



**SPECIAL PROVISIONS
FOR
CAST-IN-PLACE CONCRETE**

**Des Moines County
EDP-0977(653)--7Y-29**

**Effective Date
June 15, 2021**

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

155057.01 DESCRIPTION.

A. Summary.

Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

- Footings.
- Foundation walls.
- Slabs-on-grade.
- Pile Caps.

B. Action Submittals.

1. Product Data: For each type of product indicated.
2. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
3. Construction Joint Layout: Indicate proposed construction joints required to construct the structure. Location of construction joints is subject to approval of the Engineer.

C. Informational Submittals.

1. Qualification Data: For Installer manufacturer testing agency.
2. Welding certificates.
3. Material Certificates: For each of the following, signed by manufacturers:

- a. Cementitious materials.
- b. Admixtures.
- c. Form materials and form-release agents.
- d. Bonding agents.
- e. Adhesives.
- f. Repair materials.

D. Quality Assurance.

1. **Installer Qualifications:** A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
2. **Manufacturer Qualifications:** A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
3. **Source Limitations:** Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
4. **Welding Qualifications:** Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
5. **ACI Publications:** Comply with the following unless modified by requirements in the contract documents:
 - a. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
 - b. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
6. **Concrete Testing Service:** Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
7. **Preinstallation Conference:** Conduct conference at Project site.
 - a. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - 1) Contractor's superintendent.
 - 2) Independent testing agency responsible for concrete design mixtures.
 - 3) Ready-mix concrete manufacturer.
 - 4) Concrete Contractor.
 - b. Review special inspection and testing and inspecting agency procedures for field quality control, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, vapor-retarder installation, steel reinforcement installation, and concrete protection.

E. Delivery, Storage, And Handling.

Deliver, store, and handle steel reinforcement to prevent bending and damage.

155057.02 MATERIALS.

A. Form-Facing Materials.

1. **Smooth-Formed Finished Concrete.**
 - a. Form-facing panels that will provide continuous, true, and smooth concrete surfaces.
 - b. Furnish in largest practicable sizes to minimize number of joints.

c. Plywood, metal, or other approved panel materials.

2. Rough-Formed Finished Concrete.

- a. Plywood, lumber, metal, or another approved material.
- b. Provide lumber dressed on at least two edges and one side for tight fit.

3. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

4. Form-Release Agent.

- a. Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- b. Formulate form-release agent with rust inhibitor for steel form-facing materials.

5. Form Ties.

- a. Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
- b. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

B. Steel Reinforcement.

- 1. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60%.
- 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- 3. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- 4. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- 5. Welded Wire Reinforcement: ASTM A 1064/A 1064M-18a, plain, fabricated from as-drawn steel wire into flat sheets.

C. Reinforcement Accessories.

- 1. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
- 2. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
- 3. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

D. Concrete Materials.

- 1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - Portland Cement: ASTM C 150, Type I/II, gray.
 - Fly Ash: ASTM C 618, Class F or C.
 - Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
 - a. Maximum Coarse Aggregate Size: 3/4 inch nominal.
 - b. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Water: ASTM C 94/C 94M and potable.

E. Admixtures.

1. Air-Entraining Admixture: ASTM C 260.
2. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - b. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

F. Curing Materials.

1. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete. Subject to compliance with requirements, provide one of the following:
 - BASF Construction Chemicals - Building Systems; Confilm.
 - Conspec by Dayton Superior; Aquafilm.
 - Dayton Superior Corporation; Sure Film (J-74).
 - Euclid Chemical Company (The), an RPM company; Eucobar.
 - L&M Construction Chemicals, Inc.; E-CON.
 - Meadows, W. R., Inc.; EVAPRE.
 - Metalcrete Industries; Waterhold.
 - Sika Corporation; SikaFilm.
 - Symons by Dayton Superior; Finishing Aid.
2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 ounces per square yard. when dry.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. Subject to compliance with requirements, provide one of the following:
 - BASF Construction Chemicals - Building Systems; Kure 200.
 - Conspec by Dayton Superior; W.B. Resin Cure.
 - Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
 - Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
 - L&M Construction Chemicals, Inc.; L&M Cure R.

