

Standard Specification for Cast-In-Place Architectural Concrete (ACI 303.1-97)

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This Standard Specification states requirements for cast-in-place architectural concrete. It includes requirements for the materials, forming, concrete placement, curing, additional treatment, and inspection. The requirements are for vertical (walls) and horizontal (flatwork) architectural concrete separate from the requirements for structural concrete.

Keywords: abrasive blasting; architectural concrete; as-cast finish, bush-hammering; cements; colored concrete; colors (materials); concrete construction; concrete finishes; consolidation; curing; exposed aggregate; placing; repairs; rustications; sealants; sealers; specifications; surface retarders; texture.

FOREWORD

F1. This foreword is included for explanatory purposes only; it does not form a part of the Standard Specification ACI 303.1.

F2. Standard Specification ACI 303.1 is a Reference Standard that the Architect/Engineer may cite in the Project Specifications for project, together with supplementary requirements for the specific project.

F3. Each technical section of Standard Specification ACI 303.1 is written in the three-part Section Format of the Construction Specifications Institute, as adapted by ACI, modified to ACI requirements, and organized by types of architectural concrete. The language is generally imperative and terse.

F4. Checklists do not form a part of Standard Specification ACI 303.1. Checklists are to assist the Architect/Engineer in properly choosing and specifying Project Specifications.

PREFACE TO SPECIFICATION CHECKLIST

P1. Standard Specification ACI 303.1 is intended to be used by reference or incorporation in its entirety in the Project Specifications. Individual sections, articles, or paragraphs shall not be copied into the Project Specifications, since taking them out of context may change their meaning. SI equivalents are provided for information only and are not part of this specification.

P2. If sections or parts of Standard Specification ACI 303.1 are edited into project specifications or any other document, they shall not be referred to as ACI standards, since the Standard Specification has been altered.

P3. Building codes set minimum requirements necessary to protect the public. This Standard Specification may stipulate requirements more restrictive than the minimum. Adjustments to the needs of a particular project shall be made by the Architect/Engineer by reviewing each of the items in the Specification Checklist and then including the Architect/Engineer's decision on each item as a mandatory requirement in the Project Specifications.

P4. These mandatory requirements designate the specific qualities, procedures, materials, and performance criteria for which the alternates are permitted or for which provisions

ACI 303.1-97 became effective September 1, 1997.
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were not made in the Standard Specification. Exceptions to the Standard Specification shall be made in the Project Specification, if required.

P5. The following statement will serve to make Standard Specification ACI 303.1 a part of Project Specifications:

Work on _____(Project Title)_____ shall conform to requirements of ACI Standard Specification for Cast-In-Place Architectural Concrete, ACI 303.1, published

by the American Concrete Institute, Farmington Hills, Michigan, except as modified by the requirements of these Contract Documents.

P6. The Standard Specification Checklist identifies Architect/Engineer choices and alternatives. The checklist identifies the sections, parts, and articles of the Standard Specification and the action required by the Architect/Engineer.

SPECIFICATION CHECKLISTS

Section/Part/Article	Notes to the Architect/Engineer
M. MANDATORY REQUIREMENTS	
Section 1—General	Designate whether U.S. Customary or SI units in preface.
1.6—Quality assurance	
1.6.1—Quality control plan	Specify content and when to submit.
Section 2—Concrete for cast-in-place architectural concrete	
2.2.1—Cementitious materials	Specify type of cement required for the environment.
O. OPTIONAL REQUIREMENTS	
Section 1—General	
1.4—Reference standards	Revise standards if project outside of U.S.
1.5—Submittals	Specify size, quantity and scheduling of product submittals.
1.6—Quality assurance	
1.6.2—Field mockup	Specify details for field mockup. Allow structure wall as option, if desired.
1.6.3—Qualifications and responsibility	
1.6.3.1—Responsibility of contractor	Modify responsibility requirements for contract.
1.6.3.2—QC inspector	Specify extent of authority of inspector and experience.
1.6.5—Periodic acceptance	Delete, if not required.
Section 2—Concrete for cast-in-place architectural concrete	
2.1—General	
2.1.2—Tolerances	Specify tolerances different from ACI 117.
2.2—Products	Specify any additional requirements to ACI 301.
2.2.1—Cementitious materials	Specify source of cement, if required for color.
2.2.4.6—Admixtures for flowing concrete	Specify conditions for use.
2.2.4.7—Mineral admixtures	Prohibit if necessary to ensure uniformity of color.
2.2.4.8—Coloring agents	Designate coloring agent which matches Design Reference Standard.

SPECIFICATION CHECKLISTS

Section/Part/Article	Notes to the Architect/Engineer
2.2.5—Concrete	Specify slump, strength and durability requirements beyond ACI 301.
2.2.6—Concrete curing compounds	Specify additional requirements beyond ASTM C 309.
2.3—Execution	
2.3.4—Repairs	Specify whether tie holes are to be filled flush, partially filled or left as cast.
Section 3—Reinforcement, tie wire and bar supports	
3.2—Products	Specify choice of reinforcement, tie wire and class of bar supports. Include pertinent portions from current CRSI, MSP-1, Manual of Standard Practice.
Section 4 — Formwork for architectural concrete	
4.2—Products	
4.2.1—Formwork	As there are many types of forms, designate type used on Design Reference Standard and allow equivalent if matching. Include applicable sections from APA Y510, Plywood Design Specification.
4.2.3—Form ties	Specify cone diameter or type of form tie material, if required.
4.2.4—Rustication form strips	Specify type and size.
4.3.3—Form surface preparation	Specify required tape for sealing form joints and around ties using applicable portions of AAMA, 810.185 Specification.
4.3.4—Form stripping	Modify minimum time, if required.
Section 5—Architectural treatments	
5.2—Products	
5.2.1—Aggregate	Specify source of aggregate to be exposed, if required.
5.2.5—Acid	Designate type of acid, if required.
5.3—Execution	Specify method of aggregate exposure.
5.3.1—Aggregate exposed by abrasive blast	Specify amount of reveal.
5.3.2—Aggregate exposed by removing retarded paste on vertical surfaces	Specify amount of reveal.
5.3.3—Aggregate exposed by removing retarded paste on horizontal surfaces	Specify amount of reveal.
5.3.6—Water blast	Specify amount of reveal.

S. SUBMITTALS CHECKLIST

Section 1—General	
1.5—Submittals	Delete submittals which are not required. Specify schedule, size and method of submitting samples.
1.6.5—Periodic review	Specify different interval for periodic review of architectural concrete, if desired.

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SECTION 1—GENERAL

1.1 —Scope

1.1.1—This Standard Specification covers requirements for the materials and production of cast-in-place architectural concrete having as cast or treated surfaces which are listed in the specifications and located on the plans.

1.1.2 The provisions of this Standard Specification shall govern unless otherwise specified in the Contract Documents.

1.2—Definitions

The following definitions have been used in writing the provisions of this specification.

Accepted—Accepted by or acceptable to the Architect/Engineer.

Architect/Engineer—The architect, engineer, architectural firm, engineering firm, or architectural and engineering firm issuing Project Drawings and Specifications, or administering the work under the Contract Documents.

As-cast architectural concrete—Architectural concrete that requires no further surface treatment after stripping of the forms, except for possible repairs.

Coloring admixture/agent—A blended mixture of color oxides, water-reducing agent and a plasticizer.

Contractor—The person, firm, or corporation with whom the Owner enters in an agreement for construction of the Work.

Contract documents—Documents including Project Drawings, Specifications, Addendums, Bulletins and Change Orders covering the required Work.

Day—24 consecutive hours.

Design Reference Standard—Sample prepared under the Architect/Engineer's direction to be used by reference for bidding purposes and construction of the Field Mockup; having a minimum size of 18 × 18 in. (460 × 460 mm) by 2 in. (50 mm) thick, exhibiting the acceptable surfaces, color and texture; and listing the sources and proportions of materials used.

Excessive contrast—Degree of architectural concrete construction blemish determined unacceptable by comparison to the field mockup and remedial work or repair is required.

Field Mockup—A sample, which may be specified as to size, constructed in the field by the Contractor incorporating the forming, materials, and procedures proposed for the architectural concrete, which is to be used for comparison during periodic and final acceptance. Upon approval of the Architect/Engineer, this sample may be a portion of a wall not scheduled for architectural treatment, such as a basement wall, which can be preserved for viewing until the final acceptance of the architectural concrete.

Kerf—A saw cut placed on the backside of a wood rustication strip to allow for expansion due to possible water absorption.

Layout drawings—Drawings showing forming details for construction of formwork in the field.

Overlaid plywood—A plywood coated with a factory applied paper overlay that is impregnated with phenolic resins. MDO is a Medium Density Overlay containing 35–45 percent phenolic resin by weight of the overlay. HDO is a High Density Overlay containing 45–65 percent phenolic resin by weight of the overlay. Finnish birch has an overlay which contains a minimum of 65 percent phenolic resin overlay by weight of the overlay.

