each set of compression test specimens; additional tests when concrete consistency seems to have changed.
 - b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete; one test for each set of compression test specimens of air-entrained concrete.
 - c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40°F (4°C) and below, when 80°F (27°C) and above, and one test for each set of compressive-strength specimens.
 - d. Compression Test Specimen: ASTM C 31; 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. Properly store cylinders while awaiting transport to laboratory, maintaining temperature between 60°F and 80°F. Deliver to laboratory for curing within 24 hours of casting test specimen.
 - e. Compressive-Strength Tests: ASTM C 39; 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. 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. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
 4. 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.
 5. 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 (3.4 MPa).
- C. Test results will be reported in writing to Architect, 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.
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection. Core tests will be required.
- E. 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 Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION

