

Construction Standard Specification
Section 03351
Exposed Aggregate Concrete

Part 1 – GENERAL

1.01 Summary

- A. Section includes: **Exposed Aggregate Concrete** produced through the use of a chemical surface retarder to expose the aggregate of a gap graded concrete mix
- B. Related Sections: Refer to the following sections for related work

Section 02200: “Earthwork”

Section 03300: “Cast-In-Place Concrete”

Section 05500: “Metal Fabrications”

Section: 07900: “Joint Sealants”

1.02 References

- A. American Concrete Institute (ACI)
- B. American Society for Testing and Materials (ASTM)
 - C 31 Practices for Making and Curing Concrete Test Specimens in the Field
 - C 33 Specification for Concrete Aggregates
 - C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - C 42 Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 - C 94 Specification for Ready-Mixed Concrete
 - C 143 Test Method for Slump of Hydraulic Cement Concrete
 - C 150 Specification for Portland Cement
 - C 172 Practice for Sampling Freshly Mixed Concrete
 - C 231 Test Method for Sampling Air Content of Freshly Mixed Concrete by Pressure Method
 - C 260 Specification for Air-Entraining Admixtures for Concrete
 - C 494 Specification for Chemical Admixtures for Concrete
 - D 994 Specification for Preformed Expansion Joint Filler for Concrete

1.03 Submittals

- A. General: Submit the following items in accordance with the Conditions of Contract and Section 01330, “Submittal Procedures”.
- B. Product Data: Submit product data for the following materials and items.
- C. Reinforcement

- D. Forming Accessories
- E. Admixtures
- F. Chemical Surface Retarders
- G. Patching Compounds
- H. Sealants
- I. Shop Drawings” Submit detailed drawings for fabrication, bending and placement of concrete reinforcement.
- J. Show bar schedules, stirrup spacing, diagrams of bent bars and arrangement of reinforcement including bar overlap.
- K. Include special reinforcement required for openings through concrete slabs or structures.
- L. Laboratory Test Reports: Submit concrete test materials test reports and mix design reports certifying that each material or item complies with or exceeds the specified requirements.

1.04 Quality Assurance

- A. Codes and Standards: Comply with provisions of the following, except as otherwise indicated:
 - 1. ACI 301 “ Specifications for Structural Concrete for Buildings “
 - 2. ACI 304 “ Guide for Measuring, Mixing, Transporting and Placing Concrete “
 - 3. ACI 305 “ Hot Weather Concreting “
 - 4. ACI 306 “ Cold Weather Concreting “
 - 5. ACI 308 “ Standard Practice for Curing Concrete “
 - 6. ACI 309 “ Standard Practice for Consolidation of Concrete “
 - 7. ACI 318 “ Building Code Requirements for Reinforced Concrete “
 - 8. ACI 347 “ Recommended Practice for Concrete Formwork “
 - 9. CRSI “ Manual of Standard Practice “
 - 10. SP-66 “ ACI Detailing Manual “
- B. Mock-up Panels: Prepare one mock-up panel at the project site to demonstrate proficiency of the contractor as well as determine the best procedures and degree of aggregate exposure. Mock-up panels shall be a minimum of 6’ x 10’. Contractor shall use the methods and materials proposed for use on the final installation. Uniformity in appearance of each panel shall be the responsibility of the contractor. The approved mock-up panel shall serve as a standard of appearance for the final work to be produced.
- C. Quality Control Testing During Construction: Contractor will engage independent concrete testing service for quality control during concrete construction operations.
 - 1. Notify owner’s representative at least two (2) working days in advance of field operations requiring concrete testing, or of resumption of operations after stoppages.
 - 2. Coordinate concreting operations with testing service to facilitate quality control testing.
 - 3. Sample and test concrete during placement as follows:
 - a. Sampling Fresh Concrete: ASTM C172: except modified for slump to conform with ASTM C94
 - b. Slump: ASTM C143; test one for each concrete load at point of discharge and one for each set of compressive strength test specimens.
 - c. Air Content ASTM C231: pressure method: one for each set of compressive specimens.
 - d. Compressive Strength Tests: ASTM C39; one (1) set for each 150 cubic yards (115 cubic meters) or fractions thereof, of concrete class placed in any one day or for each 5,000 sq. ft. (465 sq. meters) of surface area placed; two (2) specimens tested seven

(7) days, three (3) specimens tested twenty eight (28) days and one (1) specimen retained in reserve for later testing if required.

- D. SCAQMD VOC Compliance: Contractor to submit documentation that flatwork finish retarders comply with SCAQMD Rule 1113 for VOC compliance in the “Flats” category, not to exceed 50 g/l. or comply with the low solids exception of less than 80 g/l

Part 2 – PRODUCTS

2.01 Form Materials

- A. Unless otherwise indicated, construct formwork with plywood metal, metal-framed plywood or other acceptable materials to provide continuous, straight, smooth exposed surfaces.
1. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bowing or deflection.
 2. Provide forms that comply with US Product Standard PS 1 when applicable
 - a. B-B High Density Overlaid Concrete Form, Class I
 - b. B-B (Concrete Form) Plywood Class I, Exterior Grade or better, edge sealed, with each piece bearing legible inspection trademark.
 3. Form Coatings: Provide commercially formulated form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 4. Form Ties: where applicable Provide factory-fabricated, adjustable length, removable or snap off metal form ties, designed to prevent deflection and to prevent spalling concrete surfaces upon removal.

2.02 Reinforcing Materials

- A. Cold-drawn steel wire. ASTM A82
- B. Welded wire fabric: ASTM A185, welded steel wire fabric, furnish in flat sheets, not rolls unless approved by the owners representative.
- C. Reinforcing Bars: ASTM A615, deformed.
1. Provide Grade 40 bars as required in details.
 2. Provide Grade 60 Bars No.3-18, except as otherwise noted.
- D. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place.
1. Use wire type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, stone, broken block or pieces of concrete.
 2. For concrete-on-grade, use supports with sand plates or horizontal runners if base material will not adequately support chair legs.
 3. For exposed – to – view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs, which are protected

with plastic, stainless steel protected, or special stainless complying with CRSI Classes, C, D, or E, respectively.

- E. Shop fabricate the reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with ACI 315. In case of fabricating errors do not re-bend or straighten reinforcement in manner that will injure or weaken material.

2.03 Concrete Materials

- A. Portland Cement: ASTM C150 Types I-II and III, “Low-Alkali” cement unless otherwise specified. Use one brand of cement throughout the project unless otherwise approved by the owner’s representative.
- B. Aggregates: Shall be gap- graded conforming to C 33, size to be approved by the owner’s representative dependant upon the type, color and etch of exposure desired.
- C. Water: Potable, clean, fresh, free from oils, acids, organic matter or other deleterious substances.
- D. Admixtures: All admixtures shall be specified in the mix design.
 - 1. Air-Entraining Admixtures: ASTM C 260
 - 2. Water-Reducing Admixture: ASTM C 494, Type A.
 - 3. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
 - 4. Chloride-containing Admixtures are not permitted.

2.04 Related Materials

- A. Expansion Joint Materials
 - 1. Typical Building: ASTM D 994, preformed strips of a bituminous mastic compositions
 - 2. Slabs – in Ground and Sidewalks: ASTM D 1751, preformed expansion joint filler having relatively little extrusion and substantial recovery after release from compression.
- B. Liquid Membrane – Forming Curing Compound: ASTM C 309, Type I or I-D, Class A.

2.05 Concrete Mix Design

- A. Exposed Coarse Aggregate Finishes: Use “ Ready Mixed “ concrete unless otherwise approved or specified; in accordance with ASTM C 94. Exposed Coarse Aggregate Concrete should meet or exceed the following criteria.
 - 1. Compressive Strength: Minimum 3,000 psi strength at 28 days
 - 2. Concrete shall be gap-graded with weathered rounded coarse aggregate consisting of 62% – 65% minimum content.
 - 3. Water/Cement Ratio: Not greater than .55 by weight.
 - 4. Slump: Not greater than 4 inches.
 - 5. Air Content: Between 4 ½% - 7 ½%
- B. Exposed Sand Finishes: Use “ Ready Mixed “ concrete unless otherwise approved or specified; in accordance with ASTM C 94. Exposed Sand Finishes should meet or exceed the following criteria.
 - 1. Compressive Strength: Minimum 3,000 psi strength at 28 days
 - 2. Concrete shall be gap-graded with weathered rounded coarse aggregate consisting of not more than 45% - 50% maximum content.
 - 3. Water/Cement Ratio: Not greater than .55 by weight.
 - 4. Slump: Not greater than 4 inches.
 - 5. Air Content: Between 4 ½% - 7 ½%

C. Admixtures

1. Use water-reducing admixtures in all concrete.
2. Use air-entraining admixture in all exterior exposed concrete.

2.06 Plant, Equipment, Machines and Tools

- A. General: Plant, equipment, machines and tools used in the workplace shall be subject to approval and shall be maintained in a satisfactory working condition at all times.
1. Provide equipment with capability of producing the required product, meeting or exceeding grade controls, thickness control and smoothness requirements as specified.
 2. Use of equipment shall be discontinued if it produces unsatisfactory results.
 3. Owner's representatives shall have access to the plant and all equipment to ensure proper operation and compliance with the specifications at all times during construction.

2.07 Concrete Surface Retarders/Finishing Aids

- A. Spray Applied, film forming top surface retarder, calibrated for specific sized aggregates and finish requirements without the use of a plastic covering. Color-coded to allow for ease of application and verification of grade being used as well as even and complete coverage.

Acceptable Materials: **Optimus Surface Retarders**

- B. Spray Applied, film forming protective coating for adjacent masonry and concrete surfaces.

Acceptable Materials: **Tem-Protect**

- C. Spray applied protective weather-proofing and temporary water retention agent for Optimus Surface Retarders during inclement or extremely hot weather.

Acceptable Materials: **Rain-Shield**

All products distributed by Architectural Concrete Chemicals, 223 West Hampton Ave., Capital Heights, MD 20743, (800) 638-2672, (301)-336 – 6598, www.acchemicals.com (Contact: Dennis Baugh V.P Sales & Marketing)

West Coast Manufacturer's Representative:

Mike Davis
Innovative Concrete Products & Marketing, Inc.
806 E. Pico Ave., Suite I-253
San Clemente, CA 92672
949-498-7077
949-498-7027 Fax
mike@icpmi.com

PART 3 EXECUTION

3.01 Form Setting

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure.
- B. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position.
- C. Design formwork to be readily removable without impact, shock or damage to cast - place – concrete surface and adjacent materials.
- D. Provisions for other trades: Provide openings in concrete formwork and slabs to accommodate other trades.
- E. Tolerances: set forms with the upper edge true to line and grade with an allowable tolerance of 1/4" (6mm) in any 10 foot (3 m) long section.

3.02 Placing Reinforcement

- A. Comply with CRSI's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports.
- B. Clean reinforcement of all loose rust and mill scale, earth, ice, oil, concrete splatter from previous pours and other materials, which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.
- D. Install welded wire fabric of same gage in as long of lengths as is practical. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps of adjacent widths to prevent continuous laps in either direction.

3.03 Preparations for Placing Concrete

- A. Remove water from excavations. Before placement, remove wood chips, shavings, and hardened concrete etc. from forms.
 - 1. Clean all equipment.
 - 2. Wet forms, except in freezing weather, or oil properly with approved release.
- B. Earth shall be uniformly moist when concrete is placed. Sprinkling method shall not be such as to form mud or pools of water. Watering sub-grade immediately prior to concrete placement is not sufficient to make the soil uniformly moist.
- C. Notify other trades to permit installation of their work. Coordinate installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

3.04 Placing Concrete

- A. Notify owner's representative 24 hours in advance prior to placement.
- B. Filed Inspection: Do not place concrete until forms and reinforcing steel have been inspected and approved.
 - 1. Place Ready-Mix concrete within specified time after batching.
 - a. Below 40 degrees F (4 degrees C) See Cold Weather Placing

- b. 40 – 85 degrees F (4-29 degrees C) 90 minutes
- c. 86 – 90 degrees F (30-32 degrees C) 75 minutes
- d. Above 90 degrees F (32 degrees C) 60 minutes

* Concrete exceeding delivery times may be rejected by the owner's representative

- 2. Adding Water: Do not add water after initial introduction of mixing water for batch except when slump of concrete is less than specified upon jobsite arrival and the maximum water/cement ratio has not been exceeded.
 - a. Notify owner's representative prior to adding any additional water.
 - b. Add only water enough to bring concrete slump within the specified limits. Turn drum at least 30 additional revolutions at maximum mixing speed. Do not add water to batch at any later time.
 - c. Insure that concrete strength meets or exceeds specified requirements, and water does not exceed maximum amount specified in the approved CONCRETE MIX DESIGN.

C. General: Comply with ACI 304, as specified herein.

- 1. Place concrete continuously or in layers of such thickness that the concrete will not be placed on a preceding layer which has hardened sufficiently to cause formation of seams or planes of weakness.
- 2. If section cannot be placed continuously, provide construction joints. Deposit concrete as nearly as practicable to its final location to avoid segregation.

D. Placing Concrete in Forms:

- 1. Consolidate placed concrete by high frequency mechanical vibrating equipment, supplemented as necessary by hand spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations not further visible effectiveness of the machines being used. Generally 16-20" apart.
 - c. At each insertion, limit duration of vibration time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in continuous operation, within the limits of construction joints, until placement of panel or section is completed. Maintain reinforcing in proper position during concrete placement operations

F. Placing Concrete Sidewalks: Place concrete in forms in one (1) layer of such thickness that when consolidated and finished, sidewalks will be of thickness indicated.

G. Cold Weather Placing: Protect concrete work from physical damage or reduced strength caused by frost, freezing actions, or low temperatures, comply with ACI 306.

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

3.05 Concrete Finishing

- A. Exposed Coarse Aggregate Finishes: Do not use tools that may force the aggregate away from the surface creating a non- uniform surface after exposure.
 - 1. Protect all curbs, borders and adjacent concrete and masonry surfaces, pavers, stones etc. that are not to receive retarder finish prior to concrete placement and retarder application using **Tem-Protect**
 - 2. Place concrete in the manner prescribed previously. Screed or strike off the surface in two (2) directions using a wooden or metal straight edge to achieve the proper elevation in a sawing motion back and forth.
 - 3. Allow the bleed water to evaporate the surface. It can than be floated using a wooden hand float or a bull-float preferably wooden to close the surface and surround the coarse aggregate with cement paste. **DO NOT OVERWORK THE SURFACE, AS THIS TENDS TO DRIVE THE AGGREGATE DOWN AWAY FROM THE SURFACE TO BE EXPOSED.** Float to a uniform appearance.
- B. Exposed Micro Sand Finishes: The use of a rolling tamper, jitterbug or rolling jitterbug shall be considered when producing exposed sand concrete surfaces. This will enable the finisher to create a denser surface paste with no obstruction due to the appearance of coarse aggregate, allowing for a uniform sand texture.
 - 1. Protect all curbs, borders and adjacent concrete and masonry surfaces, pavers, stones etc. that are not to receive retarder finish prior to concrete placement and retarder application using **Tem-Protect**
 - 2. Place concrete in the manner prescribed previously. Screed or strike off the surface in two (2) directions using a wooden or metal straight edge to achieve the proper elevation in a sawing motion back and forth.
 - 3. Allow the bleed water to evaporate the surface. It can than be floated using a wooden hand float or a bull-float preferably wooden to close the surface and surround the coarse aggregate with cement paste. Float to a uniform appearance. Follow float operations with hand trowels or Fresno steel trowels to create tight dense smooth surface. (This may require two or three passes depending upon mix design and or desired finish to be achieved)

NOTE: Do not burnish the surface or allow the exposed sand surface to prematurely dry prior to the application of Optimus Surface Retarder.

- C. Concrete Surface Retarders

Spray-applied, film forming top surface retarder, calibrated for specific sized aggregates and specific finish requirements without the use of a plastic covering. Color-coded to allow for ease of application and verification of grade being used as well as even and complete coverage.

1. Soon after the final seat finish has been completed spray **Optimus Surface Retarder** using a low-pressure sprayer with a 0.5gpm tip at a rate of 200-300 sq./ft. per gallon in a full hiding coat.
 - a. Once dry **Optimus Surface Retarder** will yield a coating that provides intermittent rain protection. Once completely dry it can sprayed with **Rain-Shield** to protect the surface if heavy extended rains are predicted or during extremely hot weather to retain moisture and protect the etch retention.

Retarder Selection Guide

Grade Selection / Aggregate Size to Expose / Color

- (01) Micro Finish* – Super-Lite / Finest Sands / Tan**
- (03) Micro Finish – Xtra-Lite / Medium Sand Texture / White**
- (05) Micro Finish- Sand / Coarse Sand Texture / Lt. Blue**
- (15) Sand Blast - Lite / 1/8" to 1/4" Agg. / Green**
- (25) Sand Blast –Med. / 1/4" to 3/8" Agg. / Orange**
- (50) Sand Blast - Deep / 3/8" to 1/2" Agg. / Blue**
- (75) Exposed – Sm Agg. / 3/8" Graded Agg. / Yellow**
- (125) Exposed – Med. Agg. / 1/2" Graded Agg. / Lt. Green**
- (175) Exposed – Lg. Agg./ 5/8" Agg. / Pink**
- (250) Exposed – XL Agg. / 3/4" + Agg. / Gray**

2. Wash surface with water rinse using stiff brooms and water hose or by high pressure washing with power equipment as early as 4- 6 hours in very hot weather or the following day up to 24 hours. Retarder removal intervals are dependent upon strength of the concrete mix, aggregate size and desired washing techniques. Earlier washing on the light etches may be necessary. Verify in accordance with the mock-up approval detailed herein.
3. ***Super-Lite grade should be washed in less than 12 hours for best results**
4. Rinse water and cement matrix removal shall be in accordance with local codes and should not be allowed to be washed or flow down to arroyos, storm sewers, ponds, streams or sanitary sewers by precipitation or other surface flows.
5. Prior to completion of the project, remove wash water residue from the site to location approved by the local district.

3.07 Concrete Surface Repairs

- A. Patching Defective Areas: Immediately cut out honeycomb, rock pockets and voids over ¼ inch (6mm) in any dimension as well as holes left by tie rods, bolts etc. down to solid concrete but, in no case to a depth less than 1 inch (25mm).
 1. Cut edges perpendicular to concrete surface.
 2. Thoroughly clean, dampen with water, and brush coat area to be patched with neat cement grout or proprietary bonding agent before placing cement mortar or proprietary patching compound.

- B. Remove and replace concrete with defective surfaces if defects cannot be repaired to the satisfaction of the owner's representative.
 - 1. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface as well as stains and other discolorations that cannot be removed by cleaning.
 - a. Dampen concrete surfaces in contact with patching concrete and brush with neat cement grout or apply concrete bonding agent.
 - b. Mix Patching concrete of same materials to provide concrete of same type of class as original concrete.
 - c. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

END OF SECTION