Owner—The corporation, association, partnership, individual, or public body or authority with whom the Contractor enters into an agreement and for whom the Work is provided.

Project drawings—The drawings that, along with the Project Specifications, complete the descriptive information for constructing the Work required or referred to in the Contract Documents.

Project specifications—The written documents that specify requirements for a project in accordance with the service parameters and other specific criteria established by the Owner.

Reference standards—Standards of a technical society, organization, or association, including the codes of local or state authorities.

Required—Required by this Specification or the Contract Documents.

Reveal—Projection of the aggregate from the mortar after completion of exposure operations. Amount of reveal is specified as brush—sufficient to dull surface sheen but not have any reveal, light—a maximum $1/16$ in. (2 mm) reveal, medium—a maximum reveal of $1/4$ in. (6 mm) or heavy—a maximum reveal of $1/3$ of the large aggregate diameter.

Submitted—Submitted to the Architect/Engineer for review.

Zones of influence—Surface area of concrete visibly affected by internal vibration. Size of area will vary with the size and type of internal vibrator used and concrete mixture characteristics and proportions.

Work—The entire construction required or separately identifiable parts thereof that are required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, as required by the Contract Documents.

1.3— Reference organizations

American Concrete Institute (ACI)
P.O. Box 9094
Farmington Hills, MI 48333-9094

American Architectural Manufacturer's Association
(AAMA)
2700 River Road, Suite 118
Des Plaines, IL 60018

American Plywood Association (APA)
P.O. Box 11700
Tacoma, WA 98411

American Society for Testing and Materials (ASTM)
100 Barr Harbor Drive
West Conshohocken, PA 19428

U.S. Department of Commerce
publications available from:
U.S. Government Printing Office
Washington DC 20402

1.4—Reference standards

1.4.1 General—Standards of the organizations referred to in this specification are listed below with their serial designations including year of adoption or revision, and are declared to be a part of this specification as if fully set forth herein.

1.4.2 American Concrete Institute (ACI)

117-90	Specifications for Tolerances for Concrete Construction and Materials
301-96	Specifications for Structural Concrete for Buildings
315-80	(Revised 1986; Reapproved 1991) Details and Detailing of Concrete Reinforcement
306.1-90	Specification for Cold Weather Concreting
318-95	Building Code Requirements for Reinforced Concrete

1.4.3 American Society for Testing and Materials (ASTM)

A 185-94a	Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A 493-92	Specification for Stainless and Heat Resisting Steel for Cold Heading and Cold Forging Bar and Wire
A 497-94a	Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
A 615-94	Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
A 706-93	Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
A 767-90	Specification for Zinc-Coated (Galvanized) Bars for Concrete Reinforcement
A 775-95	Specification for Epoxy-Coated Reinforcement Steel Bars
A 884-94a	Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Concrete Reinforcement
C 33-93	Specification for Concrete Aggregates
C 94-95	Specification for Ready-Mixed Concrete
C 144-93	Specification for Aggregate for Masonry Mortar
C 150-94	Specification for Portland Cement
C 156-93	Specification for Water Retention by Concrete Curing Materials
C 171-95	Specification for Sheet Materials for Curing Concrete
C 260-95	Specification for Air-Entraining Admixtures for Concrete
C 309-95	Specification for Liquid Membrane Forming Compounds for Curing Concrete
C 330-89	Specification for Lightweight Aggregates for Structural Concrete
C 494-92	Specification for Chemical Admixtures
C 595-94a	Specification for Blended Hydraulic Cements
C 618-95	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
C 834-91	Specification for Latex Sealants
C 845-90	Specification for Expansive Hydraulic Cement
C 920-87	Specification for Elastomeric Joint Sealants
C 957-87	Specification for High Solids Content Cold Liquid-Applied Elastomeric Waterproofing Membrane with Integral Wearing Surface
C 979-82(93)	Specification for Pigments for Integrally Colored Concrete
C 989-93	Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortar
C 1017-92	Specification for Chemical Admixtures for Use in Producing Flowing Admixtures

- C1077-95b Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation
- C1157-94a Performance Specification for Blended Hydraulic Cements
- C1193-91 Guide for use of Elastomeric Joint Sealants
- C1240-93 Specification for Silica Fume for Use In Hydraulic-Cement Concrete and Mortar

1.4.4 U.S. Department of Commerce

Federal Specification PS1-83: Construction and Industrial Plywood

1.5—Submittals

1.6.1 Quality control plan—To be submitted by Contractor prior to commencing construction of architectural concrete.

1.6.2 Field Mockup—Upon completion, to be reviewed for acceptance by Architect/Engineer by comparison to Design Reference Standard and prior to ordering forming.

1.6.2.1 Layout drawings for Field Mockup—For review prior to constructing architectural concrete formwork.

1.6.5 Periodic review—For review of architectural concrete completed to date to determine uniformity.

2.2.1 Cement—Sample for information and review of Certificates of Compliance.

2.2.3 Aggregates—Samples for information and review.

2.2.4 Admixtures—Samples for information and review.

2.2.4.8 Coloring admixture—Samples for information and review.

2.2.5 Concrete mix design—For review.

2.2.6 Concrete curing compound—For review.

2.2.7 Sheet materials for concrete curing—For review.

3.2 Reinforcement, tie wire and bar supports—Certificates of compliance.

4.2.1 Formwork—For information.

4.2.2 Form face, form liner and molds—For information.

4.2.3 Form ties—For information.

4.2.5 Form release agents—For information.

4.2.6 Miscellaneous

4.2.6.1 Compressible tape—For information.

4.2.6.2 Form joint caulking—For information.

5.1.4 Safety plan—For record.

5.2.5 Sealers or coatings—Certificates of Compliance.

5.3.6.3 Acid wash and water-blasting waste water disposal plan—For record.

6.2.1 Joint sealants—For review.

1.6—Quality assurance

1.6.1 Quality control plan—Submit quality control plan as outlined in Section 1.5 for acceptance prior to commencing any construction of architectural concrete.

1.6.2 Field Mockup

1.6.2.1 Construct Field Mockups using procedures, equipment, materials, simulated repairs and quality control plan submitted for production of cast-in-place architectural concrete. Begin fabrication of architectural forms for construction of Field Mockup upon acceptance of layout

drawings. Upon acceptance of the completed Field Mock-up, begin fabrication of the architectural concrete forms. Maintain and protect Field Mockups on the jobsite until final acceptance of architectural concrete. Construct field mockup sample to match accepted Design Reference Standard in color and texture.

1.6.2.2 For walls, include vertical, horizontal and rustication joints, demonstrate methods of repair, curing, aggregate exposure, sealers and coating. Construct mockup to include a minimum of two lifts having heights planned for placement of the architectural concrete.

1.6.2.3 For flatwork, construct a 10 × 10 ft (3 m × 3 m) sample for acceptance with the same materials and methods as planned for the production concrete.

1.6.3 Qualifications and responsibilities

1.6.3.1 Responsibility of the Contractor—Contractor shall obtain a project superintendent and forming and concrete subcontractors who are experienced in the construction of architectural concrete.

1.6.3.2 Qualification of QC inspector—The QC inspector shall be trained for inspection of cast-in-place architectural concrete and have a minimum ACI Certification as a Level II Concrete Construction Inspector or equivalent. Equivalent certification programs shall include the policies and procedures conforming to ACI Publication CP-20.

1.6.4 Reports

1.6.4.1 Maintain logs of concrete placements. Record date, location and quantities of concrete placement, air temperature, and location and identification of material and architectural concrete sampling. Maintain file of architectural concrete delivery tickets.

1.6.4.2 Report any proposed changes from procedures and materials used in the original Field Mockup. Submit new sample having the same dimensions and texture as the original Design Reference Sample for review. Upon acceptance construct another Field Mockup with the new materials and procedures for acceptance prior to proceeding further with construction of the architectural concrete. Further construction with the new materials shall be planned so as to minimize contrast with previously placed architectural concrete.

1.6.5 Periodic acceptance—Failure of the completed architectural concrete to receive acceptance during a semi-monthly periodic review requires the submittal of a plan of remedial repair and proposed revisions to methods of construction for acceptance before proceeding with additional architectural concrete construction.

1.6.6 Final acceptance—Protect accepted architectural concrete from damage after completion of the architectural concrete construction until completion of project.

1.7—Delivery, storage, and handling

1.7.1 Deliver materials to jobsite in manufacturer's original containers.

1.7.2 Store materials in a clean dry location. Maintain method of storage and temperature of materials as required by manufacturer.

1.8—Other general requirements

1.8.1 Adhere to local ordinances requiring restrictions on sound, dust and work hours during construction of architectural concrete.

SECTION 2—CONCRETE FOR ARCHITECTURAL CAST-IN-PLACE CONSTRUCTION

2.1—General

2.1.1 Scope—This section specifies requirements for cast-in-place architectural concrete having as-cast surfaces or treated surfaces which are listed in the specifications.

2.1.2 Tolerances—Tolerances shall conform to ACI-117.

2.2—Products

2.2.1 Cement shall conform to ASTM C 150, C 595, C 845, or C 1157.

2.2.1.1 Use only one source, type and brand for the project architectural concrete.

2.2.1.2 Ensure adequate supply of specified special cements for construction of architectural concrete.

2.2.2 Water

2.2.2.1 Concrete mix water shall conform to ASTM C 94.

2.2.2.2 Temperature of water for curing shall be not more than 20 F (10 C) lower than the concrete surface temperature.

2.2.3 Aggregates shall have a satisfactory service record nonstaining and not being disruptively reactive with cement alkalis

2.2.3.1 Coarse aggregate shall meet the requirements of ASTM C 33 or C 330

2.2.3.2 Fine aggregate shall meet the requirements of ASTM C 33, C 330 or C 144.

2.2.4 Admixtures—Calcium chloride, or any admixture containing calcium chloride, shall not be used.

2.2.4.1 Air-entraining agents shall meet ASTM C 260.

2.2.4.2 Water-reducing admixtures shall meet ASTM C 494, Type A

2.2.4.3 Water-reducing and retarding admixtures shall meet ASTM C 494, Type D.

2.2.4.4 High-range water reducers (superplasticizers) shall meet ASTM C 494, Types F or G

2.2.4.5 Accelerating admixtures shall meet ASTM C 494, Types C and E

2.2.4.6 Admixtures for flowing concrete shall meet ASTM C 1017, Type I or II

2.2.4.7 Mineral admixtures fly ash shall meet ASTM C 618, ground granulated blast-furnace slag shall meet ASTM C 989, and silica fume shall meet ASTM C 1240. Mineral admixtures shall be compatible with other admixtures.

2.2.4.8 Coloring admixture/agents shall meet ASTM C 979 and ASTM C 494.

2.2.5 Concrete

2.2.5.1 Slump, strength and durability requirements shall be as shown in the Contract Documents.

2.2.5.2 Concrete shall match color and surface of the Design Reference Standard and the accepted Field Mockup.

2.2.5.3 Concrete shall comply with Section 6 of ACI 301.

2.2.5.4 For colored concrete, prepare trial batches of the final design mix with specified slump at highest and lowest ambient temperatures anticipated during concrete placements. Adjust color amounts to match Design Reference Standard and the accepted Field Mockup.

2.2.6 Concrete curing compound shall conform to ASTM C 309. The cured surface shall match the Design Reference Standard. Solids content shall be between 14–22 percent. For colored concrete use curing compounds recommended by pigment or color admixture manufacturer and accepted by Architect/Engineer.

2.2.7 Sheet materials for concrete curing—Plastic film, wet burlap or burlap-backed plastic film shall not be used for curing colored horizontal architectural concrete.

2.3—Execution

2.3.1 Batching, mixing, and transporting

2.3.1.1 Deliver concrete in initially clean equipment which is exclusively limited to mix and transport the architectural concrete.

2.3.1.2 Deliver concrete of uniform slump and proportions so the resulting concrete shall match the Field Mockup.

2.3.1.3 Deliver colored concrete in full loads.

2.3.2 Conveying and placement

2.3.2.1 Support runs or gangways for the concrete transporters, pump lines, wheel barrows, other similar equipment and foot traffic so as not to disturb reinforcement or interfere with concrete placing operations.

2.3.2.2 Place concrete after forms and reinforcement have been set and accepted by Architect/Engineer.

2.3.2.3 Schedule arrival of concrete to avoid delays in placement.

2.3.2.4 Take precautions to minimize mortar splatter on form faces. Remove accidental mortar splatter from architectural form face.

2.3.2.5 Deposit concrete in the final position without segregation or loss of material. Do not move concrete horizontally.

2.3.2.6 Place concrete in uniform horizontal layers not more than 36 in. (0.9 m) high for consolidation.

2.3.2.7 Place concrete continuously without exceeding rate of placement used in design of forms.

2.3.2.8 Vibrate placed concrete for maximum consolidation of concrete. Overlap the zones of influence a minimum of 50 percent. Withdraw internal vibrators at a rate of 3 in. (75 mm) per second. Keep internal vibrators 2 in. (50 mm) away from the architectural face.

2.3.2.9 Revibrate the top 6 in. (150 mm) layer of a concrete lift during delays of up to a maximum 30 minutes as long as the vibrator will penetrate of its own weight. After 30 minutes or failure of the vibrator to penetrate of its own weight, stop placement, level lift and set construction joint.

2.3.3 Curing

2.3.3.1 Mist concrete surface with water before applying curing compounds. Apply curing compounds at rate recommended by manufacturer.

2.3.3.2 Maintain complete contact when using cotton mat curing.

2.3.3.3 Curing during cold weather shall comply with ACI 306.1.

2.3.4 Repairs and cleanup

2.3.4.1 Repair defects on as-cast architectural surfaces immediately to conform to that accepted on the Field Mockup.

2.3.4.2 Cure by covering with curing seal or edge-taped waterproof cover or as accepted by trial on Field Mockup.

2.3.4.3 Finish tie holes as accepted on Field Mockup.

SECTION 3—REINFORCEMENT, TIE WIRE AND BAR SUPPORTS

3.1—General

3.1.1 Scope—This section specifies the requirements for all reinforcement and accessories to be used in cast-in-place architectural concrete having an as-cast or treated surface.

3.1.2 Tolerances—Unless otherwise specified, conform to ACI 117.

3.2—Products

3.2.1 Reinforcing bars shall conform to ASTM A 615 or ASTM A 706. Welded wire fabric shall conform to ASTM A 185 or ASTM A 497.

3.2.2 Epoxy coated reinforcement shall conform to ASTM A 775 and epoxy-coated welded wire fabric to ASTM A 884.

3.2.3 Galvanized reinforcement shall conform to ASTM A 767.

3.2.4 Use plastic coated tie wire for epoxy coated reinforcement. Use soft stainless steel complying with ASTM A 493, or plastic coated tie wire, for securing other reinforcement.

3.2.5 Bar supports shall be Class 1, as defined in CRSI MSP-1. Stainless steel for bar supports shall comply with ASTM A 493.

3.3—Execution

3.3.1 Place reinforcement in accordance with ACI 315.

3.3.2 Provide specified concrete cover over reinforcement and coated steel embedments. Concrete cover shall be as specified after removal of rustication strips or face mortar by further treatment such as sandblasting or bush hammering.

3.3.3 Use bar supports in sufficient number, size and location to prevent vertical displacement of the reinforcement and gouging of the forming. Use bar supports or spacers in walls and columns to maintain clear distance between reinforcement and face of concrete.

3.3.4 Bend back and keep tie wires 1¹/₂ in. (40 mm) from form face. Remove tie wire clippings from horizontal surfaces that will be sandblasted, exposed to view, or weather.

3.3.5 Perform welding or similar heat processes on reinforcement or accessories prior to form erection.

SECTION 4—FORMWORK FOR ARCHITECTURAL CONCRETE

4.1—General

4.1.1 Scope—This section specifies the formwork requirements for cast-in-place architectural concrete having an as-cast or treated surface.

4.1.2 Tolerances—Formwork shall be sized to produce concrete conforming to ACI 117.

4.1.3 Design criteria

4.1.3.1 Face sheet deflection shall not exceed 1/400 of its span.

4.1.3.2 Maximum rate of placement assumed for design of formwork shall be shown on the Layout Drawings.

4.1.3.3 Concrete ties and bolts shall be sized to withstand form design pressures.

4.2—Products

4.2.1 Formwork—All formwork shall have a high density, non-vapor transmitting form face.

4.2.1.1 Overlaid plywood shall meet Federal Specification PS1.

4.2.2 Form face, form liner and molds shall produce a concrete surface matching the Design Reference Standard and Field Mockup.

4.2.3 Form ties

4.2.3.1 Provide specified diameter of cones for ties.

4.2.3.2 Washers shall not be used with snap ties for architectural concrete.

4.2.4 Rustications—Metal strips shall be fabricated from same metal as metal form face.

4.2.5 Form release agents—Use only those tested and approved on Field Mockup.

4.2.6 Miscellaneous

4.2.6.1 Compressible tape shall conform to AAMA 810.185

4.2.6.2 Sealant for form caulking shall conform to ASTM C 920, Type a, Grade NS, or C 834.

4.3—Execution

4.3.1 Formwork

4.3.1.1 Provide forms as shown on the accepted layout drawings.

4.3.1.2 Erect forms as shown on the Project Drawings and accepted layout Drawings.

4.3.2 Rustication strips

4.3.2.1 Provide rustication joints and chamfers as shown on the Project Drawings and Layout Drawings.

4.3.2.2 Wood strips shall be kerfed on the back side.

4.3.2.3 Provide minimum concrete cover of 1¹/₂ in. (40 mm) over all reinforcement. Cover shall be measured from bar reinforcement to the most deeply recessed depth of rustication or other recess in the concrete surface.

4.3.2.4 Provide closure backing materials when indented rustication is used over a ribbed form liner. Seal joint between rustication strip and form with non-absorbent caulking.

4.3.2.5 Apply impermeable coating to wood rustications or chamfers.

4.3.3 Form surface preparation

4.3.3.1 Season natural wood grain forms or untreated wood forms with cement or lime slurry consistent with the color to be used for the architectural concrete.

4.3.3.2 Seal form joints and tie holes by taping or with non-absorbent caulking. Clean taper ties and she-bolts and lubricate with a nonstaining grease or form release agent before each use. Keep form face clean until concrete is placed.

4.3.4 Form stripping

4.3.4.1 Strip formwork completely from vertical architectural concrete surfaces when the concrete has achieved a compressive strength of 1000 psi (7 MPa) or 24 hours after placement, whichever is later. Schedule formwork stripping to maintain surface appearance matching accepted Field Mockup.

4.3.4.2 Break off fiberglass ties flush with the surface of the concrete and texture to match the adjacent concrete surface and color.

4.3.5 Cleaning and storage

4.3.5.1 Clean forms after each use and discard damaged forms.

4.3.5.2 Store steel forms horizontally and fully supported.

4.3.5.3 Store plastic coated forms and liners horizontally and under cover.

SECTION 5—ARCHITECTURAL TREATMENTS

5.1—General

5.1.1 Scope—This section specifies the additional requirements for cast-in-place architectural concrete where the resulting concrete face is specially treated after form removal.

5.1.2 Acceptance—Receive acceptance of the appearance of the first day's aggregate exposure operations before proceeding further.

5.1.3 Personnel experience—Use personnel experienced in the specified procedures and trained on the Field Mockup.

5.1.4 Safety plan—Follow submitted safety plan that complies with OSHA requirements.

5.2—Products

5.2.1 Aggregate for exposure shall conform to the Design Reference Standard and the Field Mockup. Ensure adequate supply for architectural concrete.

5.2.2 Forms and form liners—Use high density and non-vapor transmitting materials.

5.2.3 Surface retarders—Use those previously tested and accepted on the Field Mockup.

5.2.4 Abrasive material—Use that previously tested and accepted on the Field Mockup for specified texture. Ensure adequate supply to complete total amount of surface specified.

5.2.5 Acid—Use muriatic or phosphoric acid to expose aggregate in locations specified or shown on the Project Drawings. Match accepted Design Reference Standard and Field Mockup.

5.2.6 Water—for water-blasting shall be free of oil or impurities capable of staining the concrete surface and shall be not more than 20 F [10 C] colder than the concrete surface at the time of aggregate exposure

5.2.7 Sealers or coatings—Use concrete sealers to match accepted Design Reference Standard and Field Mockup surface.

5.3—Execution

5.3.1 Aggregate exposed by abrasive blast

5.3.1.1 Aggregate reveal shall be as shown on the Drawings and as specified.

5.3.1.2 Expose aggregate to match accepted Design Reference Standard and Field Mockup.

5.3.1.3 Begin abrasive blasting to expose aggregate when the concrete has a minimum compressive strength of

2000 psi (14 MPa) and not less than that required for safe removal of the forms and supports. Blast exposed aggregate architectural concrete at the same age for uniform exposure and color.

5.3.1.4 Wash abrasive blasting debris off the finished wall surface before drying occurs when abrasive grits contain free water for dust abatement.

5.3.2 Aggregate exposed by removing retarded surface paste on vertical surfaces

5.3.2.1 Use surface retarder accepted for use and match accepted Design Reference Standard and Field Mockup.

5.3.2.2 Prevent concrete from washing away retarder coating from form during placement

5.3.2.3 After form removal, remove the retarded outer layer of cement paste by hand brushing, high pressure water washing, or light sandblasting. Schedule procedures and adjust timing for weather conditions to achieve uniform aggregate exposure.

