

# **City of Nevada City Community Swimming Pool**

## **Structural Pool Repair**

### **SWIMMING POOL SPECIFICATION SECTIONS**

**Terracon**

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# SPECIFICATION SECTION INDEX

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SECTION 131120 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work in this section. Principal items include:

1. The work under this section shall include all labor, materials, and equipment required to complete the concrete work for the swimming pool shell(s).
2. Materials and/or methods specified in this section as "I.B.C.", "I.B.C. Standards", or similar wording refer to the International Building Code, 2012 Edition.
3. Except as otherwise specified herein, the work of this section shall be in accordance with Chapter 19 "Concrete" of the International Building Code, 2012 Edition.

1.2 SUBMITTALS

- A. Product Data: Provide product data for each type of product indicated. Include any technical data and installation requirements.
- B. Concrete Mix Design: Provide a mix design for each strength and type of concrete. Furnish a complete list of materials including type, brand, source, and amount of cement, pozzolan, and admixtures. Obtain approval before concrete placement.
1. Provide alternate design mixtures when characteristics of materials, project conditions, weather, test results or other circumstances warrant adjustments.
  2. Indicate amounts of mixing water to be withheld for later addition at project site.
- C. Steel Reinforcement Shop Drawings: Provide placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, materials, and grades; bar schedules; stirrup spacing; bent bar diagrams; bar arrangements, splices and laps; mechanical connections; tie spacing; hoop spacing; and supports for concrete reinforcement.
- D. Formwork Shop Drawings: Provide formwork shop drawings prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
- E. Material Test Reports: Provide reports for the following, from a qualified testing agency, indicating compliance with requirements:
1. Aggregates - Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- F. Material Certificates: Provide certificates for each of the following, signed by the manufacturers:
1. Cementitious materials
  2. Admixtures
  3. Form materials and form-release agents
  4. Steel reinforcement and accessories
  5. Curing compounds
  6. Bonding agents
  7. Repair materials
- G. Provide field quality control test and inspection reports.

H. Provide minutes of pre-installation conference.

### 1.3 QUALITY ASSURANCE

- A. 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.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- C. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated and as documented according to ASTM E 548.
  - 1. Personnel conducting field tests shall be qualified as ACI Certified Concrete Field Testing Technician - Grade I according to ACI CP-01 or an equivalent certification program.
  - 2. Personnel performing laboratory tests shall be ACI Certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI Certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. ACI Publications: Comply with the following unless modified by requirements in the contract documents:
  - 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
  - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- G. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
  - 1. 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:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete subcontractor.
  - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, forms and form removal limitations, shoring and reshoring procedures, steel reinforcement installation, concrete repair procedures, and concrete protection.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Keep waterstops covered during storage to protect from moisture, sunlight, dirt, oil, and other contaminants.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Products: Products are subject to compliance with requirements. Products that may be incorporated in the work include, but are not limited to, the products specified.

2. Available Manufacturers: Manufacturers are subject to compliance with requirements. Manufacturers offering products that may be incorporated in the work include, but are not limited to, the manufactures specified.

## 2.2 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of the same type, brand, and source throughout the project.
  1. Portland Cement: ASTM C150, Standard Specification for Portland Cement.
  2. Fly Ash: ASTM C 618, Class C or F.
- B. Normal Weight Aggregate: ASTM C33, Class 5S Insert class 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.
  1. Maximum Coarse-Aggregate Size: 1 in (25 mm) nominal size.
  2. Fine Aggregate: Fine aggregate to be free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C94/C94M, Clean and potable.

## 2.3 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. 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.
  1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

## 2.4 CONCRETE MIXTURES, GENERAL

- A. 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.
  1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
  2. Limit use of fly ash to not exceed, in combination, 15% of portland cement by weight.
- B. Limit water-soluble, chloride-ion content in hardened concrete to 0.15% by weight of cement.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
  1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
  2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  3. Use water-reducing admixture in pumped concrete, and concrete with a water-cementitious materials ratio below 0.50.

## 2.5 CONCRETE MIXES

- A. All concrete: Proportion normal-weight concrete mixture as follows:
  - 1. Minimum Compressive Strength: 4,000 psi (34.5 MPa) at 28 days.
  - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
  - 3. Minimum Cementitious Materials Content: 600 lb/yd<sup>3</sup>
  - 4. Slump Limit:
    - a. All other: 3 in +/- 1 in (75 mm +/- 25 mm) or 8 in (200 mm) for concrete with verified slump of 2 to 4 in (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, +/- 1 in (25 mm).
  - 5. Use Type V Cement.
  - 6. Cement to aggregate, in dry weight, shall not be less than one to five.
  - 7. Air entrainment: 5-7%
- B. Shrinkage Tests:
  - 1. Prior to placing any concrete for walls or horizontal surfaces, a trial batch of each mix design of structural concrete shall be prepared using the aggregates, cement and admixture (if any) proposed for the project. From each trial batch at least three (3) specimens for determining drying shrinkage shall be prepared. The drying shrinkage specimens shall be a 4" x 4" x 11" prisms fabricated, cured, dried, and measured in accordance with the requirements of Tentative Method of Test for Length Change of Cement Mortar and Concrete, ASTM C157. The measurements shall be made and reported separately for 7 and 28 days of drying after 7 days of moist curing. The effective gage length of the specimens shall be 10", and except for the foundation concrete, the average drying shrinkage at 35 days shall not exceed .054%.
  - 2. Previous Test: Ready-mixed concrete manufacturer may furnish certified test reports from an approved testing laboratory as proof of meeting shrinkage requirements, provided aggregate used and concrete covered by such test report conform to mix design approved for use on this project. Use an independent testing facility for preparing and reporting proposed mix designs.
- C. Ready-Mix Concrete
  - 1. Comply with ASTM C 94/C 94M.
  - 2. Before using trucks for batching, mixing, and transporting concrete, thoroughly clean the trucks and equipment of materials capable of contaminating concrete.
  - 3. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 is required.
  - 4. When air temperature is between 85°F and 90°F, reduce mixing and delivery time from 90 minutes to 75 minutes, and when air temperature is above 90°F, reduce mixing and delivery time to 60 minutes.
  - 5. Do not add water to ready-mix concrete at project site except when slump is below specified limits and total water does not exceed the design water-cement ratio; inject added water into mixer and mix thoroughly before discharging.
- D. Provide certificate signed by authorized official of supplier with each load of concrete stating following:
  - 1. Time truck left plant.
  - 2. Mix of concrete, identify with code number of mix design.
  - 3. Amount of water and cement in mix.
  - 4. Amount and type of admixtures.
  - 5. Amount of water added at project site.
  - 6. Time truck is unloaded at project site.
- E. Truck mixers without batch tickets will be rejected.

- F. Retain certificates at project site. Submit to the owner/architect for review upon request.

## 2.6 FORM-FACING MATERIALS

- A. Forming Materials: Forming materials shall be new. Materials may be reused during the progress of the work provided they are completely cleaned and reconditioned, recoated for each reuse, capable of producing formwork of the required quality and are structurally sound.
- B. Smooth-Formed Finished Concrete: Form-facing panels shall be used to provide continuous, true, and smooth concrete surfaces. Furnish panels in the largest practicable sizes to minimize the number of joints.
  - 1. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    - a. Medium-density overlay, Class 1 or better, mill-release agent treated and edge sealed.
- C. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- D. Chamfer Strips: Wood, metal, PVC, or rubber strips,  $\frac{3}{4}$ " x  $\frac{3}{4}$ " (19 mm x 19 mm) minimum
- E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect the concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- F. Form Ties: 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.
  - 1. Furnish units that will leave no corrodible metal closer than 1 in (25 mm) to the plane of exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes no larger than 1 in (25 mm) in diameter in concrete surface.
  - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

## 2.7 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 40 (Grade 300) or better for No.3 and Grade 60 (Grade 420) for No.4 bars and larger, deformed.
- B. Plain-Steel Wire: ASTM A 82, as drawn.

## 2.8 REINFORCEMENT ACCESSORIES

- A. Bar Supports: 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:
  - 1. 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.
- B. Dowel Bar Substitutes: Tapered, threaded couplers, pre-assembled to reinforcing with mounting plate for attachment to form work and a pressed in metal disc thread protector which can be easily removed. The mechanical connection shall meet building code requirements of developing in tension or compression. The mechanical connection shall be the positive locking, taper threaded type coupler manufactured from high quality steel. The bar ends must be taper threaded using the manufacturer's requirements.
  - 1. Lenton Form Saver; Erico Corp.

## 2.9 RELATED MATERIALS

- A. 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:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

## 2.10 REPAIR MATERIALS

- A. Concrete Patching Mortar: Chemical treatment for waterproofing concrete.
  1. Xypex Concrete Waterproofing by Crystallization, Xypex Chemical Corporation.
    - a. Xypex Concentrate.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Before placing new concrete against existing shotcrete/concrete, remove unsound or loose materials and contaminants that may inhibit concrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1 in (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces before placing concrete.
  1. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper concrete bonding.
- B. Earth: Compact and trim to line and grade before placing concrete. Do not place concrete on frozen surfaces. Dampen surfaces before concrete placement. Expansive soils shall be maintained in a moist condition during construction.
- C. Rock: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken concrete bonding.

### 3.2 FORMWORK

- A. 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.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
  1. Class A, 1/8 in (3.2 mm) for smooth-formed finished surfaces.
  2. Class C, 1/2 in (13 mm) for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. 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.
  1. Install recesses, pipe sleeves and the like, for easy removal.
  2. Do not use rust-stained steel form-facing material.
- F. 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.
- G. 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.
- H. Chamfer exterior corners and edges of permanently exposed concrete. See drawings for other required profiles.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the work. Determine sizes and locations from trades providing such items.

- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.3 EMBEDDED ITEMS

- A. 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.

### 3.4 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of 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 (10°C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
  - 1. Leave formwork for beam soffits, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70% of its 28-day design compressive strength.
  - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. 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.
- C. 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 the owner/architect.

### 3.5 STEEL REINFORCEMENT

- A. General: Fabrication and placement of reinforcing for concrete construction shall be in accordance with the requirements of Title 24, Part 2, California Administrative Code, and as shown.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. 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.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

### 3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install construction joints so strength and appearance of concrete is not impaired at locations indicated or as approved by the owner/architect.
  - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless noted otherwise on drawings. Do not continue reinforcement through sides of strip placements of floors and slabs.
  - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 in (38 mm) into concrete, unless noted on drawings otherwise.
  - 3. Locate horizontal joints in walls at underside of floors and at the top of floor slabs.
  - 4. Locate vertical joints in walls at corners and in concealed locations where possible.

5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  6. No construction joints shall be placed in pool bottom slab, unless noted on drawings otherwise.
- C. Contraction Joints in Pool Bottom Slab: No contraction joints shall be placed in pool bottom slab.
- D. Expansion Joints in Gutter Decking: Expansion joints shall be installed in the gutter decking where indicated in the project plans. Expansion joints shall be  $\frac{1}{2}$ " wide and extend through the entire slab. Seal over expansion joint material with semi-rigid sealant: Metzger / McGuire "MM-80" or approved equal.

### 3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before test sampling and placing concrete, water may be added at project site, subject to limitations of ACI 301.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- C. 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.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
  2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  3. 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 in (150 mm) 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.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Maintain reinforcement in position on chairs during concrete placement.
  3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  4. Slope surfaces uniformly to drains where required.
  5. 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.
- E. 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.
1. When average high and low temperature is expected to fall below 40°F (4.4°C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90°F (32°C) 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.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

### 3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: 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.
  1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: 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.
  1. 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.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
  1. Smooth-Rubbed Finish: Not later than one day after form removal, 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.

### 3.9 FINISHING SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighen 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.
  1. Apply a trowel finish to surfaces exposed to view or to be covered with ceramic tile, paint, or another thin-film-finish coating system.
  2. Finish surfaces to the following tolerances, according to ASTM E 1155(ASTM E 1155M), for a randomly trafficked floor surface:
    - a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.

### 3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, 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 indicated or required to complete the work.
  1. All patches shall be watertight.

### 3.11 CONCRETE PROTECTING AND CURING

- A. 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.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/ft<sup>2</sup> x h (1 kg/m<sup>2</sup> 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.

- C. 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.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12 in (300 mm) lap over adjacent absorptive covers.
  - 2. 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 in (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    - c. 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.
  - 3. Curing Compound: Apply uniformly in 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. Maintain continuity of coating and repair damage during curing period.
    - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by methods recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of tile used on project.

### 3.12 CONCRETE SURFACE REPAIRS

- A. 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
- B. 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 (1.18 mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include 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.
  - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 in (13 mm) in any dimension in solid concrete, but not less than 1 in (25 mm) in depth. 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.
  - 2. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Owner/architect.

- D. Repairing Unformed Surfaces: Test unformed surfaces, such as 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.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 in (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. 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.
  4. Repair defective areas, except random cracks and single holes 1 in (25 mm) 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 ¾ in (19 mm) 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.
  5. Repair random cracks and single holes 1 in (25 mm) 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.
- E. Perform structural repairs of concrete, subject to engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to engineer's approval.

### 3.13 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
1. Steel reinforcement placement.
  2. Verification of use of required design mixture.
  3. Concrete placement, including conveying and depositing.
  4. Curing procedures and maintenance of curing temperature.
  5. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one (1) composite sample for each day's pour of each concrete mixture exceeding 5 yd<sup>3</sup> (4 m<sup>3</sup>), but less than 25 yd<sup>3</sup> (19 m<sup>3</sup>), plus one (1) set for each additional 50 yd<sup>3</sup> (38 m<sup>3</sup>) or fraction thereof.
    - a. When frequency of testing will provide fewer than five (5) 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.
  2. Slump: ASTM C 143/C 143M; one (1) test at point of placement for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  3. Concrete Temperature: ASTM C 1064/C 1064M; one (1) test hourly when air temperature is 40°F (4.4°C) and below and when 80°F (27°C) and above, and one (1) test for each composite sample.
  4. Compression Test Specimens: ASTM C 31/C 31M.

- a. Cast and laboratory cure two (2) sets of two standard cylinder specimens for each composite sample.
  - b. Cast and field cure two (2) sets of two standard cylinder specimens for each composite sample.
5. Compressive-Strength Tests: ASTM C 39/C 39M; test one (1) set of two laboratory-cured specimens at 7 days and one (1) set of two specimens at 28 days.
- a. Test one (1) set of two field-cured specimens at 7 days and one (1) set of two specimens at 28 days.
  - b. 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.
6. 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.
7. 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 (3.4 MPa).
8. Test results shall be reported in writing to the owner/architect, 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.
9. 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.
10. 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.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the work that test reports and inspections indicate dos not comply with the contract documents.
- D. Measure floor and slab flatness and levelness according to ASTM E 1155(ASTM E 1155M) within 24 hours of finishing.

### 3.14 WATERTIGHTNESS TESTING

- A. Pool shall be tested for watertightness according to procedures stated in ACI350.1-01 / AWWA 400.
1. Preliminary Test Criteria: HST-VIO.
  2. Quantitative Test Criteria: HST-100.

END OF SECTION 131120

SECTION 131122 – SHOTCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work in this section. Principal Items include.
  - 1. Shotcrete for swimming pool structure.
  - 2. Preparation of surfaces to receive shotcrete.
  - 3. Forms and ground wires.
  - 4. Furnishing and placing reinforcing steel for shotcrete.
  - 5. Mixing, delivery, placing, finishing, and curing of shotcrete.
  - 6. Protection and cleaning of adjacent surfaces.
- B. Related Work Not in this Section:
  - 1. Mass excavation and related earthwork for swimming pool.
  - 2. Cast-in-place concrete.
  - 3. Swimming pool plaster and tile finish.

1.2 DEFINITIONS

- A. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.
- B. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

1.3 SUBMITTALS

- A. Product Data: For manufactured materials and products including reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.
- B. Shop Drawings: For details of fabricating, bending, and placing reinforcement. Include support and anchor details, number and location of splices, and special reinforcement required for openings through shotcrete structures.
- C. Shotcrete Mix Design: Submit a mix design for each strength and type of shotcrete. Furnish a complete list of materials including type, brand, source, and amount of cement, pozzolan, and admixtures. Submit applicable reference specifications, and copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Obtain approval before concrete placement. Any shotcrete work placed prior to approval of the shotcrete mix design is not acceptable, is rejected and shall be removed at no cost to the Owner.
- D. Qualification Data: For Installer.

1.4 QUALITY ASSURANCE

- A. Qualifications of Shotcrete Subcontractor: Proposed Subcontractor must have at least 5 years experience in structural shotcrete construction and have constructed at least 20 significant structural shotcrete swimming pools which, on investigation, have been found to be completed in a satisfactory manner.
- B. Qualifications of Mechanics: Employ only skilled nozzlemen, nozzleman's helpers, and rodmen having at least three years of structural shotcrete placing experience and furnish written evidence of such experience upon request. Each team, consisting of the nozzleman and the helper, shall shoot a test panel of the thickness and with typical reinforcing steel pattern using each shotcreting position before commencing any wet mix shotcreting work on the pool. The Special Inspector shall witness the assembly, reinforcing, shooting and disassembly of the test. The panel shall be at least 4 feet by 4 feet. After shooting, but before the

concrete has fully set, the panel shall be disassembled to assure that the team and the equipment to be used is capable of providing sound concrete behind the reinforcing steel.

- C. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- D. Comply with provisions of the following, unless more stringent requirements are indicated:
  - 1. ACI 301, "Specifications for Structural Concrete."
  - 2. ACI 506.2, "Specification for Shotcrete."
  - 3. ACI 506R-11
- E. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing and inspections indicated below:
  - 1. Prior to construction, a test panel shall be shot, cured, cored or sawn, examined and tested by the testing agency. The panel thickness and reinforcement shall simulate the portion of the structure that is most congested with reinforcement and should not be smaller than 48 by 48 inches (1200 by 1200 mm) minimum. The panel shall be shot at the same angle, with the same nozzlemen, and with the same mix as will be used on the project. IBC 1913 shall be used as a guideline. Examination and acceptance of the cores shall be conducted in accordance with ACI 506.2.
    - a. Test each set of unreinforced specimens for compressive strength according to ASTM C 42.
    - b. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

#### 1.5 PROJECT CONDITIONS

- A. Cold-Weather Shotcreting: Protect shotcrete work from physical damage or reduced strength caused by frost, freezing, or low temperatures according to ACI 306.1 and as follows:
  - 1. Discontinue shotcreting when ambient temperature is 40 deg F (4.4 deg C) and falling. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than 50 deg F (10 deg C) and not more than 90 deg F (32 deg C).
  - 2. Do not use frozen materials or materials containing ice or snow.
  - 3. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
  - 4. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
- B. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 305R when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:
  - 1. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 100 deg F (38 deg C) for dry mix or 90 deg F (32 deg C) for wet mix.
  - 2. Reduce temperature of reinforcing steel and receiving surfaces below 100 deg F (38 deg C) before shotcreting.

### PART 2 - PRODUCTS

#### 2.1 FORM MATERIALS

- A. Form lumber: WCLIB "Construction" grade or better, WWPA No. 1 or better, or equal.
- B. Form plywood: PS 1-83, Group I, Exterior Grade B-B Plyform or better, minimum 5-ply and 5/8" thickness, grade marked, not mill oiled. Plywood having medium or high density overlay is acceptable.
- C. Form ties: Prefabricated rod, flat band, wire, internally threaded disconnecting type, or equal, not leaving metal within 2" of concrete surface.

- D. Form coating: Resin type coating free of oil, silicone, wax, and non-drying material, not grain raising. ADMIXTURES
- E. Air-Entraining Admixture: ASTM C 260.
- F. 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.
  - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

## 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615/ A 615M, Grade 40 (Grade 300) or Better for No. 3 and Grade 60 (Grade 420) for No. 4 bars and larger, deformed.
- B. Plain-Steel Wire: ASTM A 82, as drawn
- C. Supports: Bolsters, chairs, spacers, ties, and other devices for spacing, supporting, and fastening reinforcing steel in place according to CRSI's "Manual of Standard Practice" and as follows:
  - 1. For uncoated reinforcement, use all-plastic or CRSI Class 1, plastic-protected bar supports.
- D. Reinforcing Anchors: ASTM A 36/A 36M, unheaded rods or ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hex-head bolts; carbon steel; and carbon-steel nuts.
  - 1. Finish: Plain, uncoated.

## 2.3 SHOTCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type V. Use only one brand and type of cement for Project.
  - 1. Fly Ash: ASTM C 618, Class C or F.
- B. Fine aggregate: ACI 506 Gradation No. 1 or 2, ASTM C33, washed hard dense durable clean sharp sand from approved pit, free of organic matter and opaline, feldspar, or siliceous magnesium substances and containing not more than 3% by weight of deleterious substances. When tested for organic impurities by ASTM C40 method, fine aggregate color not darker than reference standard color. When tested for soundness by ASTM C88 method, loss after 5 cycles not over 10% of fine aggregate.
- C. Water: Potable, complying with ASTM C 94/C 94M, free from deleterious materials that may affect color stability, setting, or strength of shotcrete.
- D. Ground Wire: High-strength steel wire, 0.8 to 1 mm in diameter.

## 2.4 CHEMICAL ADMIXTURES

- A. General: ASTM C 1141, Class A or B, but limited to the following admixture materials. Provide admixtures for shotcrete that contains not more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.
  - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  - 2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 3. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
  - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

5. Accelerating Admixture: ASTM C 494/C 494M, Type C.

## 2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

## 2.6 RELATED MATERIALS

- A. 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:
  - 1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

## 2.7 REPAIR MATERIALS

- A. Concrete Patching Mortar: Chemical treatment for waterproofing concrete.
  - 1. Xypex Concrete Waterproofing by Crystallization, Xypex Chemical Corporation.
    - a. Xypex Concentrate.

## 2.8 SHOTCRETE MIXTURES, GENERAL

- A. Prepare design mixes for each type and strength of shotcrete.
  - 1. Limit use of fly ash to not exceed, in combination, 15 percent of portland cement by weight.
- B. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.
- C. Admixtures: When included in shotcrete design mixes, use admixtures and retarding admixtures according to manufacturer's written instructions.
- D. Design-Mix Adjustments: Subject to compliance with requirements, shotcrete design-mix adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

## 2.9 SHOTCRETE MIXTURES (Wet mix process only shall be used)

- A. Proportion wet mixtures according to ACI 211.1 and ACI 301, using materials to be used on Project, to provide shotcrete with the following properties:
  - 1. Compressive Strength (28 Days): 4,000 psi (31.0 MPa).
  - 2. Cementitious Material Content: 600 lbs/yd min.
  - 3. Maximum Water-Cementitious Ratio: 0.45.
  - 4. Use Type V cement.
  - 5. Cement to aggregate, in dry weight, shall not be less than one to five.
  - 6. Slump: The slump measured at the point of discharge from the mixer shall be minimum 1-1/2 inches and maximum 2-1/2 inches.
  - 7. Air entrainment: 5-7%

## 2.10 SHOTCRETE EQUIPMENT

- A. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.

- B. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

#### 2.11 BATCHING AND MIXING

- A. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C 94/C 94M and furnish batch ticket information.
  - 1. Comply with ASTM C 685/C 685M when shotcrete ingredients are delivered dry and proportioned and mixed on-site.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Before applying shotcrete, remove unsound or loose materials and contaminants on cast-in-place concrete or existing shotcrete that may inhibit shotcrete bonding. Chip or scarify areas to receive shotcrete to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces before shotcreting.
  - 1. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.
- B. Earth: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Do not place shotcrete on or against fill unless specified on the project plans. Dampen surfaces before shotcreting, but not so wet as to overcome suction. If sloughing or caving of earth banks occurs, fill the resulting voids with shotcrete at no extra cost to Owner; backfilling such voids with earth is not allowed.
- C. Rock: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken shotcrete bonding.

#### 3.2 FORMS

- A. General: Design, erect, support, brace, and maintain forms, according to ACI 301, to support shotcrete and construction loads and to facilitate shotcreting. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting.
  - 1. Fabricate forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.
  - 2. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gages to obtain accurate alignment, location, and grades in finished structures. Construct forms to prevent mortar leakage but permit escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages, inserts, and other features required in the Work.
- B. Form openings, chases, recesses, bulkheads, keyways, and screeds in formwork. Determine sizes and locations from trades providing such items. Accurately place and securely support items built into forms.
- C. Embedded Piping, Boxes, and Rough Hardware: Coordinate with trades that are to fasten or install in shotcrete piping, boxes, bolts, anchors, inserts, or other rough hardware and accurately set such items in forms of shotcrete, and be responsible for changes in the position of such items after setting.

#### 3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.
- C. Securely embed reinforcing anchors into existing substrates, located as required.
- D. Accurately position, support, and rigidly secure reinforcement against displacement by formwork, construction, or shotcreting. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.

- E. Place reinforcement to obtain minimum coverage for shotcrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during shotcreting. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.
- F. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

### 3.4 JOINTS

- A. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints, unless otherwise indicated.
  - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
  - 2. Locate horizontal joints in walls at top or underside of floors and slabs.
  - 3. Vertical joints in walls shall be located at corners, and in concealed locations where possible.
  - 4. Where new shotcrete is placed against existing shotcrete or concrete, the interface should be roughened to  $\frac{1}{4}$  inch amplitude and it shall be clean and free of laitance.
  - 5. Use epoxy-bonding adhesive at locations where fresh shotcrete is placed against hardened or partially hardened shotcrete surfaces.
  - 6. No construction joints shall be placed in pool walls or slabs unless noted on drawings or approved by Engineer.
- B. Contraction Joints: No contraction joints shall be placed on swimming pool walls or slab.

### 3.5 ALIGNMENT CONTROL

- A. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

### 3.6 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

### 3.7 APPLICATION

- A. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.
- B. Moisten wood forms immediately before placing shotcrete where form coatings are not used.
- C. Apply shotcrete according to ACI 506.2.
- D. Apply wet-mix shotcrete materials within 90 minutes after batching.
- E. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.
  - 1. Remove and dispose of all rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
- F. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray and prevent buildup against front face during shotcreting.
- G. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete
- H. Do not permit shotcrete to sag, slough, or dislodge.

- I. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.
- J. Do not disturb shotcrete surfaces before beginning finishing operations.
- K. Puddled Shotcrete: Use of "puddled shotcrete" in which the air pressure is reduced and the water content is increased to facilitate placing in difficult locations is not allowed. Do not place shotcrete where nozzle stream cannot impinge directly on the involved surface. Where difficult shooting conditions occur, obtain proper results by maintaining correct air pressure and water ratio and reduce supply of material.
- L. Remove ground wires or other alignment control devices after shotcrete placement.
- M. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.
- N. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117R, increased by a factor of 2.

### 3.8 SURFACE FINISHES

- A. General: Finish shotcrete according to descriptions in ACI 506R for the following finishes:
- B. Flash-Coat and Final Finish: After screeding and rodding surface, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve.

### 3.9 CURING

- A. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.
- B. Start initial curing as soon as free water has disappeared from shotcrete surface after placing and finishing.
- C. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for at least seven days with water, continuous water-fog spray, water-saturated absorptive covers, or moisture-retaining covers. Lap and seal sides and ends of covers. Do not use curing compounds of any kind.
- D. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

### 3.10 FORM REMOVAL

- A. Forms not supporting weight of shotcrete may be removed after curing at not less than 50 deg F (10 deg C) for 24 consecutive hours after gunning, provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.
  - 1. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
  - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

### 3.11 FIELD QUALITY CONTROL

- A. Owner will engage a qualified independent testing agency to sample materials, visually grade cores, perform tests, and submit reports during shotcreting.
- B. Shotcrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and 1 test for each set of compressive-strength specimens.

- C. In-Place Shotcrete or Test Panel: If test panel is used, the panel should not be smaller than 24 by 24 inches by 3.5 inches (610 by 610 by 89 mm) minimum. Take a set of 3 unreinforced cores for each mix and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed; whichever is less. Test cores for compressive strength according to ACI 506.2 and ASTM C 42. Do not cut steel reinforcement.
- D. Strength of shotcrete will be considered satisfactory when mean compressive strength of each set of 3 unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
- E. If any 28 day core from the test panels shows deficient strength, additional cores shall be taken and tested at Contractor's expense from the area of work in place represented by the test panel; two additional cores are required for each deficient core. If any additional test core proves deficient, Contractor shall remove and replace deficient shotcrete as directed and approved, at no extra cost to Owner. Should deficiency be evident in 7-day cores, Contractor may proceed with the Work on his responsibility and risk until the 28-day cores are tested.
- F. Defective Shotcrete: Cut out and replace defective shotcrete including rebound, sand pockets, sags, sloughing, and other defects at no extra cost to the Owner.

### 3.12 REPAIRS

- A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.
  - 1. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces and apply new shotcrete or patching mortar.
- B. Repair core holes from in-place testing according to repair provisions in ACI 301 and match adjacent finish, texture, and color.

### 3.13 CLEANING

- A. Remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

### 3.14 WATERTIGHTNESS TESTING

- A. Pool shall be tested for water tightness according to procedures stated in ACI350.1 / AWWA 400.
  - 1. Preliminary Test Criteria: HST-VIO.
  - 2. Quantitative Test Criteria: HST-100.

END OF SECTION 131122

SECTION 131140 – SWIMMING POOL PLASTER

PART 1 - GENERAL

1.1 REFERENCE

- A. Requirements in Addenda, Alternates and Conditions collectively apply to this work.

1.2 DESCRIPTION

- A. Principal Work Items Are:

1. Swimming pool plaster finish.
2. Swimming pool start-up and maintenance.

- B. Related Work Specified Elsewhere:

1. Section 131120 – Cast-In-Place Concrete
2. Section 131122 – Swimming Pool Shotcrete
3. Section 131125 – Swimming Pool Cementitious Waterproofing
4. Section 131130 – Sealants and Caulking
5. Section 131145 – Swimming Pool Tile
6. Section 131150 – General Contractor Requirements
7. Section 131151 – Swimming Pool Equipment

1.3 SUBMITTALS

- A. Samples: Prepare 12-inch square panel at the site showing color and texture for pool plaster. Finished plasterwork shall match the approved sample panel.
- B. Certificates: Submit certificates attesting that the materials furnished meet the requirements specified herein.
- C. Test Report: Submit results of domestic water analysis.

1.4 PRODUCT DELIVERY AND STORAGE

- A. Deliver manufactured materials to site in manufacturers' original unbroken packages or containers bearing manufacturers' name and brand labels. Keep cementitious materials dry until ready to be used and stored off the ground, under cover, and away from damp surfaces.

1.5 JOB CONDITIONS

- A. Apply plaster in exterior swimming pool only when ambient temperature is above 40°F and below 90°F, and protect applied plaster from rapid drying by sun or wind until curing is completed or pool is filled with water. Protect interior plaster applications from construction debris. Make every effort to apply plaster as late in the construction schedule as possible to avoid staining or damage to the finish. Stains or damage occurring as a result of inadequate care may result in the rejection of the installation and require complete removal and re-installation at the contractor's expense.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type I white Portland cement. Manufacturer, Federal Cement.
- B. Hydrated Lime: ASTM C206, Type S.

- C. Aggregate: Georgia Marble Pool Aggregate, Riverside Premium Pool Aggregate, or approved equal. Mix per Manufacturer's recommendations for specific application. If an onsite mix is used, aggregate must be white marble dust uniformly graded within the following limits, all passing the No. 30 sieve:

Percentage retained (by weight, plus or minus 2%) on each sieve

| SieveSize | Minimum | Maximum |
|-----------|---------|---------|
| No. 30    | 0       | 30      |
| No. 50    | 40      | 55      |
| No. 100   | 70      | 80      |
| No. 200   | 80      | 100     |

- D. Color: Swimming Pool plaster shall be white in color.
- E. Water: Clean, fresh, from domestic potable source, free from injurious amounts of acid, alkali, and organics.

## 2.2 PROPORTIONS AND MIXING (IF ONSITE MIX IS SPECIFIED)

- A. Materials are specified on a volume basis and shall be measured in approved containers that will insure that the specified proportions will be controlled and accurately maintained during the progress of the work. Measuring materials with shovels ("shovel count") is not permitted.
- B. White Marble Pool Plaster Finish Coat: Mix finish in proportion of one part by volume of white portland cement to not more than two parts by volume of sand (specified white marble dust).
- C. Mixing: Perform mixing in approved mechanical mixers of the type in which quantity of water can be controlled accurately and uniformly. While mixer is in continuous operation, charge approximately 90% of estimated quantity of water, half of sand, all cement, and the other one-half of the sand into mixer in that sequence and mix thoroughly with remainder of water until mixture is uniform in color and consistency. Avoid excess mixing to prevent hasty solution of cement resulting in accelerated set. Discard plaster which has begun to set before it is used; re-tempering is not allowed. Do not use any caked or lumpy materials. Completely empty mixer and mixing boxes after each batch is mixed and keep free of old plaster.

## PART 3 - EXECUTION

### 3.1 PREPARATION OF SURFACES

- A. Clean base surfaces of projections, dust, loose particles, grease, bond breakers, and foreign matter; make sufficiently rough to provide a strong mechanical bond. Do not apply plaster directly to the surfaces of masonry or concrete that is coated with any membrane-forming curing compound or similar agent until compound or agent is completely removed by sandblasting. Thoroughly wash entire surface with 6,000-psi high-pressure water immediately prior to plastering. Wet cementitious base surfaces with a fine fog water spray to produce a uniformly moist condition and check screeds, pool equipment, and accessories for correct alignment before plastering is started. Do not apply plaster to base surfaces containing frost. Install temporary coverings as required to protect adjoining surfaces from staining or damage by plastering operations.

### 3.2 APPLICATION OF PLASTER

- A. General: Apply finish plaster to minimum ½-inch thickness at any location. Apply finish plaster by hand or machine. If plastering machine is used, control fluidity of plaster to have a slump not exceeding 2-1/2 inches when tested using a 2" by 4" by 6" high slump cone. Do not add additional water to the mix subsequent to determining water content to meet this slump. Perform slump test according to following procedure:
  1. Place cone on level, dry, non-absorptive base plate.
  2. While holding cone firmly against base plate, fill cone with plaster taken directly from hose or nozzle of plastering machine, tamping with a metal rod during filling to release all air bubbles.
  3. Screed off plaster level with top of cone. Remove cone by lifting it straight up with a slow and smooth motion.
  4. Place cone in a vertical position adjacent to freed plaster sample using care not to disturb base plate.
  5. Lay straightedge across top of cone being careful not to vibrate cone; measure slump in inches from bottom edge of straightedge to the top of slumped plaster sample.

- B. Workmanship: Apply finish plaster in two coats by "double-back" method with second coat applied as soon as first coat is tamped and initially floated. Apply plaster with sufficient pressure to provide a good bond on bases. Work plaster to screeds at intervals of from 5 feet to 8 feet, or closer as required on curved surfaces. Finish plaster to tolerance of -0 to +1/8 inch in thickness on curved surfaces and to 1/8 inch in 8 feet on straight surfaces. Apply smooth trowel finish without waves, cracks, trowel marks, ridges, pits, crazing, discoloration, projections, or other imperfections. Form plaster carefully around curves and angles, well up to screeds. Take special care to prevent sagging and consequent drooping of applications. Produce surfaces free of visible junction marks in finish coat where one day's work adjoins another.
- C. Curing: Cure plaster with fine fog water spray applied to finish coat as frequently as required to prevent dry-out of plaster. Keep plaster damp until pool is filled. Prevent damage or staining of plaster.
- D. Patching, Pointing, and Cleaning Up: Upon completion, cut out and patch loose, cracked, damaged, or defective plaster; patches matching existing plaster in texture, color, and finish, flush with adjoining plaster. Perform pointing and patching of surfaces and plasterwork abutting or adjoining any other finish work in a neat and workmanlike manner. If 10 per cent or more of the pools plaster finish is found to be defective, the plaster shall be removed and replaced completely for the entire pool. Remove plaster droppings, voids, holes or spattering from all surfaces. Leave plaster surfaces in clean, unblemished condition ready for pool filling. Remove protective coverings from adjoining surfaces. Remove rubbish and debris from the site.

### 3.3 START-UP SPECIFICATIONS

- A. Contractor shall employ a qualified water testing agency to analyze the domestic water with which the pool will be filled within 2 weeks of the plaster date, and shall employ a swimming pool experienced, water chemistry consultant to determine types and quantities of chemicals required to ensure calcium-balanced water immediately upon the completion of water filling.
  - 1. Have on hand quantities of the chemicals as determined above, plus 25% overage for follow-up treatment. These chemicals, typically including calcium chloride, bicarbonate of soda, and muriatic acid, are in addition to standard chlorine/chlorine products and alkalizer/pH control products required elsewhere.
- B. Care shall be taken in filling the pool to assure that the water source is clean and potable and free of contaminants that could stain the fresh plaster. Flush all water lines that have not been in continuous operation before filling the pool.
- C. The pool shall not be plastered until the filtration system and chlorination system are complete and ready for start-up. Contractor shall notify the Owner in writing of start-up at least two weeks prior to the plaster date. The Owner is responsible for supplying chlorine/chlorine products and alkalizer/pH control products for maintenance of the pool by the automatic treatment systems. Should these automatic treatment systems fail or if the Contractor fails to notify the Owner as required, the Contractor shall supply all chemicals required for manual treatment of the pool water.
- D. Contractor shall maintain swimming pool for a minimum 14 consecutive days in conjunction with the mechanical system operational test. This maintenance period shall be extended with the mechanical system operational test if required per specifications. During this time, brush the entire pool plaster surface daily starting immediately after filling pool for a minimum of 5 days to remove plaster dust, periodically clean grates until no further accumulation of foreign material occurs, and add chemicals as required for acceptable water quality. The pool shall be vacuumed to maintain a clean and new condition throughout the minimum 14 day period starting no sooner than 5 days after the date of plaster. In no instance shall the pool maintenance and cleaning responsibilities cease prior to gainful occupancy of the entire facility by the Owner. After successful conclusion of the mechanical system operational testing, clean grates, vacuum pool, and leave the pool ready for use.

END OF SECTION 131140