- Meadows, W. R., Inc.; 1100-CLEAR.
 - Symons by Dayton Superior; Resi-Chem Clear.
6. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering. Subject to compliance with requirements, provide one of the following:
- BASF Construction Chemicals - Building Systems; Kure-N-Seal WB.
 - Conspec by Dayton Superior; Cure and Seal WB.
 - Cresset Chemical Company; Crete-Trete 309-VOC Cure & Seal.
 - Dayton Superior Corporation; Safe Cure and Seal (J-18).
 - Euclid Chemical Company (The), an RPM company; Aqua Cure VOX; Clearseal WB 150.
 - L&M Construction Chemicals, Inc.; Dress & Seal WB.
 - Meadows, W. R., Inc.; Vocomp-20.
 - Metalcrete Industries; Metcure.
 - Symons by Dayton Superior; Cure & Seal 18 Percent E.
7. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- a. Products: Subject to compliance with requirements, provide one of the following:
- BASF Construction Chemicals - Building Systems; Kure 1315.
 - Conspec by Dayton Superior; Sealcure 1315 WB.
 - Euclid Chemical Company (The), an RPM company; Super Diamond Clear VOX; LusterSeal WB 300.
 - L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - Meadows, W. R., Inc.; Vocomp-30.
 - Metalcrete Industries; Metcure 30.
 - Symons by Dayton Superior; Cure & Seal 31 Percent E.
- b. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Related Materials.

1. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
2. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows: Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

H. Concrete Mixtures, General.

1. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
2. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
 - a. Fly Ash: 25%.
 - b. Combined Fly Ash and Pozzolan: 25%.
 - c. Ground Granulated Blast-Furnace Slag: 35%.
 - d. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 60% Portland cement minimum, with fly ash or pozzolan not exceeding 25%.

3. Limit water-soluble, chloride-ion content in hardened concrete to 0.30% by weight of cement.

4. Admixtures.

- a. Use admixtures according to manufacturer's written instructions.
- b. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
- c. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- d. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

I. Concrete Mixtures for Building Elements.

1. Footings and Pile Caps: Proportion normal-weight concrete mixture as follows:
 - a. Minimum Compressive Strength: 4500 psi at 28 days.
 - b. Maximum Water-Cementitious Materials Ratio: 0.45.
 - c. Slump Limit: 5 inches, ± 1 inch.
2. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
 - a. Minimum Compressive Strength: 4500 psi at 28 days.
 - b. Slump Limit: 5 inches, ± 1 inch.
 - c. Air Content: 6%, $\pm 1.5\%$ at point of delivery for 3/4 inch nominal maximum aggregate size.

J. Fabricating Reinforcement.

Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

K. Concrete Mixing.

1. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information. When air temperature is between 85°F and 90°F, reduce mixing and delivery time from 1 1/2 hours to 75 minutes; when air temperature is above 90°F, reduce mixing and delivery time to 60 minutes.
2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 - a. For mixer capacity of 1 cubic yard or smaller, 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.
 - b. For mixer capacity larger than 1 cubic yard, increase mixing time by 15 seconds for each additional 1 cubic yard.
 - c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

155057.03 CONSTRUCTION.

A. Formwork.

1. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads. Pile Caps shall be formed – bank pouring is not permitted.
2. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

3. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - a. Class A, 1/8 inch for smooth-formed finished surfaces.
 - b. Class B, 1/4 inch for rough-formed finished surfaces.
 - c. Class D, 1 inch for footings.
 - d. Construct forms tight enough to prevent loss of concrete mortar.
4. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - a. Install keyways, reglets, recesses, and the like, for easy removal.
 - b. Do not use rust-stained steel form-facing material.
5. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
6. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
7. Chamfer exterior corners and edges of permanently exposed concrete.
8. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
9. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
10. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
11. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

B. Embedded Items.

1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, and embedded plates accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

C. Removing and Reusing Forms.

1. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50°F for 24 hours after placing concrete. Concrete must be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
2. 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-release agent.

3. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

D. Steel Reinforcement.

1. **General.**
 - a. Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - b. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
3. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
4. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
5. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

E. Joints.

1. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
 - a. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Retain first subparagraph below if keyed joints are used. Keyed joints are used in walls and floors and between walls and slabs or footings. ACI 302.1R recommends limiting keyed joints to lightly trafficked floors because keys may fail and lips may chip after concrete shrinks.
 - b. Form keyed joints as indicated. Embed keys at least 1 1/2 inches into concrete.
 - c. Space vertical joints in walls at no more than 60 feet on center. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - d. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - e. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
3. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

F. Concrete Placement.

1. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.

3. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
4. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - a. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - b. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - c. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations 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 lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
5. Deposit and consolidate concrete for slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - a. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - b. Maintain reinforcement in position on chairs during concrete placement.
 - c. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - d. Slope surfaces uniformly to drains where required.
 - e. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
6. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - a. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
7. Hot-Weather Placement: Comply with ACI 301 and as follows:
 - a. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water 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.
 - b. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

G. Finishing Formed Surfaces.

1. **Rough-Formed Finish.**
 - a. As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - b. Apply to concrete surfaces not exposed to public view.

2. Smooth-Formed Finish.

- a. As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - b. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.
- 3. 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.

H. Finishing Floors and Slabs.

1. Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
2. **Scratch Finish.**
 - a. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
 - b. Apply scratch finish to surfaces indicated to receive mortar setting beds for bonded cementitious floor finishes.
3. **Float Finish.**
 - a. Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - b. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
4. **Trowel Finish.**
 - a. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - b. Apply a trowel finish to surfaces indicated exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 - c. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface: Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
5. **Trowel and Fine-Broom Finish.**
 - a. Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
 - b. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
6. **Broom Finish.**
 - a. Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

- b. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

I. Miscellaneous Concrete Items.

1. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
2. 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.

J. Concrete Protecting and Curing.

1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
2. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
3. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
4. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
5. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - a. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - 1) Water.
 - 2) Continuous water-fog spray.
 - 3) Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12 inch lap over adjacent absorptive covers.
 - b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than 7 days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - 1) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - 2) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - 3) Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - c. **Curing Compound.**

- 1) Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
- 2) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
- d. Curing and Sealing Compound: Apply uniformly to slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

K. Joint Filling.

1. Prepare, clean, and install joint filler according to manufacturer's written instructions. Defer joint filling until concrete has aged at least 1 month. Do not fill joints until construction traffic has permanently ceased.
2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
3. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

L. Concrete Surface Repairs.

1. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
2. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
3. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - a. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - b. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area 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. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
4. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

- a. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - b. After concrete has cured at least 14 days, correct high areas by grinding.
 - c. Correct localized low areas 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.
 - d. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - e. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - f. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 - g. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- 5. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
 - 6. Repair materials and installation not specified above may be used, subject to Engineer's approval.

M. Field Quality Control.

- 1. Testing and Inspecting: Engineer will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- 2. **Inspections.**
 - a. Steel reinforcement placement.
 - b. Steel reinforcement welding.
 - c. Headed bolts and studs.
 - d. Verification of use of required design mixture.
 - e. Concrete placement, including conveying and depositing.
 - f. Curing procedures and maintenance of curing temperature.
 - g. Verification of concrete strength before removal of shores and forms from beams and slabs.
- 3. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - a. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cubic yards, but less than 25 cubic yards, plus one set for each additional 50 cubic yards or fraction thereof.

- b. Testing Frequency: Obtain at least one composite sample for each 100 cubic yards or fraction thereof of each concrete mixture placed each day. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
- c. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
- d. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
- e. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40°F and below and when 80°F and above, and one test for each composite sample.
- f. Compression Test Specimens: ASTM C 31/C 31M. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
- g. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - 1) Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - 2) A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
- h. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- i. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- j. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7 and 28 day tests.
- k. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
- l. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Engineer.
- m. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- n. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the contract documents.

155057.04 METHOD OF MEASUREMENT.

Areas of cast-in-place concrete pavement will not be measured for payment.

155057.05 BASIS OF PAYMENT.

Payment for this item will be incidental to all slip-form pavement, pavers on concrete base, curbs, special curbs, flush bands, retaining walls, stairs, special retaining walls, boat ramp, and the shade structure.