5.3.3 Aggregate exposed by removing retarded surface paste on horizontal surfaces

5.3.3.1 Retard unformed horizontal surfaces to match accepted Design Reference Standard and the Field Mockup.

5.3.3.2 Spray retarder on fresh cast horizontal surfaces after concrete consolidation, seeding of architectural aggregate when specified, and final finishing. Apply retarder in two perpendicular passes after bleed water has evaporated from surface.

5.3.3.3 Remove the chemically retarded surface cement paste after the mortar retaining the aggregate has set sufficiently to prevent dislodgment of the aggregate.

5.3.4 Acid etch

5.3.4.1 Use acid etch for exposure of aggregate on horizontal surfaces only.

5.3.4.2 Acid etch treatment shall match accepted Field Mockup and comply with OSHA recommended safety procedures.

5.3.4.3 Defer acid etch until concrete is at least 14 days old and compressive strength exceeds 4500 psi (30 MPa)

5.3.4.4 Wet concrete thoroughly prior to application of acid.

5.3.4.5 Continue to apply acid while actively brushing or spraying until predetermined depth of reveal is obtained.

5.3.4.6 Flush acid and debris from concrete surface immediately after acid action stops by application of water under pressure.

5.3.4.7 Protect adjacent materials, surfaces and finishes from acid and waste wash water during application and cleanup.

5.3.4.8 Dispose of waste wash water in accordance with submitted plan.

5.3.5 Mechanical tooling (bush-hammering)

5.3.5.1 Mechanical tooling shall expose aggregate to match accepted Design Reference Standard and Field Mockup.

5.3.5.2 Defer mechanical tooling until concrete is at least 14 days old and compressive strength exceeds 4500 psi (30 MPa).

5.3.5.3 Multiple bush-hammers used for tooling shall have equal wear on teeth.

5.3.5.4 Maintain control of concrete chips, dust and debris in each work area. Limit migration of airborne materials by use of tarpaulins, wind breaks, and similar devices.

5.3.6 *Water blast*

5.3.6.1 Water blast and expose aggregate to match accepted Design Reference Standard.

5.3.6.2 Defer water blasting of vertical surfaces until compressive strength exceeds 4500 psi (30 MPa).

5.3.6.3 Dispose of water used for blasting in accordance with submitted water blast plan.

5.3.7 *Repair*

5.3.7.1 Repaired areas shall be subject to final acceptance under comparison to Field Mockup repairs.

5.3.7.2 Repair defects as required to match adjacent surface after architectural surface has been treated.

5.3.7.3 Cure repaired areas as specified in Article 2.3.4.2.

5.3.7.4 Finish tie holes to match accepted Field Mockup.

5.3.8 *Finishing and final cleanup*

5.3.8.1 Protect completed architectural cast-in-place concrete surfaces from damage, staining or other contaminants by subsequent construction.

5.3.8.2 Do not allow laitance from subsequent construction or repairs to stain or harden on surfaces that have been finished.

5.3.8.3 Clean concrete surfaces just prior to project submittal for acceptance.

5.3.8.4 Use cleaning materials and processes that do not change color or texture of the completed concrete surfaces.

5.3.8.5 Rinse architectural surface thoroughly with clean water after cleaning.

5.3.8.6 Protect adjacent materials during cleaning operations.

5.3.9 *Final acceptance of architectural concrete*

5.3.9.1 Upon completion of architectural concrete, final acceptance is based upon the matching of the architectural cast-in-place concrete with the accepted Field Mockups when viewed at a distance of 20 ft (6 m) in daylight.

5.3.9.2 Only concrete listed in the specifications or identified on the plans as architectural concrete is to be included in this final acceptance.

5.3.9.3 Defective work, including repair areas not accepted, shall be removed and replaced.

SECTION 6—MISCELLANEOUS

6.1—General—Scope

This section specifies the requirements for joint filling, sealing of the concrete surface and use of coatings.

6.2—Products

6.2.1 Joint sealants in vertical surfaces and horizontal areas not subject to traffic shall conform to ASTM C 920, Use NT; joints subject to traffic shall conform to ASTM C 920, Use T.

6.2.2 *Concrete sealer*—Test compatibility with sealant on Field Mockup and conform to final color of Design Reference Standard.

6.3—Execution

6.3.1 Apply concrete joint sealants prior to any application of concrete sealer.

6.3.2 Apply sealers and sealants in accordance to manufacturer's specifications.

6.3.3 Match accepted Design Reference Standard and Field Mockup.

This standard was submitted to letter ballot of the committee and was approved in accordance with Institute standardization procedures.